Effect of Different Application Rates of Cowdung and Poultry Excreta on Water Quality and Growth of Ornamental Carp, *Cyprinus carpio* vr. *koi*, in Concrete Tanks

Prithwiraj Jha[1], Kripan Sarkar[2], Sudip Barat[1,]*
[1] Aquaculture and Limnology Laboratory, Department of Zoology, University of North Bengal, District Darjeeling, West Bengal 734 430, India
[2] Rainbow Ornamentals, Raninagar, Jalpaiguri, West Bengal 735 101, India

* Corresponding Author: Tel: + 91. 0353 2582124; Fax: + 91. 0353 2581546;
E-mail: sudipbarat@rediffmail.com
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Abstract

Larvae (0.09±0.025 g) of Koi carp (*Cyprinus carpio* vr. *koi*) were cultured in outdoor concrete tanks for 90 days. Individual weight gain and survival rates were compared among a control (C), three treatments manured every 10 days with cowdung, applied at 0.13 kg/m^3 (C1), 0.26 kg/m^3 (C2), and 0.39 kg/m^3 (C3), and three treatments manured every 10 days with poultry excreta, applied at 0.13 kg/m^3 (P1), 0.26 kg/m^3 (P2), and 0.39 kg/m^3 (P3). Weight gain of Koi carp stocked at P2 was significantly higher than other treatments. There was a significant difference in survival of Koi carp among the treatments, ranging from 65.5% to 86% in C and P2, respectively. The C3 and P3 treatments yielded significantly higher values of specific conductivity, NH_4 – N, NO_2 – N, and PO_4 – P, and significantly lower values of dissolved oxygen than the other treatments. Zoobenthos population was low in all the treatments. The results suggest that application rate of 0.26 kg/m^3 every 10 days seems to be the most suitable for Koi carp tanks manured with both cowdung (C2) and poultry excreta (P2), through maintenance of better water quality and greater abundance of plankton in the system. Suitable environment in C2 and P2 resulted in significantly better growth of Koi carp than other treatments.

Key words: Koi carp, *Cyprinus carpio* vr. *koi*, cowdung, poultry excreta, application rate, plankton abundance, zoobenthos

Introduction

In recent decades, the market for ornamental fish has grown steadily. The annual global trade value has been estimated to amount to US $ 9 billion (Swain and Jena, 2002). The culture of Koi carp (*Cyprinus carpio* vr. *koi*) is rapidly growing in India. The term 'Koi' refers to many strains of ornamental carp that have been genetically selected over many generations (Feldlite and Milstein, 1999).

A common approach for increasing fish production in ponds is the direct application of fertilizer, which enhances production of plankton, a natural food item for fish (Chakrabarti and Jana, 1998). Pond fertilization practices using animal wastes are widely used in many countries to sustain productivity at low cost (Gupta and Noble, 2001; Majumder *et al.*, 2002). Among manure used, chicken's is preferred because of its ready solubility and high level of phosphorus concentrations (Knud-Hansen *et al.*, 1991). Soluble organic matter supplied to ponds by using manure stimulates phytoplankton growth (Sevilleja *et al.*, 2001). Moreover it increases biomass of zooplankton and benthic organisms (Atay and Demir, 1998). In India, however, cowdung is the most common organic manure applied to fish ponds (Singh and Sharma, 1999).

Cyprinid larvae are known to prefer natural food items such as free living protozoa and rotifers, and larger planktonic organisms like cladocerans and copepods at fry and fingerling stage (Jhingran and Pullin, 1985). Several pond management techniques have been developed to improve environmental conditions for cyprinid fry (Rothbard and Yaron, 1995). Among the techniques, manure usage at different rates may significantly influence water quality and assist in defining the optimal conditions for continuous culture of plankton. Although a substantial amount of literature is available on the nutrition and culture of common carp (Kalmer *et al.*, 1990; Keshavanath *et al.*, 2002; Manjappa *et al.*, 2002), growth of the 'Koi' ornamental variety of the common carp (*Cyprinus carpio* vr. *koi*) in organically manured culture systems have not been well documented.

The present study was designed to test the effect of cow and chicken manure on the water quality, plankton density, abundance of benthic fauna, and growth of Koi carps in outdoor cemented tanks.

Materials and Methods

The Koi carps used in this study were the hybrid of Kohaku and Showa Koi types, produced in the Hatchery Unit of Rainbow Ornamentals, Raninagar, Jalpaiguri, India. The experiments were conducted in 21 outdoor cemented tanks (capacity 2000 L) in the aforesaid fish farm. A 10 cm layer of loamy soil was placed on the bottom of each tank, which was then filled with 2000 L of groundwater 10 days prior to stocking. This interval after manure application is a prerequisite for establishing satisfactory environmental conditions for optimum zooplankton production in tanks (Jana and Chakrabarti, 1993).

Eight thousand and four hundred Koi carps, 2-3 weeks old (0.09±0.025 g), were equally distributed to each tank (400 fish / tank). The stocking density was 0.2 fish/L, commonly practiced in ornamental fish farms (Fernando and Phang, 1985). To study the effect of different application rates of cow and poultry manure on growth and survival, fish were treated for 90 days (March – May, 2002), with the seven treatments;

(1) Cowdung applied at 0.13 kg/m^3 every 10 days (C1);
(2) Cowdung applied at 0.26 kg/m^3 every 10 days (C2);
(3) Cowdung applied at 0.39 kg/m^3 every 10 days (C3);
(4) Poultry manure applied at 0.13 kg/m^3 every 10 days (P1);
(5) Poultry manure applied at 0.26 kg/m^3 every 10 days (P2);
(6) Poultry manure applied at 0.39 kg/m^3 every 10 days (P3); and
(7) A control treatment in which a commercial pelleted diet was used as feed (C).

Three tanks were randomly assigned for each treatment. The application rates of the manures correspond to 1,300-3,900 kg/ha. The high organic load was used in view of the high manuring rate (initial dose of 10,000 kg/ha and subsequent application of 5,000 kg/ha), recommended for nursery ponds in India (Jhingran, 1991). An amount of 100 L water was replaced in each tank two times a week for aeration, since most farmers in India cannot afford aeration facilities.

The amount of total nitrogen and organic carbon in the cow and poultry manures were estimated according to Micro-Kjeldahl's method (Anderson and Ingram, 1993) and Wet Oxidation method (Walkley and Black, 1934), respectively. The manures were collected from local dairy and poultry farms, and allowed to decompose for 10 days prior to application. No manure was added to the tanks in the control treatment, where a commercial pelleted feed containing 32% crude protein, 4% crude fat, 5% crude fibre, 10% crude ash, 9% moisture, and 31% nitrogen free extract was given in the amount of 5% body weight of stocked fish daily. Dry feeds were not applied to any other treatment, where the fish fed on naturally grown food.

Water samples were collected weekly at 9 A.M. from each tank in 1 L glass sampling bottles and 100 ml Winkler bottles for dissolved oxygen (DO). Collected samples were transported to a laboratory in the University of North Bengal within 2 hrs. Water quality parameters (DO, free CO_2, alkalinity, PO_4-P, NH_4-N, NO_2-N, NO_3-N, and specific conductivity) were estimated according to methods as described by APHA (1998). Temperature was recorded by a mercury thermometer. The pH was measured in situ using a portable pH meter (Hanna Instruments).

Samples of plankton were collected with a plankton net, which was made of standard bolting silk cloth (No. 21 with 77 mesh/cm^2) two times a week. Collected plankton were concentrated to 20 ml, and preserved in 4% formalin. Enumeration of 1 ml of concentrated plankton was performed under the microscope using Sedgwick Rafter counting cell. The sediments were sampled manually. Two samples, each of about 100 cm^2 area, were collected carefully with hand from each tank weekly and washed through a series of sieves ranging 260-360 μ mesh. Benthic fauna were identified and counted with the aid of a stereoscopic microscope (Macan, 1975). During the sampling utmost precaution was taken to avoid turbidity in water and an equal amount of soil was replaced in each tank precisely in the area from where sediments were collected.

The weight of the fish was recorded at the beginning of the experiment, and, every fortnightly during the culture period, five random samples of 20 fish from each tank were captured and excess water removed on paper towel through the net before the fish were individually weighed to the nearest 0.001 g. The selected fish were anaesthetized with tricaine methane sulphonate (MS-222) of 0.04 g/L concentration.

Dead fish were removed daily, they were not replaced during the course of study, and differences between the number of fish stocked and the number of fish at harvest were used to calculate percent mortality in each treatment. Fish were harvested after 90 days and weighed. The Specific Growth Rate (SGR) was calculated as:

$$SGR = 100\,[(\ln W_t - \ln W_0)/t];$$

Where W_0 and W_t are the initial and final live weight of the fish (g), respectively, and (t) is culture period in days (Ricker, 1975).

The statistical analysis were performed using MS Excel and Mstat programmes for Windows. Data from the replicates of each group were pooled for one way analysis of variance (ANOVA), and where a significant difference ($P<0.05$) was detected, a multiple comparison test (Tukey) was applied. The degree of relationship between plankton density and fish growth was determined by regression analysis and Pearson's correlation coefficient (Sunder Rao and Richard, 1999).

Results

The amount of total nitrogen in cow and poultry manures were 2.15% and 2.66%, respectively, whereas, the amount of organic carbon were 21.24% and 30.19%, respectively.

Water temperature was between 25°C and 31°C during the 90 days. The temperature did not vary between the different treatments (P>0.05). The average pH values were about 7.0 in all treatments (Table 1). The DO never dropped below 5.0 mg/L during the period of the study in any treatment except C3 and P3 (Table 1). Significantly higher values of PO_4-P ($F_{6,84}$>20.64; P<0.05) and specific conductivity ($F_{6,84}$>14.99; P<0.05) were obtained in the P3 treatment than in the other treatments. Carbonate alkalinity was observed only in the treatments manured with poultry excreta (P1, P2, and P3), for very limited periods, when free CO_2 in these treatments was absent. The C3 and P3 treatments yielded significantly higher values of bicarbonate alkalinity ($F_{6,84}$>11.68; P<0.05), NH_4 - N ($F_{6,84}$> 23.27; P<0.05), NO_3-N ($F_{6,84}$>21.79; P<0.05) and NO_2-N ($F_{6,84}$>15.61; P<0.05) compared to the C1, P1 and control (C) treatments (Table 1).

Examination of plankton showed that the species diversity differed considerably between the manured treatments and control. Cladocerans, which formed a substantial proportion of the total plankton composition in the manured treatments, were absent from the control treatment. Other zooplankton and phytoplankton were represented in the control with low number compared to the manured treatments (Table 2). Within the manured treatments, the abundance (no./L) of the different species varied considerably. Average zooplankton abundance was highest in P2 followed by C2, P3, C3, P1, C1, and C. The differences between treatments were significant ($F_{6,175}$>1181.54; P<0.05). The Copepoda was the most dominant group ranging from 52.5% of the total plankton composition in P2 to 88.74% in the control. The phytoplankton population in C3 and P3 were significantly higher ($F_{6,175}$>1306.2; P<0.05) than the other treatments (Table 2). The benthic fauna was represented by three groups: Oligochaeta, Diptera and Gastropoda (Table 3). The differences between treatments were significant ($F_{6,84}$>207.97; P<0.05). The highest values were recorded in the C3 treatment, followed in decreasing order by P3, P2, C2, P1, C1 and C treatments. *Chironomus sp*. was the most dominant benthic fauna in all the treatments (Table 3).

At harvest, maximum weight gain of Koi carps (Table 4) was achieved in the P2 treatment, followed in decreasing order by C2, P3, C3, P1, C1, and C treatments ($F_{6,14}$>702.25; P<0.05). The Specific Growth Rate (SGR) was quite high (>3.5) in all treatments, though the differences among the various treatments were significant ($F_{6,14}$>823.71; P<0.05). There was a significant difference ($F_{6,14}$>31.80; P<0.05) in survival of Koi carps among the treatments, ranging from 65.5% in C to 86% in P2 (Table 4).

Discussion

There was autochthonous production of plankton in all treatments, following the principle of pond fertilization. As observed from the gut analysis of common carp (Chakrabarti and Jana, 1991), zooplankton was the main source of food of the Koi carps. Zooplankton in our study was also the primary food item that is significantly correlated with the growth of Koi carps in all the seven treatments (r = 0.957; d.f. = 19; P<0.05) (Figure 1).

High application rates of cowdung and poultry manure in the C3 and P3 treatments significantly increased (P<0.05) the alkalinity, PO_4-P, NH_4-N, NO_2-N, and NO_3-N values of the water. NH_4-N, incorporated from organic manure application, as well as metabolism of the water body, might be considered an index of environmental stress (Jana and Chakrabarti, 1993). Jana and Barat (1984) observed an inverse relationship between NH_4-N and DO. In our experiment, lower DO values were recorded in the C3 and P3 treatments. Critical evaluation of the data revealed that the concentration of NH_4-N was inversely related to the abundance of cladocerans in the C3 (r = - 0.614; d.f.=11; P<0.05) and P3 (r = - 0.688; d.f.=11; P<0.05) treatments.

Table 1. Mean±SE of major water quality parameters analysed for the seven treatments. Each mean represents 13 samples collected at weekly intervals during the 3 month growth period. Different superscripts in the same row indicate statistically significant differences between means at P<0.05.

Parameters	Treatments						
	C1	C2	C3	P1	P2	P3	C
pH	7.32±0.10 ^{ab}	7.23±0.14 ^{ab}	7.02±0.13^{b}	7.49±0.11 ^{ab}	7.71±0.15 ^{a}	7.43±0.15 ^{ab}	7.62±0.11 ^{a}
Dissolved oxygen (mg/L)	6.81±0.35 ^{ab}	7.14±0.33 ^{ab}	5.23±0.27^{c}	6.32±0.21 ^{bc}	7.29±0.26 ^{ab}	5.14±0.24 ^{c}	7.71±0.32 ^{a}
Free CO_2 (mg/L)	4.58±0.40 ^{a}	4.08±0.25 ^{ab}	3.48±0.19 ^{ab}	2.98±0.29 ^{b}	2.96±0.45 ^{b}	3.15±0.41 ^{b}	3.09±0.19 ^{b}
CO_3 alkalinity (mg/L)	-	-	-	0.65±0.65	1.32±0.89	0.74±0.74	-
HCO_3 alkalinity (mg/L)	55.08±2.38 ^{cd}	75.69±4.53 ^{bcd}	93.54±7.93 ^{ab}	64.73±4.05 ^{cd}	78.19±5.57 ^{bc}	106.23±9.28 ^{a}	53.15±1.74 ^{d}
PO_4 – P (mg/L)	0.152±0.016 ^{cd}	0.271±0.024 ^{bc}	0.328±0.038 ^{ab}	0.161±0.014 ^{c}	0.301±0.028 ^{ab}	0.410±0.044 ^{a}	0.029±0.002 ^{d}
NH_4 – N (mg/L)	0.129±0.014 ^{de}	0.181±0.022 ^{cd}	0.400±0.044 ^{ab}	0.287±0.030 ^{bc}	0.321±0.030 ^{ab}	0.429±0.041 ^{a}	0.03±0.002 ^{e}
NO_2 – N (mg/L)	0.026±0.003 ^{bc}	0.032±0.003 ^{bc}	0.046±0.004 ^{a}	0.023±0.003 ^{cd}	0.039±0.003 ^{ab}	0.053±0.004 ^{a}	0.008±0.001 ^{d}
NO_3 – N (mg/L)	0.121±0.011 ^{d}	0.30±0.031 ^{bc}	0.412±0.044 ^{ab}	0.162±0.019 ^{cd}	0.329±0.031 ^{b}	0.50±0.061 ^{a}	0.03±0.005 ^{d}
Specific conductivity (mmhos/cm)	0.431±0.023 ^{cd}	0.572±0.043 ^{bc}	0.688±0.054 ^{b}	0.412±0.025 ^{cd}	0.68±0.056 ^{b}	1.151±0.665 ^{a}	0.272±0.007 ^{d}

Table 2. Species composition, abundance (no./L) and relative abundance (% of total numbers) of plankton in culture tanks manured with cowdung and poultry excreta at different rates, and Control. Each mean value represents data from 26 samples collected two times a week during the 13 week (3 month) growth period.

Species	C1		C2		C3		P1		P2		P3		C	
	(no./L)	(%)	(no./L)	(%)	(no./L)	(%)	(no./L)	(%)	(no./L)	(%)	(no./L)	(%)	(no./L)	(%)
Daphnia sp.	72.31	11.97	150.20	12.59	60.12	6.50	118.70	14.75	212.39	14.15	71.19	7.04	-	-
Moina sp.	81.20	13.44	191.66	16.07	123.20	13.31	120.12	14.93	254.12	16.93	126.12	12.48	-	-
Bosmina sp.	18.24	3.02	26.42	2.22	28.20	3.05	21.30	2.65	31.24	2.08	28.24	2.79	-	-
Cladocera	171.75	28.43	368.28	30.88	211.52	22.86	260.12	32.34	497.75	33.16	225.55	22.31	-	-
Cyclops sp.	180.12	29.81	310.21	26.01	251.50	27.18	214.29	26.64	386.52	25.75	292.55	28.94	152.14	49.04
Diaptomus sp.	118.36	19.59	260.24	21.82	182.12	19.68	164.12	20.41	290.24	19.34	198.21	19.61	80.06	25.80
Nauplii	50.24	8.32	94.26	7.90	62.24	6.73	58.13	7.23	112.12	7.47	62.45	6.18	43.12	13.90
Copepoda	348.72	57.72	664.71	55.73	495.86	53.58	436.54	54.28	788.88	52.56	553.21	54.72	275.32	88.74
Brachionus sp.	28.23	4.67	46.12	3.87	36.28	3.92	30.12	3.74	58.19	3.88	45.12	4.46	20.33	6.55
Keratella sp.	12.17	2.02	24.33	2.03	28.20	3.05	29.30	3.64	38.16	2.54	26.16	2.59	-	-
Rotifera	40.40	6.69	70.45	5.90	64.48	6.97	59.42	7.38	96.35	6.42	71.28	7.05	20.33	6.55
Chlorella sp.	6.24	1.03	8.71	0.73	24.96	2.70	6.11	0.76	16.88	1.12	26.60	2.63	-	-
Navicula sp.	16.79	2.78	30.82	2.58	42.14	4.55	17.30	2.15	42.51	2.83	54.38	5.38	4.24	1.37
Spirogyra sp.	9.02	1.49	11.35	0.95	27.90	3.01	7.15	0.89	12.65	0.84	28.20	2.79	4.22	1.36
Scenedesmus sp.	-	-	2.25	0.19	9.12	0.98	2.04	0.25	3.07	0.20	6.59	0.65	-	-
Phacus sp.	11.26	1.86	33.16	2.78	45.26	4.89	13.73	1.71	39.51	2.63	41.13	4.07	4.02	1.30
Synedra sp.	-	-	2.98	0.25	4.19	0.45	1.90	0.24	3.28	0.22	4.02	0.40	2.12	0.68
Phytoplankton	43.31	7.17	89.27	7.48	153.57	16.59	48.23	6.0	117.90	7.86	160.92	15.92	14.60	4.71
Total plankton	604.18		1192.71		925.43		804.31		1500.88		1010.96		310.25	

Table 3. Species composition and abundance (no./100 cm^2) of benthic fauna in culture tanks manured with cowdung and poultry excreta at different rates, and Control. Each mean value of represents the data from 13 samples collected weekly during the 3 month growth period.

Species	Treatments						
	C1 (no./100 cm^2)	C2 (no./100 cm^2)	C3 (no./100 cm^2)	P1 (no./100 cm^2)	P2 (no./100 cm^2)	P3 (no./100 cm^2)	C (no./100 cm^2)
Tubifex sp.	2.92	5.92	5.53	4.61	5.76	5.38	1.53
Chaetogaster sp.	1.46	2.46	2.53	1.23	3.15	3.53	0.75
Oligochaeta	4.38	8.38	8.06	5.84	8.91	8.91	2.29
Chironomus sp.	6.76	7.69	10.69	6.30	7.38	9.23	2.35
Diptera	6.76	7.69	10.69	6.30	7.38	9.23	2.38
Pila sp.	1.92	1.53	1.84	2.00	2.07	1.77	1.76
Lymnaea sp.	1.84	1.92	2.23	1.23	1.46	1.84	1.53
Gastropoda	3.76	3.45	4.07	3.23	3.53	3.61	3.29
Total benthic fauna	14.90	19.52	22.82	15.37	19.82	21.75	7.96

Table 4. Mean±SE harvest weight, weight gain, specific growth rate (SGR) and survival rate at the end of 13 week growth period (March – May, 2002) of Koi carps reared in concrete tanks manured with cowdung and poultry excreta, applied at different rates and Control

	Treatments						
	C1	C2	C3	P1	P2	P3	C
Manure Application rate (kg/m^3/10 days)	0.13 (Cowdung)	0.26 (Cowdung)	0.39 (Cowdung)	0.13 (Poultry excreta)	0.26 (Poultry excreta)	0.39 (Poultry excreta)	-
Harvest weight (g)	3.31±0.05 ^{f}	7.47±0.12 ^{b}	4.89±0.13 ^{d}	4.28±0.10 ^{e}	9.17±0.07 ^{a}	6.47±0.11 ^{c}	3.03±0.04 ^{f}
Weight gain (g)	3.22±0.05 ^{f}	7.38±0.12 ^{b}	4.80±0.13 ^{d}	4.19±0.10 ^{e}	9.08±0.07 ^{a}	6.38±0.11 ^{c}	2.94±0.04 ^{g}
SGR (%/day)	4.01±0.07 ^{f}	4.93±0.08 ^{b}	4.44±0.10 ^{d}	4.29±0.06 ^{e}	5.14±0.03 ^{a}	4.76±0.04 ^{c}	3.94±0.02 ^{g}
Survival rate (%)	70.5±0.56 ^{bc}	81.5±0.24 ^{a}	70.25±0.49 ^{bc}	71.75±0.80 ^{b}	86.0±0.32 ^{a}	70.25±0.28 ^{bc}	65.5±0.37 ^{c}
Growth equation*	$Y=e^{-1.966+0.247T}$	$Y=e^{-0.551+0.220T}$	$Y=e^{-1.261+0.220T}$	$Y=e^{-1.758+0.241T}$	$Y=e^{-0.468+0.211T}$	$Y=e^{-1.017+0.222T}$	$Y=e^{-2.336+0.266T}$

* The growth models predict mass of fish (Y = g fish) as a function of time (T = weeks).
Different superscripts indicate statistically significant differences between means at $P<0.05$.

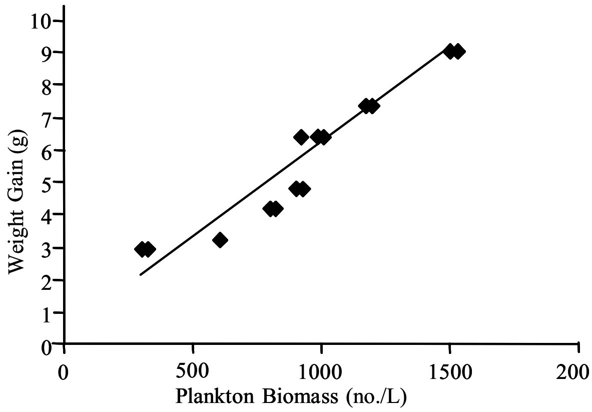

Figure 1. Relationship between weight gain of Koi carp and plankton biomass in the seven treatments.

Differences in the relative abundance of some groups of zooplankton might have contributed to the differential growth responses of the Koi carps. Lower weight gain, SGR and survival rate of Koi carp in the control treatment may be attributed to the insufficient quantity of zooplankton in the system (Szlaminska and Przybye, 1986). Zoobenthos form essential food items of many cultivated fishes in Indian ponds (Jhingran, 1991). However, in our study, the benthic fauna population (Table 3) was low and seemed insufficient to sustain fish production by itself. Compared to larger pond environment, depleted zoobenthos production have been reported in culture tanks (Majumder *et al.*, 2002). Although gut content analysis of the Koi carps were not carried out in our study, it can be assumed that the zoobenthos, with its small population played a secondary role to plankton as food for the carp. Statistical analysis of the data revealed significantly higher concentration of benthic fauna ($P<0.05$) in C3 and P3 compared to the other treatments. This may be influenced by higher rate of manure application (Wade and Stirling, 1999).

It is well known that high yield of fish can be achieved by higher abundance of plankton in culture system. However, it is not possible to increase the application rate of organic manures after a certain limit because this may reduce water quality, which cause stress for reproduction of essential zooplankton thereby causing adverse effect on fish growth. Studies on life history parameters of *Daphnia* sp. and *Moina* sp. (Jana and Chakrabarti, 1993) suggest that growth, reproductive potentials, and longevity of each species are affected by the nutrient conditions of the culture media. Dhawan and Kaur (2002) reported a decrease in cladoceran population with increased organic manure application in ponds. The presence of relatively higher density of zooplankton in C2 and P2 compared to C3 and P3 could be a consequence of relatively suitable environment in terms of water quality and food abundance (Jana and Chakrabarti, 1997). As a result, the weight gain of Koi carps were significantly higher ($P<0.05$) in the C2 and P2 treatments, compared to the C3 and P3 treatments, respectively. Similar decline in plankton biomass due to undesirable water quality with very high amounts of fertilizers have been reported by many authors (Lin *et al.*, 1997; Garg and Bhatnagar, 2000; Azim *et al.*, 2001; Cheikyula *et al.*, 2001). Perhaps, the significantly higher level of nutrients and low dissolved oxygen in the C3 and P3 treatments lowered the grazing activity by carp in these two treatments, compared to the C2 and P2 treatments, respectively. Again, the differences in the weight gain of Koi carps observed among the different treatments were not essentially due to changes in the water quality, since, growth in the C1 and P1 treatments were significantly lower than C2 and P2 treatments, respectively, despite having good water quality. It might well be that the weight gain is more directly related to differences in food concentrations, although the zooplankton density and water quality were closely related to each other.

In any given application rate, the poultry manure appeared to be more effective compared to cowdung (Table 4). In the present investigation, an application rate of 0.26 kg/m^3 every 10 days appeared to be the most suitable for Koi carp tanks manured with cowdung and poultry excreta. Higher application rates reduce water quality, deplete the plankton population and cause adverse impact on the growth of the Koi carp. Further research on husbandry management of Koi carp needs to be conducted.

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