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EFFECT OF POULTRY DROPPINGS ON WATER QUALITY PARAMETERS IN INDIAN MAJOR CARP PONDS

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ABSTRACT

The present study was designed to investigate the influence of poultry droppings on the physico-chemical factors in fish ponds during different seasons of the year. There were two treatments and a control and all the groups were replicated. Control pond did not receive any additive while treatment 1 and 2 were manured with poultry droppings at the rate of 0.15 (T_1) and 0.20 (T_2) g N/100 g wet fish body weight daily. Temperature ranged from 27.7 to 35.7, 28.9 to 35.0 and 28.3 to 35.3^{o}C, light penetration from 10 to 28, 10 to 32 and 10 to 35 cm, pH from 7.50 to 8.17, 7.0 to 8.15 and 7.40 to 8.20, dissolved oxygen from 5.30 to 8.30, 4.49 to 10.89 and 5.53 to 10.65 mg/l, total alkalinity from 220 to 450, 280 to 450 and 290 to 410 mg/l, carbonates from 10 to 40, 10 to 60 and 20 to 60 mg/l, bicarbonates from 200 to 420, 270 to 410 and 270 to 370 mg/l, total hardness from 180 to 280, 200 to 280 and 210 to 280 mg/l, calcium from 30.0 to 72.1, 30.0 to 62.65 and 27.0 to 64.4 mg/l, magnesium from 10.9 to 41.87, 17.1 to 40.0 and 17.3 to 43.7 mg/l, total solids from 814 to 1390, 818 to 1520 and 816 to 1520 mg/l and planktonic biomass from 14 to 290, 18 to 320 and 16 to 320 mg/l in control, T1 and T2 from April to September, respectively. All the parameters remained uniform in all the treatments and a control except plankton productivity which was higher in both treatments when compared with control though there were no differences between both treatments. It further proves that use of 0.15 (T_1) or 0.20 (T_2) g N/100 g wet fish body weight daily does not make any difference neither it has any deleterious effects on water quality nor any on pond productivity. Therefore lesser quantity is more safe and cost effective for fish pond applications.

Key word: Physico-chemical parameters, poultry droppings

INTRODUCTION

Pond fertilization produces microscopic plants and animals which become the natural food of fish. Regular application of fertilizers enhances pond productivity ultimately increasing fish production. Fertilization can have the negative effects too. Excessive fertilization can create obnoxious algal blooms and deteriorates water quality which induces stress to fish, retards growth and causes variety of diseases (Jha *et al.* 2007). In addition to that, the decomposition of dead algae during summer months can cause low oxygen levels, which may cause fish kills during extended period of cloudy weather.

The pond fertilization increases nutrient level of pond water and induces pond productivity (phyto and zooplanktons) which sometimes depends water quality parameters and at another time spoils them. Both organic and inorganic fertilizers are applied to induce this productivity but organic and specifically poultry droppings are good promoter of plankton productivity due to their balanced and diversified nutrient range (Lane, 2000). Poultry manure has been considered as a complete fertilizer (Njoku and Ejiogu, 1999; Njoku, 2008) having characteristics of both organic and inorganic fertilizers and fish yield up to 2717.22 kg of fish acre^{-1} has been reported when applied in fish ponds which is a good evidence of the potential of this manure as fish growth enhancer.

Therefore it can be comfortably said that pond productivity and then fish production moves around the level of nutrients present in the pond which need to be provided continuously and in quite a balanced amount to maintain a safe level of planktons. Excessive input is not only waste of resources but it also deteriorates water quality and even kills fish if it exceeds the certain levels (Hassan, 1998). The present work was, therefore, planned to investigate the effects of poultry droppings on physico-chemical parameters and pond productivity in the ponds. In addition to that the safe level of poultry dropping was also determined which can ensure proper water quality and can maintain pond productivity directly and growth of fish indirectly.

MATERIALS AND METHODS

Experimental protocol and set-up: There were two treatments and a control. Each treatment including control was replicated. Studies were conducted in earthen fish ponds measuring 25 x 8 x 1.5 m (length, width and depth) each and located at Fisheries Research Farm, University of Agriculture, Faisalabad. The ponds were sun dried for 15 days and disinfected by applications of quick lime (CaO) @ of 8.5 kg/pond (Hora and Pillay, 1962). Pond inlets were properly screened with fine mesh guaze to control entry of intruders or escape of fish from the ponds. Each pond was stocked with three species of Indian major carps viz. *Labeo rohita, Catla catla* and *Cirrhinus mrigala* in the ratio of 20:15:15 respectively. The control ponds did not receive any external input while treatment ponds were manured with poultry droppings @ 0.15 (T_1) and 0.20 (T_2) g N/100 g wet fish body weight daily.

Monitoring of Physico-chemical parameters: Water samples were collected from respective ponds on fortnightly basis and were stored in 1L glass bottles. The temperature and dissolved oxygen of the pond water were examined on the site by Dissolved Oxygen Meter (HANNA-HI, 9143) after calibration with known DO solution. The light penetration was determined by dipping Secchi disc in pond water and recording the reading on its complete disappearance. pH of the water was determined with field pH meter (HANNA-HI-9023). Total alkalinity, carbonates, bicarbonates, total hardness, calcium, magnesium and total solids, were determined following the protocol of Boyd (1981). Total dissolved solids were measured with the help of TDS meter (HANNA-HI-9635). Planktonic biomass was measured indirectly from the values of total solids and total dissolved solids by the following formula (Mahboob, 1986).

Planktonic biomass = Total solids-Total dissolved solids.

Statistical Analysis: The data were subjected to statistical analysis (Steel *et al*., 1996) to distinguish the differences between treatments and control. Correlation analysis was performed to establish relationship among various physico-chemical parameters. MSTAT and MICROSTAT computer packages were used for this statistical work.

RESULTS AND DISCUSSION

The mean values of various water quality parameters in different ponds are given in table 1a, and b. The water quality parameters remained almost uniform in different treatments and control during the course of experiment and all of them were within acceptable range for fish culture. Plankton productivity values however, differed significantly ($p<0.05$) when compared with control but there were no differences when both treatments were compared with each other. The correlation coefficient between water temperature and dry weight of plankotnic biomass remained positive and significant (Table 2a, 2b and 2c) showing the dependence of planktonic biomass on water temperature. Javed *et al*. (1995) also pointed out significant dependence of planktonic biomass on water temperature. Our results corroborate with the findings of Hawkins and Griffith (1986) who reported that water temperature contributed significantly toward planktonic productivity of ponds which influenced all the treatments.

Natural water contains many substances which further interfere with light penetration. One of the most familiar properties of water is its transparency. The light penetration values varied in treated pond during the experimental period. The results of present study are also correlated with findings of Khatri (1985) who concluded that the pattern of light varies at different times of year, depending largely on the stratification conditions and on the domination of phytoplankton. Brezonik *et al*. (1984) also reported that light penetration showed an inverse relationship with phytoplankton, greater the value of light, lower the planktonic biomass. There was a significant and negative correlation between light penetration and planktonic biomass in control and treated ponds (Table 2a, 2b, 2c) which means that light enhances pond productivity to a certain level then depresses if the intensity of light exceeds that level.

During the experimental period, pH values showed a slight variation, which favors the production of phytoplankton blooms and also vary with changes in phytoplankton load. Boyd (1981) investigated that high pH value promotes the growth of phytoplankton and results in heavy phytoplankton blooms. Mehboob (1986) also concluded that in fish ponds seasonal changes in pH were usually associated with the rate of photosynthesis. Statistical analysis revealed non-significant difference under all treatments (Table 1a, 1b). Same was the case with dissolved oxygen, level of which remained the same in control and treated ponds (Table 2a, 2b, 2c) with minor increases in ponds containing comparatively dense phytoplankton bloom. The results agree with that of Mehboob (1992) who also reported the maximum average dissolved oxygen when phytoplanktons were in abundance.

Water quality in fish pond is affected by the interaction of several physico-chemical components. pH, alkalinity and hardness exhibit profound effects on pond productivity, availability of oxygen, the level of stress which ultimately has bearing on fish health. The physico-chemical characteristics of both soil and water are not static but are dynamic and change with the introduction of fish species, provision of supplementary feeds, manures and fertilizers and other inputs (Ali *et al*., 2006; Milstein and Svirsky, 1996; Chatterjee *et al.,* 1997; Milstein *et al.,* 2001; Ali *et al*., 2001 and Jha *et al*., 2003). Interestingly any drastic change was not observed in these studies and physico chemical parameters were comparable with control except pond productivity indicating the security of dosage of poultry dropping applied to these ponds.

Table 1a: Statistical analysis of various physico-chemical parameters of control and treated ponds

Fortnight	Date	Water temp. (°C)	Light penetration (cm)	pH	Dissolved oxygen (mg)	Total alkalinity (mg/L)	Carbonates (mg/L)	Bicarbonates (mg/L)	Total hardness (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Total solids (mg/L)	Total dissolved solids (mg/L)	Planktonic biomass (mg/L)
1	01.04.2001	29.57^{G}	24.64^{B}	7.533^{B}	5.107^{E}	273.3^{E}	20.00^{D}	253.3^{E}	200.0^{D}	53.27^{AB}	16.67^{D}	816.0^{E}	8.00^{E}	16.00^{E}
2	16.04.2001	32.73^{DE}	31.67^{A}	7.667^{B}	9.263^{A}	316.7^{DE}	30.00^{DE}	286.7^{CDE}	253.3^{ABC}	58.97^{AB}	26.43^{BCD}	925.7^{D}	900.0^{D}	25.67^{E}
3	01.05.2001	32.90^{DE}	26.00^{B}	7.533^{B}	7.250^{BCD}	363.3^{ABCD}	19.33^{AB}	344.0^{ABC}	217.7^{CD}	47.67^{BC}	24.58^{BCD}	1108.0^{C}	1108.1^{BC}	41.67^{DE}
4	16.05.2001	33.97^{BC}	24.67^{B}	8.173^{A}	6.253^{CDE}	316.7^{DE}	40.00^{CDE}	276.7^{DE}	226.7^{BCD}	29.00^{D}	38.50^{A}	1293.0^{B}	1200.0^{A}	93.33^{CD}
5	01.06.2001	33.33^{CD}	31.67^{A}	8.033^{A}	6.023^{DE}	383.3^{ABC}	46.66^{ABC}	336.7^{ABC}	250.0^{ABC}	39.00^{CD}	38.10^{A}	1312.0^{B}	11674^{B}	145.0^{BC}
6	16.06.2001	35.53^{A}	26.00^{AB}	7.533^{B}	6.227^{CDE}	366.7^{ABCD}	60.00^{E}	330.0^{BCD}	230^{BCD}	58.78^{AB}	20.74^{D}	1307.0^{B}	1100^{BC}	206.7^{AB}
7	01.07.2001	34.33^{B}	10.67^{C}	8.087^{A}	8.417^{AB}	426.7^{A}	3.33^{A}	393.3^{A}	246.7^{ABC}	48.33^{BC}	31.43^{ABC}	1323.0^{B}	1100^{BC}	223.3^{A}
8	16.07.2001	33.20^{CD}	11.33^{C}	8.067^{A}	8.133^{ABC}	406.7^{AB}	43.33^{BCD}	363.3^{AB}	263.3^{AB}	54.30^{AB}	31.87^{AB}	1180.0^{C}	933.3^{D}	246.7^{A}
9	01.08.2001	31.77^{F}	10.33^{C}	8.083^{A}	8.200^{ABC}	346.7^{BCD}	30.00^{CD}	316.7^{BCD}	273.3^{A}	46.33^{BC}	36.86^{A}	1327.0^{B}	1067.0^{C}	260.0^{A}
10	16.08.2001	32.17^{EF}	12.00^{C}	7.970^{A}	6.867^{BCDE}	323.3^{CDE}	30.00^{ABC}	293.3^{CDE}	243.3^{ABC}	62.87^{A}	21.50^{CD}	1477.0^{A}	1167^{AB}	273.3^{A}
11	01.09.2001	28.30^{H}	11.00^{C}	8.080^{A}	5.233^{E}	340.0^{CD}	36.66^{AB}	303.3^{CDE}	236.7^{BC}	59.33^{AB}	22.07^{BCD}	1453.0^{A}	1200^{A}	253.3^{A}

Table 1b: Statistical analysis of various physico-chemical parameters of control and treated ponds

Parameters	Control	Treatment 1	Treatment 2	F value	Probability value
	Mean±SD	Mean±SD	Mean±SD		
Water temperature (°C)	32.58±2.41	32.60±1.97	32.40±1.92	54.15	0.000
Light penetration (cm)	19.09±8.33	19.00±8.62	21.91±10.58	25.09	0.000
PH	7.93±0.24	7.85±0.35	7.87±0.29	6.69	0.000
Dissolved oxygen (mg/L)	6.66±0.23	7.13±0.29	7.21±0.28	5. 15	0.000
Total alkalinity (mg/l)	355.45±64.39	356.36±46.75	34 8.2.±43.32	5.01	0.001
Carbonates (mg/L)	26.18±10.41	38.18±16.63	32.45±14.39	1.23	0.331
Bicarbonates (mg/L)	239.27±58.39	318.18±42.15	306.36±41.54	5.15	0.000
Total hardness (mg/L)	236.18±27.01	240.0±22.81	244.09±28.01	3.64	0.006
Calcium (mg/L)	52.64±11.82	48.72±10.39	50.79±12.54	6.12	0.000
Magnesium (mg/L)	26.14±10.15	29.51±7.86	28.55±8.41	6.06	0.000
Total solids (mg/L)	1172.27±183.85	1260.36±228.48	1255.09291.58	41.08	0.000
Total dissolved (mg/L)	1072.73±142.06	1072.73±134.84	1054.55±136.85	23.81	0.000
Planktonic biomass (mg/L)	90.45±65.78	196.73±120.01	199.64±121.67	22.32	0.000

Table 2a. Correlation coefficients among various physico-chemical parameters in control pond

	AT	WT	LP	pH	DO	TA	Carbo	Bicarbo	TH	Ca	Mg	TS	TDS	PB
AT	1.00													
WT	.82	1.00												
	P=.001													
LP	-.02	.16	1.00											
	P=.469	P=.317												
pH	.06	-.09	-.58	1.00										
	P=.427	P=.397	P=.030											
DO	.46	.18	-.78	.70	1.00									
	P=.078	P=.291	P=.002	P=.008										
TA	.55	.48	-.55	.36	.53	1.00								
	P=.040	P=.066	P=.039	P=.138	P=.048									
Carbo	.36	.34	-.08	.06	.07	.63	1.00							
	P=.141	P=.150	P=.404	P=.430	P=.421	P=.019								
Bicarbo	.54	.47	-.59	.38	.51	.99	.52	1.00						
	P=.042	P=.072	P=.027	P=.120	P=.034	P=.000	P=.052							
TH	.45	.45	-.54	.63	.68	.58	.11	.63	1.00					
	P=.084	P=.880	P=.043	P=.020	P=.010	P=.029	P=.372	P=.019						
Ca	-.27	-.17	-.47	-.15	.06	.21	.08	.22	.26	1.00				
	P=.209	P=.305	P=.073	P=.321	P=.433	P=.270	P=.404	P=.244	P=.217					
Mg	.49	.43	-.02	.53	.41	.24	.02	.26	.68	-.75	1.00			
	P=.061	P=.094	P=.480	P=.046	P=.104	P=.238	P=.484	P=.217	P=.010	P=.004				
TS	.05	.11	-.57	.62	.36	.66	.12	.71	.63	.21	.26	1.00		
	P=.446	P=.377	P=.032	P=.021	P=.139	P=.013	P=.366	P=.007	P=.020	P=.267	P=.217			
TDS	.19	.23	-.24	.44	.12	.59	.13	.64	.45	-.45	.34	.89	1.00	
	P=.284	P=.246	P=.244	P=.086	P=.346	P=.026	P=.357	P=.018	P=.081	P=.081	P=.157	P=.000		
PB	-.11	-.01	-.94	.67	.68	.55	.15	.58	.64	.44	.11	.68	.32	1.00
	P=.373	P=.293	P=.000	P=.012	P=.010	P=.040	P=.333	P=.031	P=.018	P=.018	P=.378	P=.010	P=.174	

AT = Air Temperature; WT = Water temperature; LP= Light Penetration
pH = pH; DO = Dissolved Oxgen; TA = Total Alkalinity
Carbo=Carbonates; Bicarbo, = Bicarbonates; TH = Total Hardness,
Ca = Calcium; Mg = Magnesium; TS = Total Solids
TDS = Total Dissolved Solids; PB = Planktonic Biomass

Table 2b. Correlation coefficients among various physico-chemical parameters in treated (T_1) pond

	AT	WT	LP	pH	DO	TA	Carbo	Bicarbo	TH	Ca	Mg	TS	TDS	PB
AT	1.00													
WT	.84	1.00												
	P=.001													
LP	.02	.36	1.00											
	P=.483	P=.139												
pH	.04	-.28	-.53	1.00										
	P=.450	P=.197	P=.049											
DO	.53	.47	.07	.02	1.00									
	P=.046	P=.073	P=.415	P=.484										
TA	.69	.31	-.51	.34	.21	1.00								
	P=.009	P=.175	P=.056	P=.153	P=.266									
Carbo	.05	-.16	-.42	.65	-.37	.44	1.00							
	P=.442	P=.317	P=.100	P=.015	P=.131	P=.087								
Bicarbo	.75	.41	-.39	.12	.38	.94	.09	1.00						
	P=.004	P=.105	P=.114	P=.339	P=.124	P=.000	P=.391							
TH	.59	.38	-.28	.14	.75	.46	.16	.45	1.00					
	P=.026	P=.120	P=.202	P=.339	P=.004	P=.077	P=.321	P=.084						
Ca	-.27	-.09	-.02	-.57	.03	-.31	-.33	-.21	.17	1.00				
	P=.213	P=.395	P=.479	P=.034	P=.466	P=.180	P=.161	P=.268	P=.306					
Mg	.65	.35	-.18	.57	.52	.58	.38	0.49	.58	-.72	1.00			
	P=.015	P=.142	P=.289	P=.033	P=.052	P=.029	P=.119	P=.060	P=.031	P=.008				
TS	.06	.08	-.37	.39	-.25	0.31	.81	.03	.21	-.08	.21	1.00		
	P=.426	P=.413	P=.129	P=.114	P=.232	P=.176	P=.001	P=.472	P=.273	P=.406	P=.260			
TDS	-.06	.07	-.07	.37	-.29	.16	.64	-.08	-.09	-.33	.21	.85	1.00	
	P=.433	P=.413	P=.410	P=.132	P=.188	P=.322	P=.016	P=.408	P=.388	P=.155	P=.268	P=.001		
PB	.17	.05	-.60	.30	-.09	.46	.73	.22	.46	.19	.17	.87	.51	1.00
	P=.306	P=.409	P=.025	P=.183	P=.391	P=.079	P=.005	P=.259	P=.076	P=.284	P=.302	P=.000	P=.057	

AT = Air Temperature; WT = Water temperature; LP = Light Penetration
pH = pH; DO =Dissolved Oxygen; TA = Total Alkalinity
Carbo = Carbonates; Bicarbo = Bicarbonates; TH = Total Hardness
Ca = Calcium; Mg = Magnesium; TS = Total Solids
TDS. = Total Dissolved Solids; PB = Planktonic Biomass

Table 2c. Correlation coefficients among various physico-chemical parameters in treated (T_2) pond

	AT	WT	LP	pH	DO	TA	Carbo	Bicarbo	TH	Ca	Mg	TS	TDS	PB
AT	1.00													
WT	.83	1.00												
	P=.001													
LP	.04	.28	1.00											
	P=.451	P=.197												
pH	.49	.28	-.47	1.00										
	P=.62	P=.201	P=.071											
DO	.39	.32	.07	-.16	1.00									
	P=.113	P=.171	P=.409	P-.316										
TA	.69	.45	.19	-08	.55	1.00								
	P=.009	P=.080	P=.285	P=.399	P=.039									
Carbo	.39	.47	.43	.31	.38	.28	1.00							
	P=.118	P=.072	P=.097	P=.184	P=.123	P=.196								
Bicarbo	.58	.31	.05	-.01	.44	.94	-.05	1.00						
	P=.029	P.94	P=.438	P=.485	P=.086	P=.000	P=.445							
TH	-.04	-.37	-.26	.31	.35	.26	.23	.19	1.00					
	P=.459	P=.131	P=.223	P=.182	P=.143	P=.223	P=.254	P=.288						
Ca	-.46	-.52	-.23	-.42	.22	.05	-.24	.13	.32	1.00				
	P=.074	P=.051	P=.253	P=.102	P=.262	P=.444	P=.241	P=.348	P=.174					
Mg	.37	.19	.09	.57	.30	.22	-44	.72	.43	.69	1.00			
	P=.127	P=.285	P=.390	P=.033	P=.465	P=.262	P=.087	P=.417	P=.095	P=.009				
TS	.09	.17	-.53	.69	-.32	-.17	-.12	-.14	.01	-.18	.14	1.00		
	P=.391	P=.303	P=.046	P=.009	P=.161	P=.310	P=-369	P=.344	P=.497	P=.292	P=.330			
TDS	-.05	.18	-.17	.47	-.36	-.28	-.02	-.29	-.19	-.38	.24	.86	1.00	
	P=.440	P=.296	P=.303	P=.071	P=.137	P=.195	P=.484	P=189	P=.283	P=.119	P=.243	P=.0000		
PB	.24	.11	-.75	.72	-.18	.03	-.18	.09	.23	.09	.00	.83	.43	1.00
	P=.240	P=.372	P=.004	P=.006	P=.292	P=.466	P=.290	P=.390	P=.253	P=.388	P=.489	P=.001	P=.096	

AT = Air Temperature; WT = Water temperature; LP = Light Penetration
pH = pH; DO = Dissolved Oxygen; TA = Total Alkalinity
Carbo = Carbonates; Bicarbo, = Bicarbonates; TH. = Total Hardness
Ca = Calcium; Mg = Magnesium; TS. = Total Solids
TDS. = Total Dissolved Solids; PB = Planktonic Biomass

The productivity is measured in term of biomass which represents instantaneous quantity of microscopic organisms in the form of phyto and zooplankton. Change in the planktonic biomass depends upon the physical and chemical environment of water body. The phytoplankton showed a direct relationship with light penetration, pH, oxygen, total alkalinity and total hardness of water (Mahboob, 1986). Ambient range of physico-chemical factors like water temperature, light penetration, pH, dissolved oxygen, total alkalinity, carbonates, bicarbonates, total hardness, calcium and magnesium overall favor planktonic biomass. Hayat and Hanif (1996) reported that fish yield was positively and significantly correlated with planktonic biomass. Hassan *et al*. (2000) observed positive correlation between phyto and zooplankton which also confirm our findings and further validate it that production of zooplankton is heavily dependent on the proportionate production of phytoplankton. When phytoplankton productivity was compared between treatments differences were non significant but levels were significantly higher in both groups than that of control. It means plankton productivity can not be enhanced without proper application of poultry droppings and 0.15 of N/100 g of fish can fulfill the pond requirements and can produce desired quantity of both phyto and zooplankton.

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