Comparative Efficiency of Vermicompost Over Single Super Phosphate in Carp Culture

Abstract

Qualitative and quantitative analyses of phytoplankton and zooplankton, and growth performance of Cyprinus carpio (Ham.) were done in earthen vats receiving compost, single super phosphate (SSP) and vermicompost as direct application fertilizer. Significant differences were observed in the diversity and abundance of plankton in response to fertilization with compost, SSP and vermicompost. The different organic manures used can be graded in the following descending order: vermicompost, SSP and compost. The least concentration was accounted in control sets.

The highest production of fish was obtained in vats treated with vermicompost (3,970.56 kg.ha-1 90 day-1) followed by SSP (2,933. 76 kg.ha-1 90 day-1), compost (1,952.64 kg.ha-1 90 day-1) and lowest in control sets (385.92 kg. ha-1 90 day-1). Highest yield of fish in vats applied with vermicompost is attributed to its highest manorial value.

Keywords: Organic manure; vermicompost; compost; plankton; fish production.

Introduction

The purpose of pond manuring is primarily to provide adequate amounts of essentials nutrients for phytoplankton production (Steinberg et al., 2006; Wang, 2000). Manuring is widely practiced in fish ponds for natural fish production as it is important to sustainable aquaculture and to reduce expenditure on costly feeds and fertilizers which form more than 50% of the total input cost (Edwards, 1980; Oribhabor and Ansa, 2006). Wide variety of organic manures such as grass, leaves, sewage water, livestock manure, industrial wastes, night soil and dried blood meal have been used (Hickling, 1962) to improve fish production. Although organic fertilizer can be utilized as food for invertebrate fish-food organisms and fish (Taiganides, 1978), they are intended primarily to release inorganic nutrients for phytoplankton and zooplankton growth. Phytoplankton and zooplankton are rich source of protein often containing 40−60% protein on a dry matter basis and is sufficient to support excellent fish growth (Pillay, 1995; Silva and Anderson, 1995). Studies on growth performance of culturable fish in relation to feeding provide information for successful application in the management and exploitation of the resources. The present trial was undertaken to study both qualitative and quantitative analysis of various groups of phytoplankton and zooplankton, their protein concentration and also to assess the growth performance of the test fish Cyprinus carpio in cisterns receiving three organic manures, namely compost, SSP and vermicompost.

Methods

The present trial was conducted in private premise at Krishnagar (longitude 88033/E, latitude 23024/N) over period of 90 days during May – July (Temp 34°C). Twelve earthen vats (area 0.33 m2; depth 30 cm; capacity 150 liters) were treated with three different types of organic manures namely, compost (T-2), SSP (T-3) and vermicompost (T-4) having thrice replicates of each kind. Control sets (T-1) were also run simultaneously without manure. Each vat was provided with an uncontaminated soil base of 8 cm. All the cisterns were then filled exclusively with ground water (pH 7.16, temperature 34°C, DO 4.0 mg.ℓ-1). The amounts of different organic manures were applied on as per the P2O5 content of the fertilizer and manures. All the treatment series received manure at 15 days intervals. The first application of manure was done 15 days prior to fish introduction. The total phosphate content of the manures applied was determined prior to its use in experimental vats. The weight of manures were ranged from (4.5−620.0 g) on 50 kg P2O5 content basis *(Table 1)*. No supplementary feed was applied during this period. Fry of Cyprinus carpio (average weight 2.5 ± 0.01 g; average length 1.40 ± 0.02 cm) were stocked at 12 No.vats-1 these fry of Cyprinus carpio and fishes were acclimatized in out door vats prior to their release in treatment vats. A constant water level was maintained in the test vats by weekly supply of ground water to compensate the water loss due to evaporation in every vat. Water quality such as temperature, pH, dissolved oxygen, free cabon dioxide, total alkalinity, hardness, ammonia-nitrogen and phosphorous, were estimated at 15 days intervals following standard methods (2002). Qualitative and quantitative analyses of phytoplankton and zooplankton (4% formalin preserved) from each vats were also done using Sedgwick rafter count cell at an interval of 45 days by filtering 20 liters of water through a conical plankton net of number 25 bolting silk cloth (80 mesh.cm-2). The plankton samples were then hot air dried for 24 hours at 100°C and after that measured for their dry weight. The total weight of the fish was determined at 45-day intervals by weighting more than 50% of fishes from each of the cisterns. The absolute growth (AG), growth increment (GI) and the total weight gain (TW) was estimated as follows.

Absolute growth (AG) =
Final body weight − Initial body weight

$$\text{Growth increment (GI)} = \frac{\text{Final body weight} - \text{Initial body weight}}{\text{Number of culture days}}$$

$$\text{Total weight gain (TW)} = \frac{\text{Final body weight} - \text{Initial body weight}}{\text{Initial body weight}}$$

Results

Water quality

The water temperature was remained similar (≥ 22.5 °C) in all the experimental sets and then there was no marked difference of temperature (22.5−22.59 °C), pH (7.06−7.43) and dissolved oxygen of water (6.21−7.74 mg.ℓ-1) among the treatment *(Table 2)*. The orthophosphate and acid hydrolysable phosphate were highest in concentrations in the SSP (0.52 mg.ℓ-1) treatment and lowest in control (0.09 mg.ℓ-1). The amount of organic phosphate, on the other hand was highest (0.35 mg.ℓ-1) in the vermicompost treatment. The concentration of total P was higher in SSP (0.85 mg.ℓ-1) than in the vermicompost treatment (0.68 mg.ℓ-1). There was no significant differences (P < 0.05) in the concentration of total P among treatments (T-2, T-3, T-4), and in available P concentration *(Fig 1)* of treatments received SSP and vermicompost. However, as expected control series showed always lowest concentration of total and available P among the all test combinations. But the total nitrogen concentration showed significant differences among all test combinations and this trend was also followed for available N in the test series SSP and control *(Fig 2)*.

Parameters	Control (T_1)	Compost (T_2)	SSP (T_3)	Vermicompost (T_4)
Fertilizer / Manure added (g)	0	620	4.56	510
Stocking density	10.00	10.00	10.00	10.00
Initial average individual length (cm)	1.40 ± 0.02	2.4	2.4	2.4
Initial average individual weight (g)	2.50 ± 0.01	2.50	2.50	2.50
Final average individual length (cm)	4.44 ± 0.03	6.86	7.80	8.96
Final average individual weight (g)	3.60 ± 0.01	8.14	12.22	16.54
Growth increment (g fish^{-1} day^{-1})	0.0129	0.0641	0.1130	0.1560
Total weight gain (TWG) (g fish^{-1})	0.44	2.25	3.88	5.61
Survival (%)	85	88	86	90

Table 1 Details of fish production (Cyprinus carpio) in the experiment.

The control sets and SSP administrated showed no significant difference in their available N concentration.

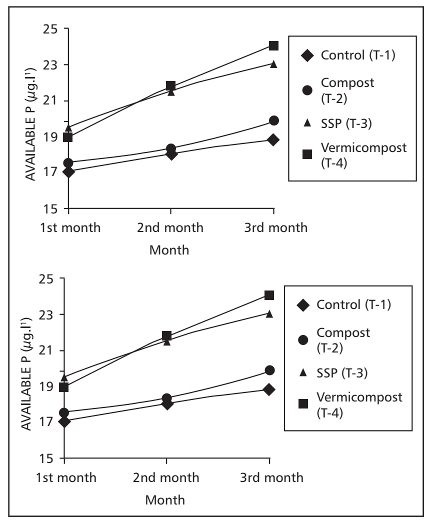

Figure 1 Temporal changes of available and total P contents of water in four treatments employed.

Plankton analysis

In all the treatments dry weight and population (no.ℓ-1) of the both phytoplankton and zooplankton population were significantly (P<0.001) higher than control.

Phytoplankton composition was represented by four groups, namely Myxophyceae, Chlorophyceae, Cyanophyceae and Bacillariophyceae in all the experiment series. Among the four phytoplankton groups Bacillariophyceae exhibited highest percentage composition (66.25−72.31) in all the four treatments on various sampling days, whereas Cyanophyceae exhibited lowest (5.33−12.28) trend in all the treatments. The phytoplankton population was found *(Fig 3)* in increasing order in vats treated with vermicompost (2,759 nos.ℓ-1) followed by SSP (2,441 nos.ℓ-1) than by compost (2,080 nos.ℓ-1). Also, overall observation revealed an increasing trend of phytoplankton population in various sampling days of the experimental period in all the treatments. Significant differences were also found between vermicost and compost.

The zooplankton composition was represented by three groups, namely, Rotifera,

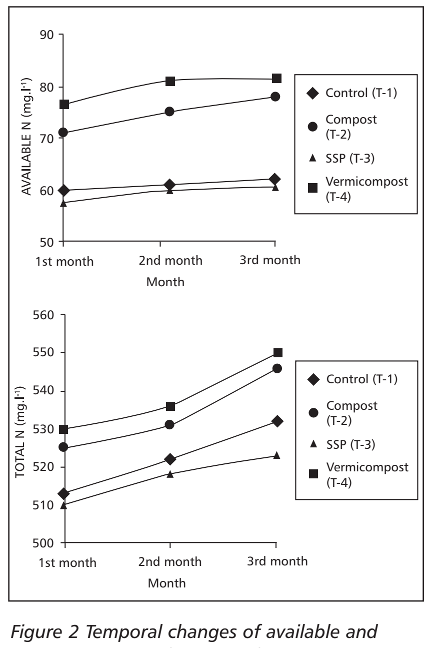

Figure 2 Temporal changes of available and total N contents of water in four treatments employed.

	Control (T_1)	Compost (T_2)	SSP (T_3)	Vermicompost (T_4)
Temp (°C)	22.5 ± 6.5	22.5 ± 6.5	22.59 ± 6.5	22.59 ± 6.5
pH	7.06 ± 1.3	7.16 ± 1.6	7.34 ± 1.1	7.43 ± 0.9
Dissolved Oxygen (mg.ℓ$^{-1}$)	6.01 ± 0.9	6.21 ± 1.1	7.74 ± 1.0	7.02 ± 1.2
Ortho phosphate (mg.ℓ$^{-1}$)	0.09 ± 0.09	0.19 ± 0.06	0.52 ± 0.10	0.30 ± 0.14
Organic phosphate (mg.ℓ$^{-1}$)	0.08 ± 0.19	0.27 ± 0.15	0.29 ± 0.14	0.35 ± 0.21
Total phosphate (mg.ℓ$^{-1}$)	0.10 ± 0.10	0.66 ± 0.16	0.85 ± 0.25	0.68 ± 0.21
No3-N (mg.ℓ$^{-1}$)	0.06 ± 0.08	0.12 ± 0.06	0.13 ± 0.03	0.16 ± 0.04
Total inorganic N (mg.ℓ$^{-1}$)	0.16 ± 0.24	0.40 ± 0.22	0.20 ± 0.19	0.62 ± 0.23
N / Ortho phosphate	1.78	2.10	0.38	2.07
Community respiration (mg C m^{-1} h^{-1})	20.13 ± 9.3	28.13 ± 12.5	35.79 ± 18.2	38.58 ± 13.1
Final mean body weight (g) Cyprinus carpio (Ham.)	18.24 ± 2.3	22.25 ± 3.6	39.50 ± 4.3	45.77 ± 3.9

Table 2 Mean values (± SD) of physico-chemical parameters of water, primary productivity of phytoplankton and final body weights of Cyprinus carpio (Ham.) in various treatments. Each mean value applies to three months samples.

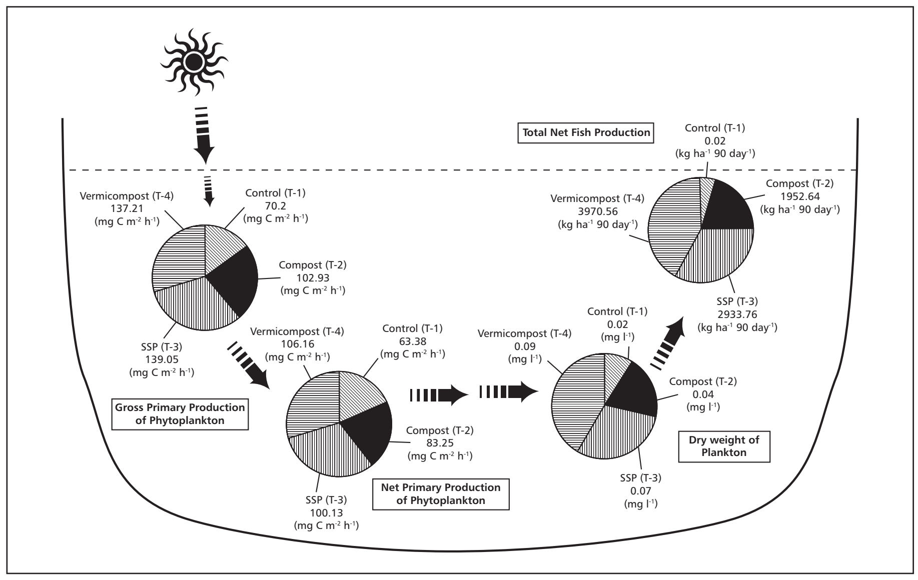

Figure 6 Diagramatic model of Fish Production through ecological chain.

Cladocera and Copepoda. The contribution of different zooplanktons group showed similar trend in the entire treatment group. Among all zooplankton Cladocera dominated (33.74−42.94) with followed by Copepoda (38.23−55.81) and rotifera (6.98−24.54) in the entire treatment group. Among the various treatments, the highest zooplankton population was observed *(Fig 4)* in the cisterns treated with vermicompost (680 nos.ℓ-1) followed by SSP (448 nos.ℓ-1), compost (326 nos.ℓ-1) and control (43 nos.ℓ-1). Moreover, the zooplankton count was increased with days of sampling in all treatments except in the control sets where a declining trend of zooplankton count was observed.

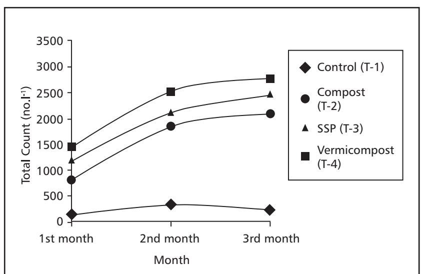

Figure 3 Monthly Sampling of Photoplankton

Fish growth and production

There was regular increase in weight of fish in all the treatments; however, the growth was much greater in the treated ponds than in the control. Among the various treatments, maximum growth increment, total gains were recorded with vermicompost followed by SSP, compost. Minimum growth rate was recorded in control.

The average growth of individual fishes *(Fig 5)* among treatment varied significant (P > 0.05) and a step wise multiple regression analysis also attested the findings *(Fig 5)*. The total yield of fish was higher in the system with high plankton count as revealed from the vats treated with vermicompost (3,970.56 kg.ha-1 90 day-1) as compared to low plankton count in control sets (3,85.92 kg.ha-1 90 day-1). The net production of fish from the cisterns manured with was 2,933.76 kg.ha-1 90 day-1 and with compost was 1,952.64 kg.ha-1 90 day-1 *(Fig 6)*.

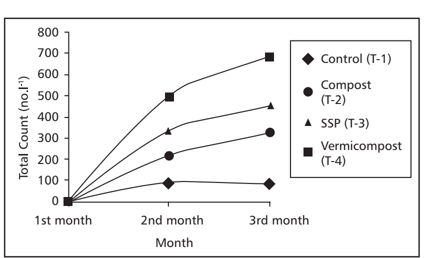

Figure 4 Monthly Sampling of Zooplankton

Discussion

Large variation of fish yield (> 9.5 times) among four experimental sets might be explained in terms of P/N ratio of water. The lowest and highest production of fish in vermicompost (T4) and control (set) was related to the lowest and moderate P/N ratio of the vats. There was direct relationship between dry weight of plankton and fish yield (r = 0.87) in all the treatment series. Superiority of vermicompost was well pronounced as it served the double role as direct feed to growing fishes and as direct manure for increasing growth of fish food.

Because the average weight and total fish yield achieved in any treatment charged with vermicompost were essentially higher than to that of the SSP treatment, it is apparent that vermicost might be a cost-effective fertilizer in carp culture, replacing the expensive chemical fertilizer SSP. This is particularly significant in developing nations, where the purchasing power of fish farmers for chemical fertilizer is very low, and vermicompost forms an abundant alternative natural resource for inexpensive P fertilizer.

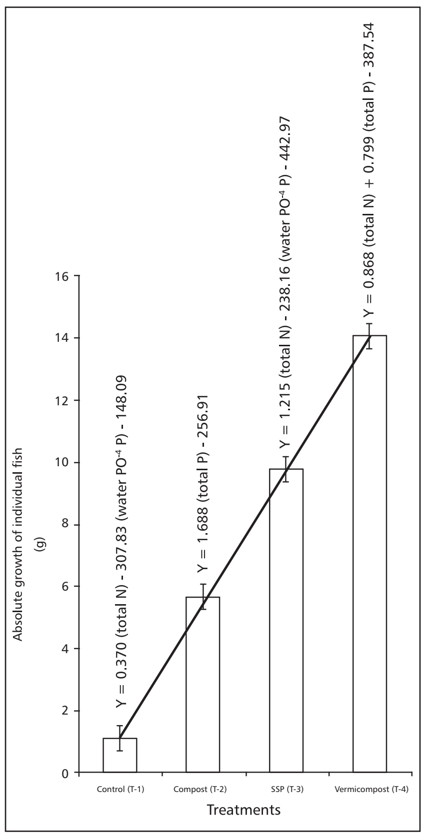

Figure 5 Absolute growth of individual fish

Large variations of fish yield among treatments were attributable to variations in the available P contents of surface sediments as well as orthophosphate level of water. It is likely that the sediment phosphorus in each treatment eventually affected fish growth through mud-water exchange mechanisms and induced the orthophosphate level of water which, in turn, maintained sustained primary productivity of phytoplankton *(Fig 6)* for functional stability of the grazing food chain. The primary productivity of phytoplankton was, however, not directly dependent upon the orthophosphate level of water in these treatments (P > 0.05).

The results of multiple regression analysis *(Fig 5)* were highly significant (P < 0.05) in each case. It is evident that both total P and total N of surface sediments exerted considerable influence in the vermicompost treatment. Total P of surface sediments and orthophosphate of water, on the other hand, were the major determinants in SSP treatment.

Manuring of fish ponds, whether it is a nursery, rearing or a stocking pond, is one of the well known practices in efficient farm management to boost up its fish production. The vermicompost applied to the culture waters is utilized for fish growth in many ways. It served as a direct feed for the fish and also acted as pond fertilizer for autotrophic and for heterotrophic production of natural fish food organisms (Muendo et. al., 2006).

The addition of manures affects the relative abundance of the plankton and their community structure. Proper combinations of inorganic nutrients (NPK) are the major factors that influence the growth and production of phytoplankton in a pond. Vermicompost contains all the major organic nutrient components (N, P and K). Trace elements also found in vermicompost. Several investigators observed high total phytoplankton in ponds treated with organic manure, mainly due to content of phosphates and nitrates (Dhawan, 1989). Thus, the greater volume of plankton in vats treated with vermicompost and SSP proved the superior nutrient status from the vats treated with compost.

High rates of fish yield and excellent growth in the present experiment can largely be attributed due to higher availability of natural food of high nutritional value in the treatments. Smith and Swingle (1939) established a direct relationship between average plankton and fish production. Similar results were observed in the present experiment where the absolute growth of fish in all the treatments exhibited a highly predictive correlation with the primary productivity of water.

A positive correlation (r = 0.99) observed between absolute growth of test fish, Cyprinus carpio and dry weight of plankton (Fig 6) signifies that natural food (plankton) alone offers all the constituents of a complete and balance diet more essentially the amino acids, required for fish growth. 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; Ansa and Jiya, 2002).

The present study thus demonstrates that carp production under similar culture conditions can be greatly enhanced using vermicompost, in place of traditionally used compost or using costly SSP. Higher rates of nutrient, increased plankton production of high nutritional value and optimum water quality conditions in the vermicompost applied vats accounts for the increased growth rate of fish as compared to control sets without manure.

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