EFFECT OF USING DIFFERENT TYPES OF ORGANIC MANURE (COMPOST, CHICKEN, MYCELIUM) AND MINERAL FERTILIZER ON WATER QUALITY, PLANKTON ABUNDANCE AND ON GROWTH PERFORMANCE OF *OREOCHROMIS NILOTICUS* IN EARTHEN PONDS

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Abstract

An experiment was conducted to evaluate the effect of using different types of organic manure (field produced compost produced of different aquatic plants, commercial compost produced by Shafey Company (SHAMKO) and chicken litter) and mineral fertilizer (Urea and super phosphate) compared with feed only as the control treatment on water quality, plankton abundance, and growth performance of Oreochromis niloticus fingerlings in earthen ponds. The study was conducted 1000m3 for each. Thirty ponds were allocated the study where as 3 ponds were randomly allocated to each treatments. Fish weighing 5g were stocked into 30 ponds at 3 fish/ m3 (3000 fish/ pond) in each treatments (Compost locally) + feed, Compost (Commercially) + feed, Mycelium + feed, chicken litter + feed, Mineral fertilizer (Urea +Super phosphate) + feed, Compost (locally) + feed + Mineral fertilizer, Compost (Commercially) + feed + Mineral fertilizer, Mycelium (by product of Citric acid company) + feed + Mineral fertilizer, chicken litter + feed + Mineral fertilizer, and feed only as a control). The study lasted 150 days. By the end of the study fish in the local compost, commercial compost and chicken litter treatments with feed and mineral fertilizer were significantly larger and had higher net yields than those in the same treatments without mineral fertilizer, mineral fertilizer and feed only treatments. The feed only treatment had higher survival rates than those in other treatments. Significantly higher amounts of chlorophyll a and higher abundance of phytoplankton and zooplankton were found in ponds fertilized with the chicken manure, all compost and Mycelium treatments with mineral fertilizer. The overall results obtained in this study suggest that the use of organic manure with mineral produces better results than the same treatments without mineral fertilizer and feed only, and recommends the use of some byproduct as an organic sources in earthen ponds with low cost.

Key words: organic and mineral fertilizer, compost, Mycelium, fish production, Tilapia, water quality, plankton, earthen ponds

INTRODUCTION

Nitrogen, phosphorus and occasionally carbon are the limiting nutrients for phytoplankton production in natural waters and also in fish ponds. Organic manures and inorganic fertilizers have been extensively used, either alone or in combination, as nutrient sources in pond fertilization (Sinha and Saha 1980). The doses and frequencies of fertilizer use influence water quality parameters significantly, often reaching 'critical limits' exerting considerable stress on the rearing species. Water quality, a major factor determining the production of fish, is dramatically influenced by the pond soil as well as pond management practices such as stocking density, fertilization strategy and supplemental feeding. Both fertilizer and feed, upon mineralization, together influence the water quality. Cow dung and poultry manures are the most commonly used organic manures in pond culture, often used in combination with urea and super phosphate as inorganic nitrogen and phosphorus sources.

Therefore, knowing the maximum permissible limit of the critical inputs such as manure, fertilizers and feed, and, also, the intermittent time required for mineralization of organic inputs and hydrolysis of inorganic fertilizers ultimately reflecting the water quality parameters is of paramount importance. The pond bottom plays a vital role in the mineralization process and supplies the required nutrients to the overlying water. The extent of decomposition of organic matter is much higher in the sediment compared with that in the water column due to the higher microbial density of all functional groups as well as the heterotrophic activity in pond sediment

Hopkins, *et al.*, (1994). Information on the specific role of pond soil in response to individual application of different critical inputs and the associated changes in the water quality is limited.

The use of manure in aquaculture supports the production of protein using inputs of little nutrient value to man or livestock (Wohlfarth & Hulata 1987). Inorganic fertilizers are expensive and their use by smallholder farmers may be limited (Swift, 1993). Animal manures have a long history of use as a source of soluble phosphorus, nitrogen and carbon for algal growth and natural food production (Knud-Hansen 1998). Animal manure is often used in semi-intensive systems to improve the primary production of the ponds and fish growth (Knud-Hansen, *et al.* 1993, Edwards, *et al.* 1997, Nguenga, *et al.* 1997). Poultry and cattle manures have been tried with *Oreochromis niloticus* and *O. fishiranus* in ponds and produced good results (Gupta, *et al.* 1992, Kamanga and Kunda 1998). The various types of manure have been found to influence the natural productivity of fish pond differently in terms of abundance and prevalence of phytoplankton and zooplankton as well as the benthic materials found in ponds. Boyd (1982) reported that poultry manure triggers more production of phytoplankton in ponds than any organic fertilizers including chemical fertilizers. However, traditionally not many fish farmers utilize this cheap resource. The use of organic manure can be a good option for small-scale farmers. The present study is an attempt to assess the changes in the water quality parameters in response to the application of organic and inorganic inputs and the role of soil influencing such changes.

MATERIALS AND METHODS

Experimental facilities and set up

This experiment was carried out in ponds at Central Laboratory for Aquaculture Research, Abbassa (CLAR), Egypt. Thirty earthen ponds measuring

1000m^2 (25x40m) and 1.25m deep were prepared by drying about 10 days before the beginning the experiment. Ponds were filled with water from Esmailia Canal. The experiment includes ten treatments, Compost (locally) + feed, Compost (Commercially treated) from El Shafey Company (Shafko Egypt) + feed, Mycelium (by product of Citric acid company) + feed, chicken litter + feed , Mineral fertilizer (Urea +Super phosphate) + feed, Compost (locally) + feed + Mineral fertilizer (Urea +Super phosphate), Compost (Commercially treated) + feed + Mineral fertilizer (Urea +Super phosphate), Mycelium (by product of Citric acid company) + feed + Mineral fertilizer (Urea +Super phosphate), chicken litter + feed + Mineral fertilizer (Urea +Super phosphate), and feed only as a control, were assigned to ponds at random in a completely randomized design (CRD) and each was replicated three times.

Fertilization regime

The ponds were fertilized 2 weeks before the fish were stocked into ponds, to ensure that production of plankton and other organisms occurred. Application was done once a week at the following rates: compost at 125 kg/feddan (fed.)/week/ Mycelium (by product of Citric acid company) at 175 kg/ feddan/ week, chicken litter at 150 kg/ feddan/ week, and mineral fertilizers at 2 kg urea + 8 kg triple super phosphate/ feddan/week.

Biochemical analysis of organic manure used

Organic fertilizers were analyzed before application using standard methods (AOAC 1990). Analysis of dry matter was done by drying pre-weighed samples in an oven at 105 °C for about 16 h to reach a constant weight, nitrogen analyzed using the Kjeldahl method, and phosphorus and potassium analyzed using spectrophotometry (Table1).

Fish stocking and sampling

Oreochromis niloticus all male fingerlings were collected from a commercial fish hatchery. The experiment started on first at June and harvested on 30th of October 2004, the experimental period was about 150 days. After one week of acclimation in the concrete ponds, experimental fish were stocked at the rate of 3 fish/ m^2. Fish were allowed to acclimate to pond conditions and mortality once occurred monitored. During the acclimation period, dead fish were replaced with fish of similar size. The initial weight of fish in all treatments was 5±1g. A sample of 100 fish were individually weighed and measured. Fish sampling was done biweekly using a seine net. Sampled fish were individually weighed (g), while total length was measured (cm). At the end of the experiment, ponds were drained and all fish were counted. Fish growth performance and yield were calculated using the following formulae:

(a) Weight gain=final mean weight (g)–initial mean weight (g)

(b) Increase in weight (%) = final weight–initial weight/initial weight x 100.

(c) Specific growth rate = (ln final weight (g) – ln initial weight (g)/ time x 100.

(d) Gross yield of fish/ feddan = harvested fish weight (kg)/unit area (feddan)

(e) Net yield / fed. = (harvested fish weight - initial fish weight)/unit area (fed.)

(f) Survival rate (%) = (initial number - number of dead fish)/ initial number x 100

(g) Faulton's condition factor = weight (g)/ $length^3$ / 100.

Table 1. Proximate composition (%) of the organic manure applied in experimental ponds (dry weight) (Mean ± SD)

Proximate component	Compost (local)	Compost (commercial)	Chicken litter	Mycelium
Dry matter*	89.74±1.88	91.08±1.92	90.12±1.48	45.5±0.74
Nitrogen	2.36±0.05	2.22±0.08	1.54±0.06	0.98±0.66
Phosphorus	1.66±0.03	1.84±0.08	1.68±0.05	0.64±0.18
potassium	0.82±0.02	0.98±0.11	0.66±0.04	0.34±0.04

Plankton monitoring and enumeration

Plankton was monitored in all ponds. Zooplankton was enumerated once a week by passing 50 L of pond water through a nylon plankton collecting net (40 µm). The pond water was collected from four positions around the pond using a 10 L bucket. The samples were then collected in bottles and fixed with two to four drops of 10% formalin solution. The organisms were concentrated in a 100ml from which sub-samples of 1.0 ml were taken for counting on a Sedgewick-rafter counting chamber mounted on a microscope at x40 magnification (APHA 2000). Zooplankton was enumerated and categories included copepods, cladocerans, rotifers and euglena. The phytoplankton samples were also collected once a week (APHA 2000).

Chemical composition of fish and zooplankton

A random sample of 50 fish was taken before the start of the experiment. Fish were weighed and dried, then grounded before being assayed for moisture, crude protein, crude fat, and ash using standard methods (AOAC 1990). At the end of the experiment, fish and zooplankton from the various treatments were also assayed for proximate body composition.

Stomach contents analysis

At the end of the experiment, a sample of thirty fish was taken from each treatment. The fish were dissected, and stomachs removed and stored in 10% formalin solution. The stomachs were weighed, dissected and the constituent food items separated, enumerated under light microscope and weighed (Meschiatti and Arcifa 2002). Plant fragments were differentiated from detritus on the basis of color, shape and cell structure. Differentiation of plankton and detritus was based on subjective indicators such as physical integrity. The stomach contents were grouped as detritus, higher plant, phytoplankton, zooplankton (Brummett 2000), insects and 'others' categories that could not be well identified. The numerical percentages of the total particles in the stomach content were calculated based on weight (Bubinas and Lozys 2000).

Analysis of pond sediments

Pond bottom soils were collected twice (before and after the experiment) to assess organic matter loading. The organic matter content was determined using the dry ash method (Boyd 1995). Sediments were dried at 105°C, pulverized, sub-sampled, weighed and ignited in a muffle furnace at 350°C for 8 h (Ayub and Boyd

1994). Percent organic matter was estimated by subtracting the weight of the ash from the dry matter.

Water quality monitoring

Temperature (°C), dissolved oxygen (mg/l), saturation of dissolved oxygen % were measured by oxygen meter Aqua Lytic OX 24, pH by pH meter Orion 543, salinity g/l were measured using a conductivity meter Orion. Recordings were taken every day, 7 days a week, at 09:00 hour throughout the culture period. Secchi disk visibilities (cm), ammonia (mg/l), nitrite (mg/l), total alkalinity as $CaCO_3$ (mg/l), total hardness (mg/l) phosphorus (mg/l) and chlorophyll a µg/l were also measured once a week using standard methods (APHA 2000).

Statistical analysis

The data was first checked for assumptions for analysis of variance. The data was then subjected to analysis of variance (ANOVA) using a general linear model (GLM), repeated measures design on weight measurements with time. One-way ANOVA analysis was then performed at each time for weight, and other data collected to determine significance. If significant ($P<0.05$) differences were found in the ANOVA test, Duncan's multiple range test (Duncan1955) was used to rank the groups. The data are presented as mean SE or otherwise stated, of three replicate groups. All statistical analyses were carried out using SPSS program, 10.0 (SPSS, 1999).

RESULTS AND DISSCTIONS

Water quality parameters

The fertilizer application affected the quality of the water in a number of ways during this experiment (Table 2). There were significant differences ($P < 0.05$) among treatments in pH, oxygen levels, ammonia, nitrite, alkalinity level, secchi disk visibilities, nitrate, chlorophyll a as well as phosphorus as total and available. However, there were no significant differences in temperatures and salinity levels and total hardness. The other parameters were within ranges for tilapia cultures. Water quality in this experiment varied with the type of organic manure applied but did not affect the well-being of the fish. The temperatures were within the normal range for Tilapia (27-28 °C) according to Philipart and Ruwet (1982). The other water parameters in the present experiment were within ranges for tilapia cultured in fertilized ponds (Bowman, *et al.* 2002, Chaula, *et al.* 2002). These conditions were also conducive for growth and propagation of zooplankton, such as Rotifers, Copepoda and Cladocerans, which grow and propagate well under the conditions in this experiment (Delbare and Dert, 1996).

Phytoplankton production in the form of chlorophyll a indicated that the application of mineral fertilizers with all organic (all compost, chicken manure and Mycelium) propagated significantly ($P<0.05$) higher amounts of chlorophyll a than without mineral fertilizers, which did not differ significantly from each other (Table 2). But there were differ significantly among treatments without mineral and with mineral fertilizers. The feed only treatment had a significantly lower amount of chlorophyll a. The average values of chlorophyll a were 88.92, 90.18, 96.42, 68.98, 82.88, 128.12, 136.22 and 114.28µg/l for local compost+ feed, commercial compost +feed , chicken litter +feed, Mycelium +feed, mineral fertilizer +feed , local compost+ feed + mineral fertilizer, commercial compost +feed+ mineral fertilizer, chicken litter +feed+ mineral fertilizer, Mycelium +feed+ mineral fertilizer and feed only respectively (Table 2). Significantly higher amounts of chlorophyll a were recorded in ponds fertilized with organic and inorganic indicating that there was a higher level of phytoplankton production. This is consistent with the work reported by Diana, *et al.* (1988) with higher inputs of chicken manure (500 kg/ ha/week).

Table 2. Means of some physico-chemical parameters in earthen ponds under different fertilization types and systems during the experimental Period.

Item / Treatment	Temp °C	pH	SD Cm	DO mg/l	Satu. %	NH_4 mg/l	NH_3 mg/l	NO_2 mg/l	NO_3 mg/l	Total alkalinity mg/l	Total hardness mg/l	Salinity g/l	Total phosphorus mg/l	Ortho phosphate mg/l	Chlorophyll a µg/l
Compost local + feed	27.5 ±1.5 a	8.54 ±0.5 b	14.0 ±1.5 b	4.76 ±0.6 b	55.75 ±1.26 b	1.3 ±0.05 c	0.34 ±0.01 c	0.10 ±0.01 c	0.28 ±0.05 b	256.0 ±22 a	276 ±24 a	2.2 ±0.1 a	1.10 ±0.04 b	0.64 ±0.04 a	88.92 ±6.36 b
compost comm. +feed	27.5± 1.5a	8.56± 0.7b	14.2± 1.2b	4.88± 0.4b	58.48 ±2.1b	1.3± 0.04c	0.34± 0.01c	0.09± 0.01c	0.28± 0.04b	258.0± 20a	274± 22a	2.3± 0.1a	1.12± 0.02b	0.66± 0.06a	90.18± 4.28b
chicken litter + feed	27.6± 1.0a	8.90± 0.8b	11.5± 1.5c	6.85± 0.8a	80.4± 5.2a	1.9± 0.05b	0.94± 0.03b	0.14± 0.02b	0.39± 0.04a	268.5± 18a	320± 20a	2.3± 0.1a	1.36± 0.04a	0.74± 0.05a	96.42± 5.38b
Mycelium + Feed	27.8± 1.0a	7.80± 0.5c	15.5± 2.1b	4.88± 0.6b	59.9± 2.12b	1.9± 0.10b	0.15± 0.01c	0.12± 0.02c	0.24± 0.06b	194.5± 18c	280± 18a	2.2± 0.1a	1.04± 0.06b	0.54± 0.03b	68.98± 3.44b
Mineral fertilizer +F	28.0± 1.5a	8.88± 0.8b	12.4± 1.4c	5.75± 0.7b	71.22 ±3.6b	1.6± 0.4bc	0.59± 0.02b	0.11± 0.01c	0.32± 0.08b	222.0± 16b	284± 16a	2.3± 0.1a	1.46± 0.08a	0.88± 0.05a	82.88± 7.22b
comp. loc. + feed + min.	27.5± 1.2a	9.20± 0.9a	12.6± 1.2c	5.70± 0.5b	70.84 ±2.5b	1.7± 0.06b	1.07± 0.05b	0.18± 0.03b	0.44± 0.08a	268.0± 14a	272± 14a	2.2± 0.1a	1.56± 0.05a	0.74± 0.06a	124.4± 8.12a
comp. com.+ feed + min.	27.0± 1.2a	9.30± 0.5a	12.4± 16c	5.74± 0.3b	70.28 ±2.4b	1.7± 0.06b	1.3± 0.1a	0.17± 0.02b	0.42± 0.07a	266.0± 26a	272± 12a	2.4± 0.1a	1.58± 0.05a	0.78± 0.03a	128.12± 6.92a
chicken+ feed + min	27.5± 1.2a	9.40± 0.6a	10.2± 1.3c	7.22± 0.3a	88.5± 7.5a	2.3± 0.14a	1.76± 0.13a	0.21± 0.02a	0.48± 0.08a	274.0± 22a	280± 16a	2.3± 0.1a	1.78± 0.06a	0.84± 0.05a	136.22± 8.2a
Mycelium + Feed + min	28.0± 1.2a	8.12± 0.5c	13.1± 1.2c	5.12± 0.4b	68.86 ±1.8b	2.4± 0.12a	0.29± 0.01c	0.26± 0.02a	0.56± 0.11a	236.5± 18b	278± 14a	2.2± 0.1a	1.32± 0.04a	0.64± 0.05a	114.28± 4.24a
Feed only	27.0± 1.4a	8.32± 0.5c	19.2± 1.4a	3.96± 0.2c	38.36 ±1.1c	1.5± 0.10c	0.27± 0.01c	0.09± 0.01c	0.18± 0.03c	206.5±14 bc	274± 12a	2.2± 0.1a	0.88± 0.07c	0.44± 0.03b	38.36± 2.16c

- Values with different superscripts in a column are significantly different ($P < 0.05$).

Table 3. Growth performance and fish production per feddan of *Oreochromis niloticus* in earthen ponds under different fertilization systems

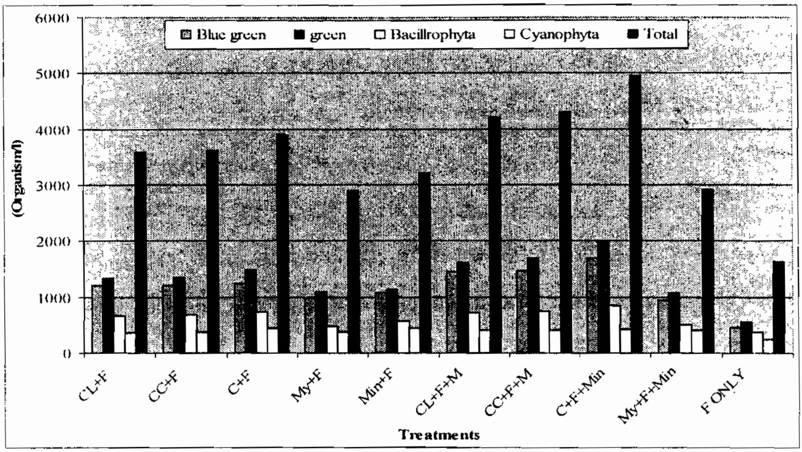
Item / Treatment	final weight (g)	net gain (g)	daily gain (g)	Gain (%)	Survival rate (%)	total production (kg)	Net production	Production/ Feddan	SGR	K
Compost local+ feed	198.5± 11b	193.5± 12b	1.29± 0.2a	3870± 152b	95.5± 1.5b	568.7± 41.5b	554.4± 38.2b	2274.8± 192b	2.452± 0.15a	4.04± 0.1a
Compost comm.+ feed	200± 10.5b	195± 15b	1.3± 0.12a	3900± 212b	96.5± 1b	579± 44.2b	564.25± 40b	2316± 134b	2.459± 0.12a	4.07± 0.1a
Chicken litter + feed	212± 15b	207± 22a	1.38± 0.14a	4140± 226b	96.0± 1.0b	610.56± 39a	596.16± 35a	2442.4± 146a	2.498± 0.18a	3.64± 0.1b
Mycelium + Feed	175± 14bc	170± 18bc	1.13± 0.11b	3400± 174b	96.0± 1.5b	504± 50.5bc	489.6± 44bc	2016± 130bc	2.369± 0.1b	5.19± 0.2a
Mineral fertilizer + F	165.5± 22bc	160.5± 16bc	1.07± 0.11b	3210± 136b	96.0± 2.0b	475.2 ±34c	462.24± 31c	1900.8± 98c	2.333± 0.11b	4.9± 0.2a
Comp. loc. + feed + min.	222.5± 12.5a	217.5± 24a	1.45± 0.16a	4350± 242a	95.0± 1.5b	634.125 ±48a	219.9± 45a	2536.5± 144a	2.529± 0.2a	3.24± 0.1b
Comp. com. + feed + min.	238.5± 15a	233.5± 24a	1.56± 0.13a	4670± 244a	96.0± 1.5b	686.88± 26a	672.5± 25a	2747.52± 186a	2.576± 0.14a	3.48± 0.1b
Chicken+ feed+ min	245.5± 12a	240.5± 21a	1.6± 0.15a	4810± 388a	95.5± 1.5b	703.36± 33a	687.6± 30a	2813.44± 212a	2.596± 0.13a	3.07± 0.1b
Mycelium + Feed +min	194.5± 17b	189.5± 13b	1.26± 0.1b	3790± 236b	95.0± 2.5b	554.3± 16.5b	540.1± 15b	2217.2± 122b	2.44± 0.17a	3.96± 0.1ab
Feed only	118.5± 13c	113.5± 7c	0.76± 0.07c	2270± 156c	98.5± 0.5a	350.17± 14.5c	335.4± 13c	1400.68± 78c	2.11± .13c	5.39± 0.1a

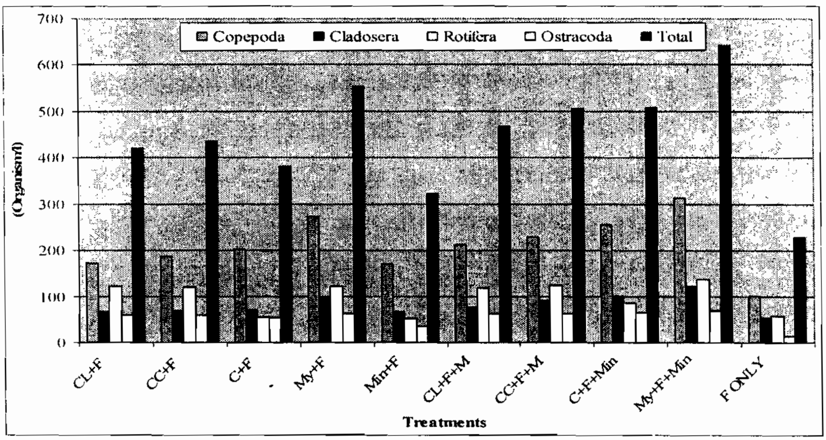
* Values with different superscripts in a column are significantly different ($P< 0.05$).

Plankton abundance

There were significant differences in numbers among the classes of zooplankton such as copepods, cladocerans and rotifers. Copepod, cladocerans (daphnia and moina) and rotifers numbers per liter of water sampled was significantly ($P<0.05$) different among treatments. The feed only treatment had significantly lower numbers of zooplankton compared with other treatments. Mycelium +feed + mineral fertilizer propagated significantly higher numbers of zooplankton compared with other treatments. But zooplankton numbers in all compost and chicken without mineral fertilizer did not differ significantly ($P<0.05$). On the other hand, the added of mineral fertilizer with all fertilization types significantly increase of phytoplankton and zooplankton according to Jeremiah, *et al.* 2006. Also, there were significant differences in numbers of phytoplankton among treatments. The highest numbers in phytoplankton recorded in chicken litter treatment with mineral fertilizer followed by all compost (local and commercial) with mineral fertilizers (fig.1). While, the lowest number recorded in feed only treatment. On the other hand, there were significant differences among treatment without mineral and treatments with mineral fertilizer. Phytoplankton is reported to have protein levels ranging from 12% to 35%, lipids ranging from 7.2% to 23% and carbohydrates ranging from 8.2% to 8.7% on a dry weight basis. Phytoplankton is considered to also be high in ascorbic acid (Coutteau, 1996). In a related study, Yi *et al.* (2002) reported high levels of ash (51-52%) in some species phytoplankton species in ponds. Ash content was significantly higher in the chicken manure treatment while the lowest was in the feed only treatment. This was consistent with work reported in several studies (Delbare and Dert, 1996). Copepod propagation did not differ significantly in all compost and manure treatments and this was similar to that reported by Kamanga and Kaunda, (1998).

Fig 1. Phytoplankton and Zooplankton community organism /l under different fertilization systems.





CL+ F = Compost local + feed, CC+F = Compost comm. + feed, C + F = Chicken litter + feed, My + F= Mycelium + Feed, Min + F = Mineral fertilizer + F, CL+F+M = Comp. loc. + feed + min., CC + F + M = Comp. com. + feed + min., C + F + Min = Chicken + feed + min, My + F + Min = Mycelium + Feed +min, F ONLY = Feed only.

Also, adding of mineral fertilizers increased significantly the propagation of zooplankton (fig.1). However, the differences from their report were higher numbers of copepods (312 org/l in Mycelium with feed and mineral fertilizer), while the lowest number was recorded in feed only (102 org. /l). Cladoceran, especially daphnia, was better in the Mycelium with feed and mineral fertilizer and chicken manure and feed with mineral fertilizers ponds and this was consistent with work reported by Kamanga and Kaunda, (1998). Copepoda and rotifers were abundant in all ponds, there was increase significantly in fertilized ponds. The number of zooplankton was higher in the present experiment than reported by Pratap, *et al.* (2005) in an organic (Napier grass) fertilization regime with *T. rendalli*. However, Kamanga and Kunda, (1998) reported surprisingly higher numbers of copepods, rotifers and Cladocerans in no-manure treatment in concrete tanks. These variations may be due to differences in the nutrient levels in the organic manure used.

The initial mean weight of experimental fish (5 g) was not significantly different (Table 3). Significant differences among the treatments continued to the end of the experiment, where fish in the all treatment were 198.5, 200, 212, 175, 165.5, 222.5, 238.5, 245.5, 194.5 and 118.58g for local compost+ feed, commercial compost +feed, chicken litter +feed, Mycelium +feed, mineral fertilizer +feed, local compost+ feed + mineral fertilizer, commercial compost +feed+ mineral fertilizer, chicken litter +feed+ mineral fertilizer, Mycelium +feed+ mineral fertilizer and feed only respectively. The local and commercial compost and chicken litter with mineral fertilizer had significantly higher final mean weights compared with the same treatments without mineral fertilizer, mycelium with, without mineral and feed only treatments. Also, fish in the feed only treatment had a significantly lower mean weight throughout the experiment with a final mean weight of 118.5 g. The weights of fish in the first three treatments were not significantly different throughout the experiment.

Fish in the all compost treatments and chicken litter treatments (with and without mineral) also showed significantly ($P<0.05$) higher specific growth rates than fish

in the other treatments. Specific growth rates of fish in the Mycelium treatments (with and without mineral fertilizers) did not differ significantly. However, fish in the feed only treatment exhibited significantly lower specific growth rates.
This trend was also true for weight gains per day ranging from 0.76 g/ day for feed only treatment to 1.38 g/ day for chicken manure treatment without and 1.6 for chicken manure treatment with mineral fertilizers. Fish in ponds fertilized with organic and mineral grew significantly better than fish in the other treatments. This result is consistent with fertilization systems where yields are above those from unfertilized ponds (Edwards, *et al.* 1988). The specific growth rates of fish in this study were significantly higher in organic and mineral fertilizer treated ponds. Chikafumbwa, *et al.* (1993) reported low growth rates for *T. rendalli* (0.42% day) and *Oreochromis shiranus* (0.37%day) in ponds supplied with Napier grass, *Pennisetum perpureum*. However, their results compare well with the specific growth rates in the all treatments reported in this experiment. Chaula, *et al.* (2002) reported 0.70% /day for *O. shiranus* in a similar input system, which was within the range of the present results in feed only, though slightly lower. Garg and Bhatnagar, (2000) reported similar specific growth rates (0.71 %/day) in Indian major carp, *Cirrhinus mrigalla*, grown in ponds fertilized with a mixture of cow dung, triple super phosphate and urea. The percent increase in weight for *Oreochromis niloticus* was higher for fish in all compost and chicken with mineral fertilizer in this experiment compared with those from similar systems where increase was reported for fish in ponds treated with bamboo trunks and poultry manure for *T. zillii* (Nwachukwu, 1997).

Survival was higher in feed treatment, while survival rates did not vary among treatments. Yields obtained in this experiment were 2274.8, 2316, 2442.4, 2016, 1900.8, 2536.5, 2747.52, 2813.44, 2217.2 and 1400.68 kg/feddan for the same treatments respectively. Extrapolated net yields obtained in this experiment from all treatments were within the range of those reported by other earlier researchers in Malawi (Costa-Pierce, *et al.* 1991, Chikafumbwa *et al.* 1993, Brummett and Noble, 1995b). Brooks, *et al.* (1997) reported T. rendalli raised in ponds with fertilization produced net yields ranging from 1000 to 1500 kg/ ha/year. The present yields are higher than those reported by Chaula, *et al.* (2002), which was 2536.5 kg/ fed.year for *O. niloticus* grown in ponds supplied with local compost with mineral at 125 kg/ fed/week plus 2 kg urea +8 kg super phosphate/fed./week).

Fish body composition

Moisture, ash, fat, and protein were significantly (P<0.05) different among treatments (Table 4). Moisture levels varied significantly (P<0.05) among treatments with the lowest in the initial sample (72.56%) and in the feed only (74.56%) treatment, while, did not vary (P<0.05) from each other. Fish cultured in the Mycelium treatments with and without mineral had significantly higher moisture than fish in all treatments and initial sample. Ash content decreased while protein increased across treatments. However, protein content of the fish did not differ significantly among treatments. While, protein increased in all treatments than in initial fish. Application of manure had a significant effect on the proximate composition of the fish indicating that the availability of food, among others, could influence the composition. The amount of protein in the present experiment is within the range reported by Yi, *et al.* (2002) where they fed different species of phytoplankton to sex reversed Thai red tilapia. However, they reported higher moisture (83%) and ash (23-26%) content in their study than reported in this experiment.

Table 4.Whole-body composition (moisture, ash, crude fat and crude protein) of *Oreochromis niloticus* in earthen ponds fertilized with different organic manure (dry weight) (mean± SE)*

Item / Treatment	Moisture	Fat	Ash	Protein
Initial	72.56±1.1c	10.20±0.22d	12.52±0.1a	72.6±1.24b
Compost local+ feed	77.32±1b	12.56±0.12b	12.88±0.1a	74.66±1.18a
Compost comm.+ feed	77.44±0.7b	12.78±0.08b	12.98±0.2a	75.12±1.36a
Chicken litter + feed	77.66±1.2b	13.22±0.08a	13.66±0.1a	74.98±1.0a
Mycelium + Feed	79.22±0.8a	11.46±0.10c	11.12±0.1b	75.08±1.12a
Mineral fertilizer + F	76.22±0.7b	11.78±0.12c	13.10±0.3a	74.46±1.12a
Comp. loc. + feed + min.	77.26±0.9b	12.62±0.09b	12.22±0.2ab	75.22±1.14a
Comp. com. + feed + min.	77.28±1b	12.66±0.07b	12.88±0.3a	75.24±1.22a
Chicken+ feed+ min	77.66±0.8b	13.10±0.1a	13.76±0.1a	75.36±1.26a
Mycelium + Feed +min	79.02±0.75a	11.68±0.12c	12.98±0.3a	75.18±1.1a
Feed only	77.56±1.2b	14.32±0.11a	13.46±0.1a	74.78±1.32a

Values with different superscripts in a column are significantly different (P< 0.05).

This may be due to the species and saline environment in their experiment. Veverica, *et al.* (2000) in inorganic fertilized ponds stocked with *O. niloticus* and *C. gariepinus*, reported a decrease in fat content and a slight increase in moisture, protein and ash. This was in contrast to fairly high increases in fat content and a reduction in ash from the initial samples experienced in the present experiment across treatments.

Stomach contents

The stomach contents of fish came variable and varied significantly ($P<0.05$), depending on the type of manures used. The fish from the Mycelium plus feed without & with mineral fertilizer and feed only treatments had a significantly higher amount of detritus (52.5, 50.5 and 49.5 %) in their stomachs followed by fish cultured in local compost plus feed (41.5%), commercial compost plus feed (38.5%), local compost plus feed plus mineral fertilizer 38%, commercial compost plus feed plus mineral fertilizer 37.5% and lastly those in chicken manure plus feed without and with mineral fertilizer 38 & 37.5% respectively (fig. 2). Higher plant, zooplankton and phytoplankton contents in fish stomachs had significant differences among treatments and were predominant in fish stomachs from chicken manure treated ponds. The lowest amounts of phytoplankton were found in stomachs of fish from the feed only treatment (11.5 %,). Insects were significantly ($P<0.05$) higher in stomachs of fish cultured in the feed only ponds (6.5%) followed by Mycelium plus feed (4.5%), local and commercial without (1.5%), mineral plus feed and commercial compost with mineral fertilizer (1.5%) and lastly the pig chicken litter plus feed, chicken litter plus feed plus mineral fertilizer, local compost plus feed plus mineral and Mycelium plus feed plus mineral fertilizer (0.5%). Insects were not consumed in large amounts but detritus was highly consumed across treatments. The stomach contents of fish in this experiment ranged from detritus, higher plants, zooplanktons, phytoplankton to insects. Jeremiah, *et al.* (2006) found the same categories of stomach contents in *T. rendalli* but insects and plankton were absent in fish ranging from 21to 40 g, which was not the case in the present experiment, whereas we noted that fish cultured in the all Mycelium treatments and feed only treatment consumed significantly higher amounts of detritus followed by those in the all compost treatments and all chicken manure treatments.

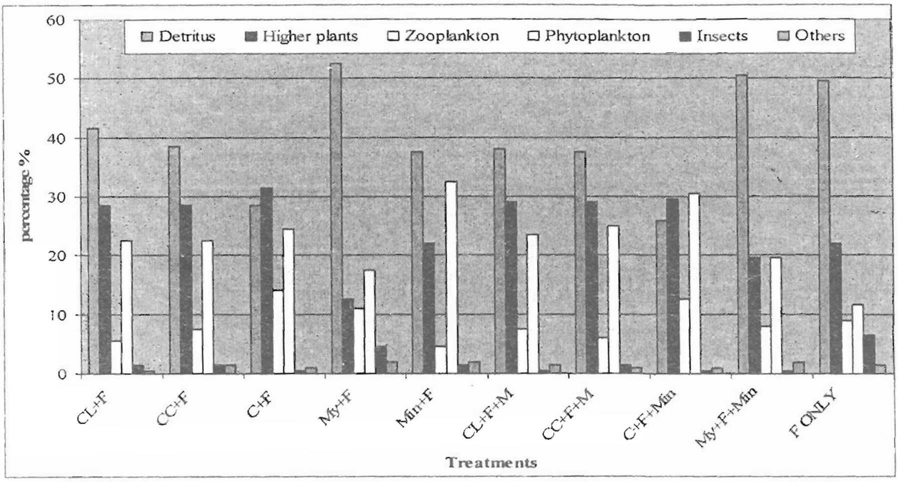


Fig. 2. Mean (SE) of stomach contents, detritus, higher plants, zooplankton, phytoplankton, insects and others for Tilapia in earthen ponds under different fertilization systems.

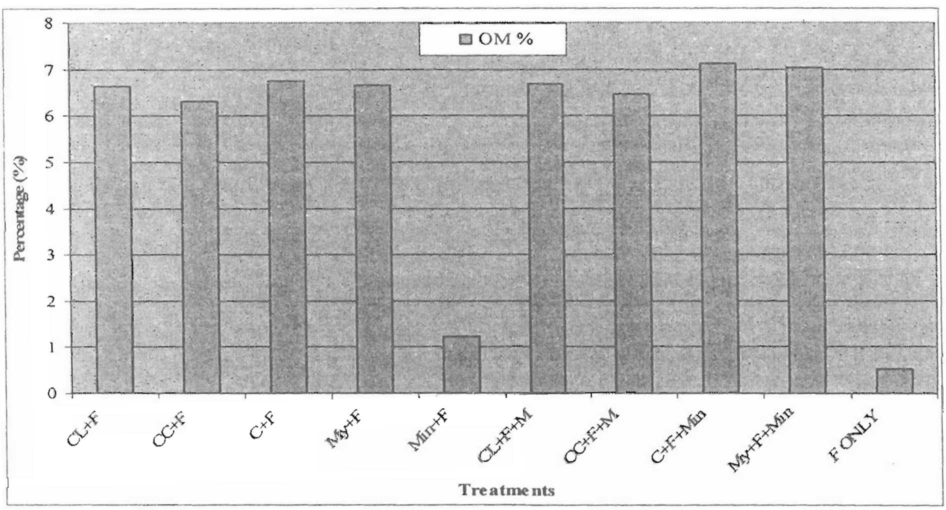


Fig. 3. Organic matter as percentage in soil under different fertilization systems.

Fish in the range of 100-150 g consumed high amounts of detritus and was similar to that reported by Brummett, (2000). Fish in the chicken manure ponds preferred higher plants, phytoplankton and zooplankton and reduced their intake of detritus. Insects were found least in stomachs of the fish, although those fish in the feed only treatment had significantly higher amounts of insects in their stomachs. Tilapia is believed to change feeding habits as they grow. They change from carnivorous when young (7-33mm) and consume lots of zooplankton, aquatic insects and detritus, which make up about 26% of their stomach contents in the wild (Meschiatti and Arcifa 2002). They turn herbivorous as they grow (Brummett 2000). Detritus was one of the important stomach contents encountered during the analysis. The nutritional quality of detritus from various environments (tropical and temperate) is variable in terms of protein level, which range from 2.9% to 24.2% with good amino acid profiles (Bowen, 1987).

Soil organic matter loading

The application of manure in ponds was expected to increase the organic matter loading. In the experiment, it was found that at the application rate of 600 kg/ fed./ week of chicken manure and 500kg/fed./week of compost and 700kg/fed./week of Mycelium, the percent organic matter loading was significantly ($P<0.05$) different among treatments (fig. 3). The no-manure treatment was significantly lower (0.52%) in organic matter loading. However, organic matter loading did not differ significantly among chicken, all compost and Mycelium with and without mineral fertilizer in earthen ponds despite the fact that Mycelium was applied at a higher rate. Organic matter loading due to fertilization was significantly higher in ponds fertilized with chicken manure but did not differ significantly with all compost with and without mineral fertilizer treatments. The levels of loading were comparable with those reported by Boyd (1990) and Jeremiah *et al.* (2005). It is reported that pond soils tend to acquire greater organic matter concentration than surface soils and may increase with organic fertilization (Boyd 1995). The organic matter acts as substrate for the heterotrophic production of microorganisms and protozoans in microbial food webs that can be utilized by fish to obtain the much needed nutrition through natural crops of algae, bacteria and other microorganisms in organically fertilized ponds (Boyd 1995, Moriarty 1997).

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تأثير استخدام الأنواع المختلفة من الأسمدة العضوية والمعدنية على خواص المياة ونمو الهائمات النباتية والحيوانية وإنتاجية أسماك البلطى النيلى فى الأحواض الترابية

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فى تجربة لدراسة تأثير إستخدام الأسمدة العضوية المختلفة (الكمبوست المنتج من النباتات المحلية والكمبوست التجارى وزرق الدواجن) بالإضافة الى الأسمدة المعدنية ممثلة فى السوبر فوسفات الثلاثى واليوريا مقارنة بالتغذية الصناعية على خواص جودة المياة ونمو الهائمات النباتية والحيوانية وكذلك نمو الأسماك وكانت أهم النتائج المتحصل عليها:-

١- زيادة الكلوروفيل و الهائمات النباتية والحيوانية فى جميع المعاملات المستخدمة للسماد العضوى مع المعدني.

٢- زيادة نسبة الأسماك الحية فى معاملة التغذية فقط عن باقى المعاملات.

٣- زيادة الإنتاجية السمكية ومعدل الأداء للأسماك في التسميد العضوي مع المعدني والتغذية عن التسميد العضوي والمعدني فقط.

٤- زيادة الإنتاجية في المعاملات السمادية عن التغذية فقط.

٥- عدم وجود أى فروق معنوية نتيجة إستخدام مخلفات مصنع حمض الستريك (الميسليوم) كسماد عضوي.

٦- خلصت الدراسة إلى أهمية إستخدام الأسمدة المعدنية بالإضافة للأسمدة العضوية.