RESEARCH PAPER:

Hydrological characters and their relationship in fish ponds manured with different organic manures

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Asian Journal of Environmental Science, (June, 2010) Vol. 5 No. 1 : 14-18

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SUMMARY

Hydrology of water bodies play an important role in regulating the various metabolic activities of fish. Optimum levels of these parameters are essential for the better survival and growth of fish as organic manures influence the quality of water to a large extent. The present investigation describes the effect of three organic manures *viz.*, raw cowdung (T_1), vermicompost (T_2) and poultry manure (T_3) on various hydrobiological and physico-chemical characteristics in ponds stocked with carp fry. Dissolved oxygen (DO), pH, transparency, alkalinity, free CO_2, H_2S, nitrate nitrogen, ammonical nitrogen, phosphorus and plankton were estimated. Amount of free CO_2, H_2S and ammonical nitrogen was found to be higher in cowdung and poultry manure treatments and for some period of time, it was found above the toxicity level. The hydrological characteristics and productivity profiles of ponds reveal that vermicompost is better manure for fish culture than poultry manure and cowdung.

Key words : Hydrological characters, Cowdung, Vermicompost, Poultry manure, Fish pond

Accepted : ***February, 2010***

The use of organic manures as fertilizers in aquaculture is an ancient practice and continues to be used as an efficient and economical means of increasing production in aquaculture ponds. In many tropical developing countries, where the priority is to provide low cost meat to low income population, use of supplementary feed is not feasible as it raises the cost of production, making the product beyond the reach of majority of population.

Several studies have been conducted on the fish production efficiencies of different manures in various countries (Sharma and Olah, 1986; Little and Muir, 1987; Singh and Sharma, 1999). However, very few investigations have been done to evaluate the impact of different organic manures on the hydrobiology of fish ponds (Ghosh *et.al.*, 1984; Fang *et al.*, 1986; Salomoni and Caputo, 1989; Zaccarato *et al.*, 1995 and Singh and Sharma, 1999). The present study was designed to obtain a comparative account of hydrobiology and their relation in fish ponds manured with cowdung, vermicompost and poultry manure.

MATERIALS AND METHODS

The experiment was conducted at the Fish Seed Farm, Department of Fisheries, College of Agriculture, IGAU, Raipur, for a period of hundred days during September to December 2004. Six earthen ponds of average 750 m^2 with 1.25 m average depth were stocked with carp fry @ 1 lakh fry/ha. Water temperature, pH, transparency, DO, free CO_2, total alkalinity, H_2S, nitrate and ammonical nitrogen and phosphorus were recorded at weekly intervals following standard methods (APHA, 1989). Quantitative estimation of phytoplankton was done with the help of drop method and zooplanktons were counted with the help of Sedgwick-Rafter cell. Correlation between physico-chemical and biological parameters was determined.

RESULTS AND DISCUSSION

Observations on physico-chemical parameters and plankton population in the ponds treated with the three organic manures are reported in Table 1 and Fig. 1.

The amplitude of variation in water temperature was 9^0C with minimum 23^0C and maximum 32^0C observed during September to December. Water transparency varied between 15-27 cm. in all the treatments during the whole experimental period. It was higher in initial periods and lower towards the end of the experiment. Less visibility in vermicompost (24.0 cm) and poultry manure (19.6 cm) treatments was observed due to good number of plankton population. Whereas, transparency was high in ponds treated with raw cowdung (28.7 cm). Sinha and Shrivastava (1989) and

Table 1 : Mean values of physicochemical characteristics and plankton production in different manured ponds

↓Parameters/Treatments→	Raw cow dung (T_1)	Vermicompost (T_2)	Poultry manure (T_3)
Temperature (°C)	25.7	26.9	28.4
Transparency (cm)	28.7	24.0	19.6
pH	7.2	8.0	7.2
DO (ppm)	3.8	7.5	7.9
Alkalinity (ppm)	57.3	80.3	76.7
Free CO_2 (ppm)	3.8	1.6	2.8
H_2S (ppm)	0.0399	0.0163	0.0539
Nitrate-N (ppm)	0.405	0.695	0.926
Ammonical-N (ppm)	0.380	0.291	0.478
Phosphate (ppm)	0.080	0.135	0.180
Phytoplankton (No/L)	2539.4	3660.5	4442.0
Zooplankton (No/L)	4956.0	5712.8	7294.6

Singh and Sharma (1999) also found high visibility in ponds treated with cowdung.

The pH of the pond water was distinctly alkaline throughout the experimental period in ponds treated with poultry manure (T_3) and vermicompost (T_2) but in ponds treated with raw cowdung (T_1) the pH shifted towards acidic range for a short period of time. Dutta and Goswami (1988) found high pH values in ponds treated with poultry manure and low pH values in ponds treated with cowdung. Singh and Sharma (1999) also found low pH values in the range of 6.8-7.3 in ponds treated with cowdung. Inspite of variation among treatments, overall the water condition was alkaline.

Higher levels of DO were observed in poultry manure and vermicompost ranging between 6.6-9.0 ppm,as shown whereas lower values of DO were observed ranging between 3.2-4.8 ppm during the whole experimental period in treatment with raw cowdung (T_1) with an average of 3.8 ppm. Srisumantach *et al.* (1982), Rao *et al.* (1982) and Singh and Sharma (1999) also observed highest level of DO in ponds treated with poultry manure and lowest in ponds treated with cowdung. Sinha and Shrivastava (1989) and Dhawan and Singh (2000) also found higher values of DO in ponds treated with poultry manure.

Lower values of bicarbonate alkalinity was seen in all the treatments due to utilization of CO_2 by increased phytoplankton. Singh and Sharma (1999) observed higher values of carbonate and bicarbonate alkalinity in ponds treated with poultry excreta than other treatments. Sinha and Shrivastava (1989) found steep decrease in bicarbonate alkalinity values after seventh day of manuring suggesting utilization of CO_2 by the increased phytoplankton.

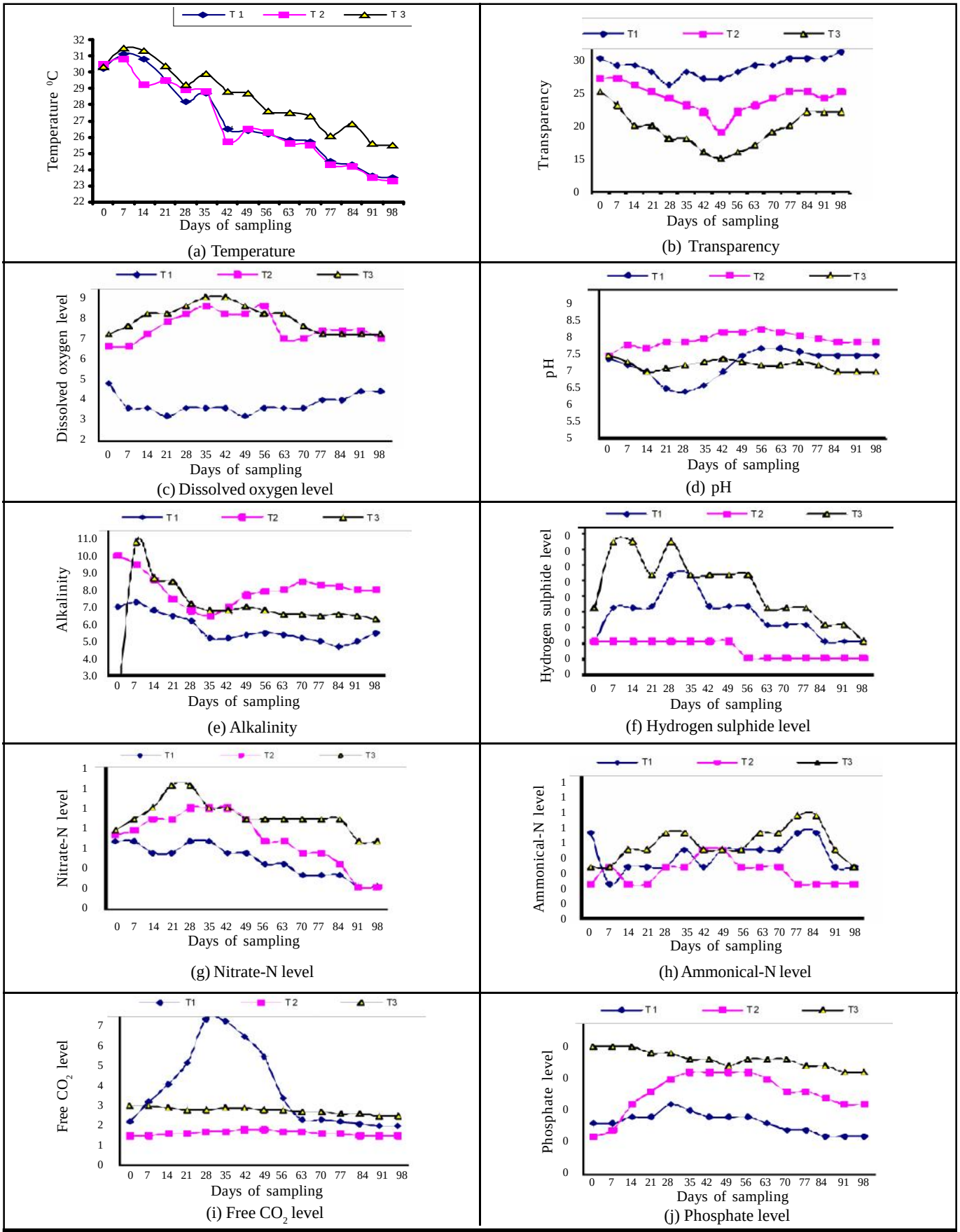
Highest amount of free CO_2 (3.8 ppm) was observed in ponds treated with raw cowdung followed by poultry manure (2.8 ppm) treatment. Amount of free CO_2 was lowest (1.6 ppm) in case of vermicompost treated ponds. Increased photosynthetic activity in ponds treated with vermicompost and poultry manure resulted in decrease of free CO_2 whereas ponds treated with raw cow dung could not produce sufficient amount of phytoplankton but it is very rich source of organic matter which on decomposition produces more amount of CO_2. Sinha and Shrivastava (1989), Singh and Sharma (1999) and Dhawan and Singh (2000) recorded the same trend.

Release of H_2S gas was maximum (0.0539 ppm) in poultry manure followed by raw cow dung (0.0399 ppm) whereas lowest amount of H_2S gas (0.0163 ppm) was observed in ponds treated with vermicompost. Highest amount of H_2S was released between 28^{th} to 35^{th} days of experiment. This may be due to maximum possible decomposition of organic matter of manures took place at this period. For some period of time, its level was above the toxicity range *i.e.* 0.05 ppm (Chattopadhyay, 1997).

Nitrate nitrogen is main source of nitrogen used for the pond productivity by microphytes. Its amount was highest (0.926 ppm) in ponds treated with poultry manure followed by vermicompost (0.695 ppm). Raw cowdung was poorest source of nitrate nitrogen releasing (0.405 ppm) nitrate-N. Ammonical nitrogen was also found highest in treatment with poultry manure (0.478 ppm) followed by treatment with cowdung (0.380 ppm). Ammonical nitrogen is unionized, inassimilable and undessicated form of nitrogen and is known to be poisonous at 0.5 ppm level (Chattopadhyay, 1997) and harm the survival and growth of fish. Its level exceeded from toxicity level for sometime in poultry manure (T_3) and raw cowdung (T_1) treatments.

Highest amount of phosphate was found in poultry manure (0.180 ppm) treated ponds followed by treatment with vermicompost (0.135 ppm) whereas, raw cowdung (T_1) was found to be the poorest source of phosphorous (0.080 ppm). During the whole experimental period phosphate level in poultry manure (T_3) and vermicompost (T_2) was almost same suggesting the availability of phosphorus throughout the experiment. Dahril *et al.* (1998) and Dhawan and Singh (2000) also reported higher phosphate and nitrate contents in ponds receiving poultry manure.

In ponds treated with poultry manure, the plankton population was highest with phytoplankton (4442.0 No./L) and zooplankton (7294.6 No./L) followed by treatment



Fi.g 1 : Status of physicochemical characteristics during the whole experimental period

with vermicompost where phytoplankton was (3660.5 No./L) and zooplankton was (5712.8 No./L). Treatment with raw cowdung showed lowest plankton population with phytoplankton (2539.4 No./L) and zooplankton (4956.0 No./L). Sinha and Shrivastava (1989); Rapport and Bejeram (1977); Fang *et al.* (1988); Singh and Sharma (1999); Dhawan and Singh (2000); Dhawan and Toor (1992) and Natarajan and Varghese (1990) observed higher number of plankton in poultry manure treatment than other trials. A positive correlation between phytoplankton and zooplankton was observed in all the three treatments at 1% level of significance. Singh and Sharma (1999) and Sinha and Shrivastava (1989) also found a direct correlation between phytoplankton and zooplankton

Correlation between different physicochemical parameters has been shown in Table 2. This table shows that transparency is both significantly and non-significantly negatively correlatated between and pH, DO, Free CO_2, phytoplankton and zooplankton in different treatments. Whereas positively correlated with alkalinity at 1% and 5% level of significance. Almost similar findings have also been reported by Rao *et al.* (1982), Srisumantach *et al.* (1982) and Singh and Sharma (1999).

High degree of positive correlation was observed between pH and DO in all the three treatments. Lower level of DO present in treatment with raw cow dung (RCD) resulted into formation of carbonic acid by which the pH fell down to lower levels. Singh and Sharma (1999) also found a positive correlation between pH, DO and phytoplankton at 5% level of significance. pH is negatively correlated with alkalinity and Free CO_2. Non-significant negative correlation was observed between pH and phytoplankton in all the three treatments.

Significant direct correlation was observed between DO and phytoplankton in all the three treatments at 1% level of significance, which means that higher level of DO in vermicompost (VC) and poultry manure (PM) is associated with increased biomass of phytoplankton. Whereas, negative correlation was observed between DO and free CO_2, alkalinity and zooplankton in all the treatments.

Alkalinity was negatively correlated with phytoplankton, zooplankton, pH and DO whereas positively correlated with free CO_2. Singh and Sharma (1999) also found a significant negative correlation between alkalinity and phytoplankton. In Chhattisgarh ponds, carbonate alkalinity is generally not found.

Table 2 : Correlation between different parameters in raw cowdung (RCD), vermicompost (VC) and poultry manure (PM) treated ponds

	Transparency	pH	DO	Alkalinity	Free CO_2	Phytoplankton	Zooplankton
Transparency (RCD)	1						
Transparency (VC)	1						
Transparency (PM)	1						
pH (RCD)	0.570 *	1					
pH (VC)	0.832**	1					
pH (PM)	0.163	1					
DO (RCD)	0.726 **	0.364	1				
DO (VC)	0.714**	0.581*	1				
DO (PM)	0.777**	0.862**	1				
Alkalinity (RCD)	0.088	0.370	0.22	1			
Alkalinity (VC)	0.874**	0.563*	0.832**	1			
Alkalinity (PM)	0.578*	0.400	0.156	1			
Free CO_2 (RCD) Free	0.874 **	0.809 **	0.100**	0.100**	1		
CO_2 (VC)	0.844**	0.750**	0.579*	0.579*	1		
Free CO_2 (PM)	0.056	0.750**	0.720**	0.720**	1		
Phytoplankton (RCD)	0.674**	0.039	0.660**	0.459	0.421	1	
Phytoplankton (VC)	0.099	0.060	0.524*	0.451	0.465	1	
Phytoplankton (PM)	0.181	0.077	0.844**	0.595*	0.421	1	
Zooplankton (RCD)	0.312	0.352	0.399	0.723**	0.108	0.836 **	1
Zooplankton (VC)	0.108	0.833**	0.701**	0.778**	0.712**	0.874**	1
Zooplankton (PM)	0.746**	0.298	0.911**	0.732**	0.531*	0.735**	1

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Non-significant negative correlation was observed between phytoplankton and free CO_2 whereas free CO_2 and zooplankton are significantly positively correlated. It means that zooplankton contribute in the level of free CO_2 by respiration

A significant positive correlation between phytoplankton and zooplankton was observed in all the three treatments at 1% level of significance. Singh and Sharma (1999) and Sinha and Shrivastava (1989) also found a direct correlation between phytoplankton and zooplankton.

Conclusion:

This study on hydrobiology of ponds treated with different organic manures concludes that vermicompost being partially decomposed form is a good source of nutrients, which are readily soluble in water and so easily available to microflora thus, it does not produce large amount of toxic and noxicious gases which is harmful for fish growth and survival like H_2S, NH_3 and excessive amount of free CO_2 thus, it is most efficient organic manure for fish culture. In spite of some side effects, poultry manure is better than cowdung being richest source of nutrients thus it can also be used efficiently for manuring ponds.

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