AQUABYTE

Editor: M.V. Gupta

Aquaculture Section
of the Network of Tropical Aquaculture
and Fisheries Professionals (NTAFP)

Pig Dung as Pond Manure: Effect on Water Quality, Pond Productivity and Growth of Carps in Polyculture System

A. Dhawan and S. Kaur

Abstract

Pig dung was used as manure at 18 and 36 t/ha/year in carp polyculture (without supplementary feeding) for 270 days. It was observed that pig dung at both the levels did not degrade the physico-chemical properties (pH, dissolved oxygen and alkalinity) of water. The nutrient (phosphates and nitrates) level of water was higher in manured ponds than control ponds (no manuring, only supplementary feeding). Further, plankton levels (phyto- and zooplankton) were also significantly higher in manured ponds. The growth of *Catla catla* and *Labeo rohita* was significantly more in manured ponds than in control ponds. Growth of *Cirrhinus cirrhosus* and *Cyprinus carpio* was significantly more in ponds manured with pig dung at 18 t/ha/year than in control ponds and the growth of *Ctenopharyngodon idellus* was significantly more in control than in manured ponds.

Introduction

Sustainable aquaculture depends upon eco-friendly and economically and socially viable culture systems. The recycling of organic wastes for fish culture serves the dual purpose of cleaning the environment (by avoiding the problem of waste disposal) and providing economic benefits. The recycling of animal dung/wastes in fish ponds for natural fish production is important to sustainable aquaculture and to reduce expenditure on costly feeds and fertilizers which form more than 50% of the total input cost. However, the indiscriminate use of these manures in fishponds, instead of improving the pond productivity, may also lead to pollution. Therefore, it is necessary to know the standard doses of these wastes which would keep the physico-chemical parameters of pond water in a favorable range required for the survival and growth of fish. Although a lot of work has been done on the utilization in fish culture ponds, of animal manures, particularly farmyard manure, poultry droppings, cow dung and biogas slurry which are suitable substitutes for costly feeds and fertilizers (Schroeder 1980; Dhawan and Toor 1989), there are few reports on the recycling of pig dung (Sharma 1988) in fish ponds. Therefore, the present study was conducted to work out the effect of pig dung as pond manure on physico-chemical and biological parameters of water and on the growth of carps (Indian major carps and exotic carps) in the polyculture system.

Materials and Methods

The present study was conducted at the fish farm of Punjab Agricultural University, Ludhiana for 270 days (September 1997 to June 1998).

Preparation of tanks: Experiments were conducted in concrete tanks of 20 m^2 with a depth of 1 m. A thin layer of soil was spread on the bottom of all tanks. Subsequently all the tanks were filled with tube well water.

Manuring of tanks: The pig dung was used as manure at 18 (PM18) and 36 (PM36) t/ha/year i.e. 34.5 and 69.0 g/m^2/week respectively, during the course of the experiment. No supplementary feeding was given to fish in these two treatments. In control treatments (C), no manure was added and fish were fed with supplementary feed containing 50% deoiled rice bran and 50% deoiled mustard oil cake at 2% of fish biomass. Both manured and control groups were replicated three times.

Stocking of fish: Each tank was

stocked with fry (2 fish/m^2) of different fish species: 8 catla (*Catla catla*), 10 rohu (*Labeo rohita*), 8 mrigal (*Cirrhinus cirrhosus)*, 8 common carp (*Cyprinus carpio*) and 6 grass carp (*Ctenopharyngodon idellus*) in September 1997. Mean total weight of the fishes at the time of stocking was 3.0-5.0 g for catla; 5.0-12.0 g for rohu; 2.5-3.0 g for mrigal; 2.0-2.7 g for common carp and 2.2-2.7 g for grass carp.

Observations recorded: The water from all tanks was analyzed at monthly intervals between 7-8 a.m.) for physico-chemical parameters: temperature, pH, free carbon dioxide, phenolphthalein alkalinity, methyl-orange alkalinity and total alkalinity according to APHA (1991), water soluble phosphates according to Jackson (1967) and nitrate-nitrogen according to Keeney and Nelson (1982). Qualitative and quantitative analyses of phytoplankton and zooplankton were also done at monthly intervals, following the methods of Vollenweider (1971) and APHA (1991). Fish sampling was done at monthly intervals, growth of fish was recorded and total weight gain (TWG) and specific growth rate (SGR) was estimated:

$$TWG = \frac{\text{Final body weight} - \text{Initial body weight}}{\text{Initial body weight}}$$

$$SGR = \frac{\ln(\text{Final body weight}) - \ln(\text{Initial body weight})}{\text{Number of culture days}} \times 100$$

Results

Physico-chemical parameters

During the 270 days of culture, water temperature ranged from 12-35°C, with the maximum mean temperature in Control treatments followed by PM18 and PM36 (Table 1), pH varied from 8.03-9.24, with the highest mean pH in Control and PM18 followed by PM36, dissolved oxygen ranged from 6.25-14.00 mg/l, the highest mean DO in PM18 followed by PM36 and Control. Free carbon dioxide ranged from 0-164 mg/l, with a maximum mean level in Control followed by PM36 and PM18, phenolphthalein alkalinity varied from 0-120 mg/l, with a maximum mean in PM18 followed by Control and PM36, methyl-orange alkalinity varied from 100-268 mg/l, the maximum mean value in Control followed by PM18 and PM36 and total alkalinity ranged from 140-350 mg/l, with the highest mean alkalinity in Control followed by PM18 and PM36. Nitrate-nitrogen varied from 0.44-2.45 mg/l, with the highest mean level in Control followed by PM36 and PM18. The differences in the above physico-chemical parameters between manured groups and controls were not significant. The water-soluble phosphates varied from 0.07-9.38 mg/l, highest mean levels being in PM36 followed by Control and PM18 and the differences were significant (PM36 > C = PM18) (Table 1).

Biological parameters

Phytoplankton: Total phytoplankton varied from 4.89-89.82 x 10^6/l, the highest mean levels in PM36 followed by PM18 and Control and the differences were significant. Cynophyceae ranged from 1.15-67.29 x 10^6/1, with maximum mean levels recorded in PM36 followed by PM18 and Control and the differences were significant between treatments, Chlorophyceae varied from 0.75-24.59 x 10^6/1, with highest mean levels in PM18 followed by Control and PM36 and the differences were not significant and Bacillariophyceae varied from 0-0.72 x 10^6/1, with highest mean levels recorded in Control followed by PM18 and PM36 and the differences were significant (Table 2).

Zooplankton: Total zooplankton varied from 490.69-2484.84/1, with maximum mean levels in PM36 followed by PM18 and Control and the differences between treatments were significant. Copepoda varied from 58.44-1053.43/1, with

Table 1. Changes in physico-chemical parameters of water in different treatments.

Parameters[1]	Treatment[2]		
	C	PM18	PM36
Temp. (°C)	23.30 ± 2.39^a (13-35)	22.80 ± 2.36^a (12-35)	22.80 ± 2.38^a (12-35)
pH	8.61 ± 0.13^a (8.10-9.20)	8.61 ± 0.14^a (8.03-9.24)	8.47 ± 0.11^a (8.13-8.94)
DO (mg/l)	9.28 ± 0.74^a (6.25-13.50)	9.97 ± 0.80^a (6.25-14.00)	9.70 ±0.80^a (6.50-13.60)
FC02 (mg/l)	16.40 ± 16.40^a (0-164)	4.00 ± 4.00^a (0-40)	10.60 ± 5.49^a (0-42)
PA (mg/l)	78.30 ± 8.92^a (0-98)	79.10 ± 10.16^a (0-120)	59.80 ± 13.36^a (0-100)
MOA (mg/l)	201.00 ± 15.56^a (136-268)	187.80 ± 15.32^a (128-264)	177.70 ± 17.54^a (100-265)
TA (mg/l)	279.30 ± 19.32^a (156-350)	266.90 ± 19.98^a (144-331)	237.60 ± 22.15^a (140-347)
$N0_3$-N (mg/l)	1.32 ± 0.22^a (0.44-2.45)	1.06 ± 0.18^a (0.70-2.45)	1.18 ± 0.17^a (0.60 ± 2.45)
WSP (mg/l)	1.31 ± 0.31^b (0.07-2.65)	1.59 ± 0.68^b (0.81-3.63)	3.57 ± 0.95^a (0.94-9.38)

[1]C- Control, PM18 - pig dung at 18 t/ha/yr, PM36 - pig dung at 36 t/ha/yr
Temp – Temperature, DO – Dissolved oxygen, $FC0_2$ - free carbon dioxide, PA - phenolphthalein alkalinity, MOA - methyl-orange alkalinity, TA - total alkalinity, WSP – Water Soluble phosphates, $N0_3$-N – Nitrate-nitrogen
[2]Figures with same superscripts in a row did not differ significantly. Figures in parentheses are ranges

Table 2. Changes in biological parameters of water in different treatments.

Parameters1	Treatment[2]		
	C	PM18	PM36
TP *	24.51 ± 7.01[b] (4.59 - 67.86)	44.23 ± 8.13[a] (9.01 - 89.82)	53.26 ± 5.35[a] (20.02 - 71.06)
Cy *	16.92 ± 4.43[b] (1.15 - 46.94)	36.50 ± 6.29[a] (8.27 - 67.29)	46.99 ± 5.43[a] (17.58 - 65.08)
Ch *	7.27 ± 2.63[a] (1.51 - 24.59)	7.56 ± 2.59[a] (0.75 - 22.17)	6.18 ± 1.48[a] (1.55 - 14.17)
Bc *	0.24 ± 0.05[a] (0.07 - 0.55)	0.22 ± 0.07[ab] (0 - 0.72)	0.12 ± 0.03[b] (0 - 0.39)
TZ **	723.99 ± 28.09[b] (598.55 - 862.22)	1100.67 ± 196.74[a] (490.69 - 2484.84)	1226.26 ± 174.68[a] (675.13 - 2072.87)
Cp **	258.15 ± 35.88[b] (58.44 - 420.18)	363.89 ± 65.92[a] (199.45 - 779.93)	494.59 ± 88.99[a] (197.30 - 1053.43)
Cl **	132.05 ± 15.70[b] (60.15 - 204.22)	260.66 ± 55.82[a] (51.56 - 698.87)	254.23 ± 47.62[a] (100.13 - 595.22)
Rt **	333.78 ± 28.16[b] (200.68 - 496.75)	476.12 ± 89.91[a] (209.11 - 1006.4)	477.44 ±74.49[a] (206.25 - 906.90)

[1]C- Control, PM18 - pig dung @ 18t/ha/yr, PM36 - pig dung @ 36t/ha/yr
TP - Total phytoplankton, Cy – Cyanophyceae, Ch – Chlorophyceae, Bc - Bacillariophyceae, TZ - Total zooplankton, Cp - Copepoda, Cl - Cladocera, Rt – *Labeo*.
* - Values are in No. X 10^6/1
** - Values are in No./1
[2]Figures with same superscripts in a row did not differ significantly. Figures in parentheses are ranges

maximum mean levels in PM36 followed by PM18 and Control and the differences between treatments were significant; Cladocera varied from 51.56-698.87/1, with maximum mean levels in PM18 followed by PM36 and Control and the differences were significant; *Rotifera* varied from 200.68-1006.04/1, the maximum mean levels being in PM36 followed by PM18 and Control and the differences were significant (Table 2).

Table 3. Growth of different fish species in different treatments.

Parameters[1]	Treatments[2]		
	C	PM18	PM36
C. catla			
TWG (%)	316.67[b]	1050.00[a]	1081.82[a]
SGR	0.53	0.90	0.91
L. rohita			
TWG (%)	1598.53[b]	2630.49[a]	2210.34[a]
SGR	1.05	1.23	1.16
C. cirrhosus			
TWG (%)	2765.38[a]	2620.00[a]	1785.25[b]
SGR	1.24	1.22	1.09
C. carpio			
TWG (%)	1165.45[a]	1166.67[a]	669.23[b]
SGR	0.95	0.94	0.76
C. idellus			
TWG (%)	1076.00[a]	540.00[b]	870.37[b]
SGR	0.91	0.69	0.84

[1]C- Control, PM18 - pig dung at 18 t/ha/yr, PM36 - pig dung at 36 t/ha/yr
TWG – Total weight gain, SGR – Specific growth rate
[2]Figures with same superscripts in a row did not differ significantly.

Percent total weight gain and specific growth rate, in *C. catla* was highest in PM36 followed by PM18 and Control and the differences were significant; *L. rohita* had higher growth in PM18 followed by PM36 and Control and the differences were significant; *C. cirrhosus* had maximum growth in Control followed by PM18 and PM36 and the differences were significant; *C. carpio* had maximum growth in Control followed by PM18 and PM36 and the differences were significant. In the case of *C. idellus*, maximum growth was in Control followed by PM36 and PM18 and the differences were significant (Table 3).

Discussion

Physico-chemical parameters of water play a significant role in the biology and physiology of fish. In the present study the physico-chemical parameters of water in different manured and control groups remained within the favorable range required for carps (Jhingran 1991). Water temperature, pH, dissolved oxygen, free carbon dioxide and alkalinity (phenol-phthalein, methyl-orange and total) did not differ significantly between different treatments. This suggests that pig dung even at a higher dose (36 t/ha/year) did not have any adverse effect on the physico-chemical parameters of water. Sharma and Das (1988) reported that even heavy organic loading through pig excreta did not reduce the dissolved oxygen content of water. The nitrate-nitrogen content of water did not differ significantly between different treatments; however, the water soluble phosphates were significantly higher in PM36 than PM18 and controls. This may be attributed to the presence of phosphorus in pig dung. Sharma (1989) also recorded higher levels of phytoplankton in ponds receiving pig dung.

The biological productivity of any aquatic body is generally judged through the qualitative and quantitative estimation of plankton, which form the natural food of fish (Ahmed and Sing 1989). Animal wastes lead to increased biological productivity of ponds through various pathways, which result in an increase in fish production. In the present study, the biological parameters of water total phytoplankton and its subgroups Cyanophyceae and Chlorophyceae (excluding Bacillariophyceae which was significantly lower in manured ponds) and total zooplankton were significantly higher in ponds receiving pig dung than in control ponds. This may be due to a high level of water-soluble phosphates in the pig dung. However, no significant difference was recorded in the pond productivity between the two doses of pig dung used. A uniform production of plankton has also been reported in ponds with recycled pig dung (Govind et al. 1978; Sharma and Das 1988). Singh (1996) also reported that pond productivity could be maintained for longer periods through the use of pig manure in comparison to cattle dung. Pig dung provides zooplankton with an additional food source from the bacteria, which thrive on the added organic fertilizer. The nature of the manure also affects the community structure of plankton. In the present study, among phytoplankton, Cyanophyceae was the dominant group followed by Chlorophyceae, whereas, Bacillariophyceae was poorly represented; among zooplankton, *Rotifera* was the dominant group followed by Copepoda and Cladocera in all the treatments including controls.

The growth (weight gain) of the different fish species cultured revealed that in *C. catla* and *L. rohita*, TWG and SGR were significantly more in PM18 and PM36 than in controls, whereas, in *C. cirrhosus* and *C. carpio*, TWG and SGR were significantly more in controls and PM18 than PM36. Higher growth of these carps in manured ponds may be due to higher availability of natural food in these treatments. Moreover, some carps even feed upon the undigested fraction of these manures directly, which may be low in nutrient value but the micro-organisms adhering to them are of high protein value (Schroeder 1980). Further, direct feeding upon pig dung may be more beneficial for the growth of carps since more than 70% of the food of pigs remains undigested and rich in nutrients (Sharma 1989). However, pig dung at both the levels used in the present study did not have a positive effect on the growth of *C. idellus*, which was to be expected, *C. idellus* being a herbivore.

The above study reveals that pig dung even at a higher dose (36 t/ha/year) did not adversely affect the physico-chemical parameters of water. The pond productivity was significantly higher in manured ponds than control ponds. The growth of *C. catla* and *L. rohita* in manured ponds was better than in control ponds and the growth of *C. cirrhosus* and *C. carpio* in PM18 was equivalent to controls. This clearly indicates that carps can be cultured well in ponds receiving pig dung at 18 t/ha/year, without supplementary feeding.

Acknowledgements

The authors thank Prof. and Head, Department of Fisheries, PAU, Ludhiana for providing the necessary research facilities. Thanks are also due to Prof. P.K. Saxena, former Head, Dept. of Fisheries, for reviewing the manuscript.

References

Ahmed, S.H. and A.K. Singh. 1989. Correlation between antibiotic factors of water and zooplanktonic communities of a tank in Patna, Bihar, p. 119-121. ***In*** Proc. Nat. Sem. On Forty Years of Freshwater Aquaculture in India, 7-9 November 1989, Central Institute of Freshwater Aquaculture, Bhubneshwar..

APHA 1991. Standard Methods for the Examination of Water and Waste water. American Public Health Association, Washington, 1193 p.

Dhawan, A. and H.S. Toor. 1989. Impact of organic manure and supplementary diet on plankton production and fish growth and fecundity of an Indian major carp, *Cirrhina mrigala* (Ham.) in fish ponds. Biol. Waste 29: 289.

Govind, B.V., K.V. Raja Gopal and G.S. Singh. 1978. Studies on the comparative efficacy of organic manures as fish feed producers. J. Inland Fish. Soc. India 10: 101-106.

Jackson, M.L. 1967. Soil Chemical Analysis. Prentice Hall of India, Private United, New Delhi.

Jhingran, V.G. 1991. Fish and Fisheries of India. Hindustan Publishing Corporation, Delhi, 727 p.

Keeney, D.R. and D.W.Nelson. 1982. Nitrogen-Inorganic forms, p 643-698. ***In*** A.L. Page, R.H. Miller and D.R. Keeney (eds.). Methods of soil analysis, Part II. American Society of Agronomy Inc. and Soil Science Society of America Inc., Madison, U.S.A.

Parmeswaran, S., S. Radha Krishnan, C. Selvorarya and B.R. Buyan. 1971. Fish yield from Assam ponds under different experimental conditions. Indian J. Fish 18: 67-83.

Schroeder, G.L. 1980. Fish farming in manure loaded ponds, p 73-86. ***In*** ICLARM- SEARCA Conf. Agri. Aquac. Farm. System, Manila, Philippines,

Sharma, B.K. 1988. Carp farming integrated with pig raising in India. Envir. Ecol. 6: 159-168.

Sharma, B.K. 1989. Fish culture integrated with various systems of livestock farming. I. Fish-cum-pig, II. Fish-cum-duck, III. Fish-cum-poultry, IV. Fish-cum-cattle, Compendium of Lecture No. 2 of Training programme on Integrated Fish Farming, 12-31 January 1989, CIFA (ICAR), Bhubneshwar.

Sharma, B.K. and M.K. Das. 1988. Studies on integrated fish-livestock carp farming system. Fishing Chimes 7: 15-27

Singh, A.K. 1996. Investigation on the effect of pig manure on growth and survivability of Indian major carps and exotic carps spawn in nursery pond, p. 134. ***In*** The Fourth Indian Fisheries Forum, 24-28 November 1996, Uni. Science. & Technol., Cochin..

Vollenweider, R.A. 1971. A Manual of Methods for Measuring Primary Production in Aquatic Environment. IBP Handbook No. 12.

A. Dhawan *and* **S. Kaur** *are from the Department of Fisheries, Punjab Agricultural University, Ludhiana 141004, India.*