EFFECT OF APPLYING AGRICULTURAL BY-PRODUCTS AS FERTILIZERS ON FRESHWATER FISH PONDS QUALITY

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Abstract

Six hundred m^3 earthen ponds were divided into three groups, the first and second treatments received different combinations of compost (agricultural by-products) with chemical fertilizers (triple super phosphate + urea). The third treatment received chemical fertilizers only. Results revealed that partial substitution of chemical fertilizers with compost reduced nitrogenuous wastes and increased densities of both phyto and zooplankton. Moreover, water quality of the treated ponds demonstrated better characteristics.

INTRODUCTION

The most common substances used in pond aquaculture are fertilizers. They are highly soluble and release nutrients that can cause eutrophication of natural waters. Fertilizers are corrosive and some are highly explosive, so proper handling is necessary to prevent accidents. (Boyd and Massaut, 1999). It was observed that the long-term use of chemical fertilizers has a negative impact on the fertility of the topsoil. Fertilizers consist of up to 60 % of the so-called 'fillers', so that the nutrients contained in the fertilizer can be more easily broadcasted and spread out. This filler mainly consists of pure sand, resulting in an application of tons of pure sand each year, so the soil becomes more and more sandy. Extensive aquaculture provides a way to use the wastes from other farm enterprises as an input to the fishpond, making small-scale farms more productive without additional external inputs. Wastes such as crop by-products, weeds and tree leaves become valuable resources, and fertilizers which were lost to the environment before. Fish convert plant and animal residues into high quality protein and reduce commercial fertilizers with its adverse long-term effects. So, the positive effect is two-fold, where the external inputs are reduced and at the same time the amount of primary farm products increase (Lightfoot, 1990).

Therefore, the present study aimed to investigate the possibility of using agricultural by-products as fertilizers in fish ponds in order to reduce the amounts of chemical fertilizers that are currently introduced into the aquatic environment and to make use of the huge quantities of agricultural by-products instead of being an environmental problem.

MATERIALS AND METHODS

This study was conducted in experimental earthen ponds at the Central Laboratory for Aquaculture Research (CLAR), Agricultural Research Center, Ministry of Agriculture, Egypt.

Experimental design

Earthen ponds were divided into three groups. Physiochemical analysis of compost and amount of different fertilizers applied to each treatment, are shown in Tables 1 and 2.

Table 1. Chemical and physical analysis of tested compost.

Item	Value
Cubic meter weight (kgm)	600
Humidity	30%
pH	9
Electric conductivity (EC)	6.5 ml mhos
Total nitrogen	1.75%
Ammonia nitrogen	100 ppm
Nitrate nitrogen	45 ppm
Organic matter	54 %
Organic carbon	31%
Ash	45%
C:N ratio	18:1
Sodium chloride	3.5%
Humic acids	15%
Total phosphorous	0.44%
Total potassium	1%
Iron	1000 ppm
Manganese	100 ppm
Copper	50 ppm
Zinc	250 ppm

Table 2. Rate of applying compost and chemical fertilizers.

Treatment	Rate of different fertilizers added (Kg / feddan weekly)		
	urea	triple Super phosphate	compost
I	8.75	14	350
II	17.5	28	175
III	26.25	42	0

Ponds description and preparation

All experimental ponds were equal in their water volume (600 m^3), each had the dimensions of 20 X 40 m with the same average depth of 0.75 m. Before the start of the experiment, ponds were drained, cleaned and exposed to sun for two weeks. The source of irrigation was Nile water from Gadaon channel branched from Ismailia canal. Water depth for each pond was maintained constant along the study period, where the water loss due to evaporation or seepage was compensated through irrigation pipes covered with a screen to prevent the entrance of any wild fish.

Analytical procedures

Water quality measurements

The following physical and chemical properties were measured biweekly.

Outdoor measurements

Some water quality parameters were measured outdoor as follows:

-Water temperature and dissolved oxygen (DO) using (YSI model 57) oxygen meter.

-Electric conductivity (EC) using (YSI model 33) conductivity meter.

-pH values using pH meter (model Corning 345).

-Water visibility using Secchi disk (SD).

Laboratory analysis

Five liters of water from each pond were mixed and taken to the laboratory for the following measurements:

-Total alkalinity and total hardness were measured as $CaCO_3$ according to the methods described in APHA (1985).

-Total ammonia concentration (NH_3 + NH_4^+ as N) was determined by nesslerization method (APHA, 1985), and then ammonia (NH_3) was calculated from total ammonia according to the following equation (Boyd, 1990): $NH_3 = A/100 \times 1.2 \times$ total ammonia

Where: A is a coefficient related to water pH and temperature measured at the time of sampling.

-Nitrate-nitrogen (NO_3-N), nitrite-nitrogen (NO_2-N), Total available phosphorous and filterable orthophosphate (PO_4^-) were measured according to methods described in APHA (1985).

Biological examinations

Chlorophyll *"a"*

Chlorophyll *"a"* concentration was determined photometrically, using spectrophotometer (mode Milton Roy 21D). The concentration of chlorophyll *"a"* was determined according to Vollenweider (1969).

Phytoplankton assessment

Phytoplankton cells were counted microscopically in a counting chamber, using a micrometer eye lens and identified to the main four divisions: Green algae (Chlorophyceae), Blue-green algae (Cyanophyceae), Diatoms (Bacillariophyceae), and Euglenas (Dinophyceae)

Zooplankton assessment

Zooplankton organisms were counted and identified to the main four divisions: Rotifera, Cladocera, Copepoda, and Ostracoda, using Sedgewick Rafter Counting Cell.

Statistical analysis

Statistical analysis was performed using analysis of variance (ANOVA). Duncan's Multiple Range Test was used to evaluate the differences among treatments means for all parameters at the 0.05 significance level. Standard errors were estimated. All statistics were run using the SAS program (SAS, 1987).

RESULTS AND DISCUSSION

Physico-chemical characteristics of water:

Data of water quality properties are summarized in Tables (3-6). Water temperature values along the period of the study were correlated with sampling time, while different treatments did not affect water temperature, revealing that the type of fertilization had no thermal effect. Boyd (1990) mentioned that water temperatures in ponds are related to solar radiation and air temperatures. The highest water temperature (29 °C) was recorded in the 2^{nd} month (during August), while the lowest (24.5 °C) was recorded in the 4^{th} month (during October). Average means of water temperature were 26.63, 26.63 and 26.88°C for treatments I, II and III, respectively. In most sampling times, dissolved oxygen concentrations were significantly lower in mixed treatments (I and II) (Table 3). Average means of dissolved oxygen concentrations were 7.61, 7.44 and 8.29 mg/l for treatments I, II and III, respectively. Boyd (1981) revealed that organic fertilizers act as an energy source for bacterial growth and the aerobic decomposition of organic matter by bacteria, which could be considered an important drain of oxygen supplies in ponds. Qin *et al.* (1995) reported that using alfalfa as an organic fertilizer resulted in lower dissolved oxygen concentrations. Kurten *et al.* (1999) reported that dissolved oxygen concentrations in ponds receiving cottonseed meal as an organic fertilizer, in addition to mineral fertilizers were significantly lower than in ponds treated with mineral fertilizers only.

Table 3 Means* ± SE of temperature, dissolved oxygen, pH and Secchi disc visibility of water in different treatments along the period of study.

Time (Month)	Treat.	Temperature (°C)	Dissolved oxygen (mg/l)	pH	Secchi disk visibility (cm)
July	I	26.0 a ± 0	8.9 a ± 0.35	8.7 c ± 0.05	14.0 a ± 0
	II	26.5 a ± 0.3	8.5 a ± 0.17	8.85 b ± 0.03	14.0 a ± 0
	III	26.5 a ± 0	8.9 a ± 0.05	9.0 a ± 0	12.0 b ± 0
August	I	29 a ± 0.6	6.9 b ± 0.057	9.5 b ± 0	12.0 a ± 0.58
	II	28.5 a ± 0.1	6 8 b ± 0.057	10.25 a ± 0.14	12.0 a ± 0.58
	III	29.0 a ± 0.6	7.8 a ± 0.35	9.9 ab ±0.23	9.5 b ± 0.29
September	I	26.5 a ± 0	7.25 a ± 0.14	7.8 b ± 0.06	12.5 a ± 0.29
	II	27.0 a ± 0.3	6.4 b ± 0.23	9.25 a ± 0.14	11.5 b ± 0.29
	III	27.0 a ± 0.14	7.55 a ± 0.14	9.55 a ± 0.14	10.5 c ± 0.29
October	I	25.0 a ± 0	7.4 b ± 0.058	9.7 a ± 0.058	12.5 a ± 0.87
	II	24.5 a ± 0	8.05 b ± 0.03	9.7 a ± 0.12	9.5 b ± 0.29
	III	25.0 a ± 0.58	8.9 a ± 0.35	9.9 a ± 0.06	10.5 b± 0.29
Average	I	**26.63**	**7.61**	**8.93**	**12.75**
	II	**26.63**	**7.44**	**9.51**	**11.75**
	III	**26.88**	**8.29**	**9.59**	**10.6**

- Means among different treatments in particular time followed by different letters are significally different.

The pH values recorded during the present study revealed that there were no significant differences between treatments II and III, almost along the period of the study (Table 3). Treatment I, in which ponds received highest quantities of the compost, recorded the lowest values of pH along the period of the study. Average means of pH values were 8.93, 9.51 and 9.59 for treatments I, II and III, respectively. Similar results were obtained by Barkkoh (1996) who mentioned that in striped bass (*Morone saxatilis*) fingerlings production ponds, pH values recorded in only alfalfa meal treatment were significantly lower than those recorded in ponds treated with both alfalfa meal and mineral fertilizers (ammonium nitrate + phosphoric acid). Kurten *et al.* (1999) mentioned that pH values in Florida largemouth bass (*Micropterus salmoides floridanus*) spawning ponds treated with liquid inorganic fertilizer in combination with cottonseed meal were significantly lower than those recorded in ponds treated with inorganic fertilizer only. They explained that by the elevated levels of carbon dioxide in mixed fertilization treatment, which in turn apparently contributed to lower pH values. In an experiment conducted to investigate the effect of nitrogen fertilization on yield of both *Oreochromis niloticus* and *Cyprinus carpio*, the application of urea caused a significant increase in pH values (Abdalla, 1997). As an explanation for that is through urea hydrolyses to carbon dioxide and ammonia, then the latter hydrolyses to form ammonium ions ($NH4^{+}$) and hydroxyl ions (OH^{-}) (Knud-Hansen and Pautong, 1993). A decrease in Secchi disk readings was recorded in all treatments (Table 3). The average means of such readings were 12.75, 11.75 and 10.6 cm for treatments I, II and III, respectively. Similar results were obtained by Diana *et al.* (1991) who observed that Secchi disk depths were significantly lower in ponds treated with mineral fertilizers than in ponds received organic fertilization. This may be attributed to the fact that organic materials are commonly used to remove clay turbidity from water (Irwin and Stevenson, 1951).

Table 4. Means ± SE of electric conductivity (mmhos/cm), total hardness and total alkalinity (mg/l as $CaCo_3$) of water in different treatments along the period of study.

Time (month)	Treat.	E. C	T. Alkalinity	T. Hardness
July	I	0.67 a ± 0.04	287 a ± 21.65	230 a ± 5.8
	II	0.65 ab ± 0.03	262.5ab ± 7.22	190 b ± 5.77
	III	0.55 b ± 0.028	237.5 b ± 7.22	125 c ± 2.88
August	I	0.51 b ± 0.031	200 a ± 5.77	185 a ± 8.66
	II	0.73 a ± 0.07	180 b ± 2.89	130 b ± 0
	III	0.53 b ± 0.02	157.5 c ± 1.44	120 b ± 1.15
September	I	0.5 a ± 0	267.5 a ± 4.33	218 a ± 1.15
	II	0.4 b ± 0	257.5a ± 18.76	173 b ± 4.04
	III	0.35 c ± 0	197.5 b ± 4.33	132 c ± 4.6
October	I	0.49 a ± 0.052	245 a ± 2.89	197 a ± 4.04
	II	0.41 ab ± 0.006	217.5b ± 10.11	146 b ± 5.77
	III	0.37 b ± 0.01	155 c ± 2.89	120 c ± 3.46
Average	I	**0.54**	**249.9**	**205**
	II	**0.55**	**229.4**	**159.8**
	III	**0.45**	**186.9**	**124.25**

Means among different treatments in particular time followed by different letters are significally different (Duncan's Multiple Range Test $P<0.05$).

Electric conductivity values decreased by time until the end of the experiment. Average means of such values were 0.54, 0.55 and 0.45 mmhos/cm for treatments I, II and III, respectively. As a general trend, there were significant differences among treatments along the period of the study. Treatments included compost (I & II) were higher in their electric conductivity measurements than chemical fertilizer treatment alone (III) except at the end of the experiment. This could be explained by the increased concentration of different ions associated with compost application to pond water as an organic fertilizer (Boyd, 1990). Santerio and Pinto-Coelho (2000) reported that applying organic fertilizers significantly increased water electric conductivity.

Both total alkalinity and total hardness (as $CaCO_3$), showed almost similar and constant pattern, where their values in treatment I were significantly higher than those recorded in treatment II, which in turn were significantly higher than those recorded in treatment III (Table 4). Average means of total alkalinity values were 249.9, 229.4 and 186.9 mg/l as $CaCO_3$, while average means of total hardness values were 205, 159.8 and 124.25 mg/l (as $CaCO_3$) for treatments I, II and III, respectively. Garg and Bhatnagar (1996) found that total alkalinity concentrations were increased in ponds treated with a combination of both organic (cowdung) and inorganic (mono super phosphate) fertilizers. Alkalinity values increased with increasing fertilizer levels. Abdel-Mageed (1997) mentioned that organic fertilization treatment recorded higher values of total alkalinity than inorganic fertilization treatment. Liti *et al.* (2001) mentioned that total alkalinity concentrations in ponds received pig pellets were higher than in ponds treated with inorganic fertilizers.

From Table (5), it could be noticed that all tested forms of nitrogenous compounds (total ammonia, un-ionized ammonia, nitrates and nitrites) showed significant increase of their concentrations in treatment III. Average means of total ammonia concentrations were 0.43, 0.58 and 0.70 mg/l, for treatments I, II and III, respectively. Average means of un-ionized ammonia concentrations were 0.18, 0.39 and 0.49 mg/l for treatments I, II and III respectively. Average means of nitrates concentrations were 0.73, 0.73 and 0.79 mg/l for treatments I, II and III, respectively. Average means of nitrites concentrations were 0.037, 0.037 and 0.040 mg/l for treatments I, II and III, respectively. The increased quantities of all nitrogenous compounds in treatment III may be attributed to the relatively higher amounts of urea, which that treatment received. Diana *et al.* (1991) reported that nitrate and nitrite were the predominant nitrogen sources in organically fertilized ponds, while ammonia predominated in inorganical treatments. Similar results were obtained by Abdalla (1997), were a significant increase in total ammonia-nitrogen and nitrate-nitrogen concentrations was recorded in ponds that received higher urea levels beside equal quantities of triple- super phosphate. The explanation, that urea hydrolyses to carbon dioxide and ammonia, and the latter hydrolyses to form ammonium ions (NH_4^+) and hydroxyl ions (OH^-) (Knud-Hansen and Pautong, 1993). Garg and Bhatnagar (1996) mentioned that nitrogenous compounds concentrations significantly increased as a result of applying a combination of organic and inorganic fertilizers. El-Ebiary (1998) mentioned that higher values of total ammonia were recorded in ponds fertilized with poultry manure than in non-fertilized ponds.

Table 5. Changes in means* ± SE of nitrogenous compounds (mg/l) in different treatments along the period of study.

Time (month)	Treat.	T. Ammonia	Un ionized ammonia	NO_3	NO_2
July	I	0.38 c ± 0.01	0.09 c ± 0.02	0.65 b ± 0.006	0.033 b±0.006
	II	0.5 b ± 0.03	0.16 b ± 0.01	0.72 ab ± 0.03	0.036 b±0.006
	III	0.7 a ± 0.028	0.28 a ± 0.02	0.86 a ± 0.099	0.043 a±0.01
August	I	0.45 b ± 0.03	0.32 c ± 0.04	0.73 a ± 0.02	0.037a±0.01
	II	0.5 b ± 0	0.45 b ± 0.01	0.67 ab ± 0.01	0.034 b±0.008
	III	0.8 a ± 0.029	0.67 a ± 0.13	0.6 b ± 0.027	0.03 c±0.00
September	I	0.5 a ± 0	0.02 c ± 0.004	0.62 b ± 0.06	0.031 c±0.009
	II	0.45 a ± 0.03	0.24 b ± 0.03	0.67 ab ± 0.06	0.034 b±0.003
	III	0.45 a ± 0.03	0.31 a ± 0.03	0.86 a ± 0.045	0.043 a±0.01
October	I	0.4 c ± 0.028	0.30 c ± 0.06	0.92 a ± 0	0.046 a±0.01
	II	0.85 a ± 0	0.69 a ± 0.02	0.85 a ± 0.01	00.043 b±0.0
	III	0.85 a ± 0	0.69 a ± 0.02	0.85 a ± 0.01	00.043 b±0.0
Average	I	**0.43**	**0.18**	**0.73**	**0.037**
	II	**0.58**	**0.39**	**0.73**	**0.037**
	III	**0.7**	**0.49**	**0.79**	**0.04**

* Means among different treatments in particular time followed by different letters are significally different.

Total available phosphorous concentrations recorded along the period of the present study showed no significant differences between treatments II and III, while their values in treatment I were the lowest (Table 6). Average means of total available phosphorous concentrations were 0.74, 0.93 and 1.1 mg/l for treatments I, II and III, respectively. The average concentrations of orthophosphates were 0.1, 0.11 and 0.11 mg/l for treatments I, II and III, respectively. Qin *et al.* (1995) that organic fertilizer alone is unlikely to provide adequate nutrients to pond water obtained a similar conclusion. Garg and Bhatnagar (1996) mentioned that applying a combination of organic (cowdung) and inorganic (monosuperphosphate) significantly increased total phosphorous and orthophosphates.

Table 6. Changes in means*± SE of total available phosphorous (T.Av.P) and orthophosphate (mg/l) in different treatments along the period of study.

Time (month)	Treat.	T.Av.P	O. phosphate
July	I	0.57 b ± 0.03	0.13 c± 0.0005
	II	0.79 b ± 0.01	0.17 a ± 0.02
	III	1.13 a ±0.18	0.157 b±0.006
August	I	0.72 b ± 0.08	0.09 a ± 0.001
	II	0.93 a ± 0.03	0.09 a ± 0.001
	III	0.95 a ± 0.03	0.09 a ± 0.003
September	I	0.73 b ± 0.036	0.08 a ± 0.002
	II	0.99 a ± 0.029	0.082 a±0.001
	III	1 a ± 0.004	0.082 a±0.001
October	I	0.94 b ± 0.013	0.113 a±0.007
	II	1 b ± 0.08	0.097 b ± 0.0
	III	1.239 a ± 0.01	0.098 b ± 0.0
Average	I	**0.74**	**0.1**
	II	**0.93**	**0.11**
	III	**1.1**	**0.11**

*Means among different treatments in particular time followed by different letters are significally different.

Biological characteristics

Chlorophyll *"a"* concentrations showed a significant increase in ponds that received inorganic fertilization (treatment III) in comparison to those treated with a combination of both compost and inorganic fertilizers (treatments I and II) (Table 7). Average means of chlorophyll *"a"* were 79.98, 122.75 and 166.75 µg/l for treatments I, II and III, respectively. Chlorophyll *"a"* concentrations usually increase in fish ponds fertilized with variable nutrient inputs (Diana *et al.*, 1991; Kastner and Boyd, 1996). Brummett (2000) reported that chlorophyll *"a"* concentrations in inorganic (diammonium phosphate plus urea) fertilized ponds were significantly higher than in ponds that received organic fertilizer (Napier grass).

Table 7. Changes in means* ± SE of chlorophyll *"a"* (µg/l) in different treatments along the period of study.

Time (Month)	Treatment		
	I	II	III
July	76.6 b ± 9.6	100.9 b ± 1.7	151.4 a ± 19.3
August	70.00 c ± 1.37	122.5 b ± 10.1	172.8 a ± 17.9
September	79.00 b ± 7.7	101.4 ab ± 1.9	118.5 a ± 9.6
October	94.3 c ± 7.7	166.2 b ± 1.9	224.3 a ± 2.5
Average	**79.98**	**122.75**	**166.75**

*Means among different treatments in particular times followed by different letters are Significally different.

Phytoplankton

Table (8) revealed that the type of fertilizers applied to ponds, greatly affects phytoplankton dominance and their community composition. For all phytoplanktonic taxa, their densities at the first two months of study were higher in treatments II and III than in treatment I. Average densities of green algae were 48.15, 33.75 and 23.88 (10^3 organism/l), for blue-green algae were, 41.75, 23.95 and 13.3 x 10^3 organism/l, for diatoms were 15.8, 17.1 and 12.75 x 10^3 organism/l, and for euglenas were 32.18, 36.23 and 26 x 10^3 organism/l, for treatments I, II and III respectively. The mean averages of phytoplankton total count were 137.88, 110.93 and 75.93 x 10^3 organism/l, for treatments I, II and III respectively. The increase in different phytoplankton taxa densities associated with the second and third treatments, at the first month of the study could be attributed to the elevated ratios of inorganic fertilizers in treatments II and III, where chemical fertilizers rapidly dissociated rather than organic fertilizers. Starting by the third month of the present study, densities of green, blue-green, diatoms and Euglena reached their highest values in treatment I. Consequently, highest total phytoplankton density was recorded in that treatment. This result indicated that decomposition of organic fertilizers greatly supply water with nutrients needed for phytoplankton enrichment, when applied with chemical fertilizers as a source of inorganic phosphorous and nitrogen. Boyd (1990) revealed that the main effect of organic fertilizers was decomposing and releasing nutrients (nitrates and phosphates) that stimulate phytoplankton growth. Another explanation given by Hayes and Anthony (1964) that phytoplankton population increases as total alkalinity increased. Abdel-Mageed (1997) reported that total phytoplankton count in chicken litter treated ponds were higher than its count in chemical fertilizers treated ones. Brummett (2000) found that phytoplankton density was higher in inorganic fertilization treatment than in organic fertilizers one.

Table 8. Dynamics and overall mean (10^3 organ/l) of Phytoplankton taxa under different treatments along the period of study.

group	Tret.	Time (month)				
		1	2	3	4	**Average**
Green algae	**I**	2	2.6	160	28	**48.15**
	II	35	4	84	12	**33.75**
	III	27.5	16	36	16	**23.88**
Blue-green algae	**I**	2.2	4.8	144	16	**41.75**
	II	8	2.4	72.4	13	**23.95**
	III	7.6	9.6	28	8	**13.3**
Diatoms	**I**	3.6	3.6	48	8	**15.8**
	II	4.4	2	54	8	**17.1**
	III	16.2	4.6	25	5.2	**12.75**
Euglenas	**I**	7.7	8	97	16	**32.18**
	II	8.9	4.5	114	17.5	**36.23**
	III	32	10	51	11	**26**
Total	**I**	15.5	19	449	68	**137.88**
	II	56.3	12.9	324	50.5	**110.93**
	III	83.3	40.2	140	40.2	**75.93**

Data representing community composition obtained from the present study (Table 9) revealed that green algae dominated the community in different treatments, while diatoms contributed the least percentage of the community. Garg and Bhatnagar (1996) reported that green algae were the dominant phytoplankton group in both organic and inorganic fertilization treatments.

Tilman and Kiesling (1984) suggested that high nutrient loading rates in aquaculture ponds and high temperature provide the two most important variables controlling Cyanobacterial dominance. However, Boyd (1990) reported that many aquaculture ponds infested with blue-green algae have high concentrations of inorganic nitrogen.

Table 9. Average percentage of different taxa of phytoplankton community under different treatments.

Groups Treat.	I	II	III
Green algae	34.92	30.39	31.45
Blue-green algae	30.28	21.57	17.52
Diatoms	11.46	15.4	16.79
Euglenas	23.34	32.63	34.24

Zooplankton

Data in Table (10) shows that different types of applied fertilization, affected total zooplankton count but did not affect community composition. Zooplankton densities increased in all ponds whatever the type of fertilization they received. Average Rotifera densities for treatments I, II and III were 108.75, 172 and 113.25 organism/l, respectively. Average Copepoda densities along the period of the study for treatments I, II and III were 76, 142.5 and 89.5 organism/l, respectively. Average Cladocera densities for treatments I, II and III were 84, 126 and 76.5 organism/l, respectively. Average Ostracoda densities recorded for treatments I, II and III, were 20.5, 19 and 18.5 organism/l, respectively. The highest densities of Rotifera, Copepoda and Cladocera were recorded in treatment II. The density of Ostracoda was almost the same in the tested treatments. Average total zooplankton counts recorded along the period of the study for treatments I, II and III, were 289.25, 459.5 and 297.75 organism/l, respectively.

The increase in zooplankton densities may be attributed to a corresponding increase in phytoplankton. This finding supports those reported by Geiger (1983) and Barkoh and Robeni (1990), those zooplankton densities in fertilized fishponds are influenced by available food sources such as phytoplankton, protozoa and bacteria. Despite that phytoplankton densities were highest in treatment I, highest zooplankton densities were found in treatment II. This finding may be attributed to the composition of the phytoplanktonic community and the selectivity nature of planktivorous zooplankton.

Table 10. Dynamics and overall means (organ/l) of zooplankton under different treatments along the period of study.

group	Treat.	Time (week)				Average
		1	**2**	**3**	**4**	
	I	52	86	124	173	**108.75**
Rotifera	**II**	96	163	186	243	**172**
	III	71	115	117	150	**113.25**
	I	90	42	72	100	**76**
Copepoda	**II**	142	152	218	58	**142.5**
	III	88	72	66	132	**89.5**
	I	48	64	113	111	**84**
Cladocera	**II**	89	108	154	153	**126**
	III	53	69	92	92	**76.5**
	I	22	18	21	21	**20.5**
Ostracoda	**II**	17	18	12	29	**19**
	III	13	16	16	29	**18.5**
	I	212	210	330	405	**289.25**
Total	**II**	344	441	570	483	**459.5**
	III	225	272	291	403	**297.75**

Phytoplankton community composition obtained throughout the present study revealed that blue-green algae represented 30.28 % of the community in treatment I, while contributed only 21.75 % of the community in treatment II. Crowley (1973) and Paerl (1988) reported that bloom forming Cyanobacteria are not readily utilized as a nature food source by zooplankton. Organic debris and its associated microbes constitute an important portion of the diet of zooplankton (Makarewicz and Likens, 1979, Glamazda and Katretskjy, 1980).

Data recorded during the present study revealed that Rotifera dominated other taxa in all treatments followed by Copepoda (except in treatment I), and then Cladocera, while Ostracoda represented the lowest percentage of the community. Similar results were reported by Garg and Bhatnagar (1996) indicating that in different organic and inorganic fertilization treatments, Rotifera and Copepoda were the dominant zooplankton groups followed by Cladocera and Ostracoda.

Table 11. Average percentage of different taxa of zooplankton community under different treatments.

Groups / Treat.	I	II	III
Rotifer	37.6	37.43	38.04
Copepoda	26.28	31.01	30.06
Cladocera	29.04	27.42	25.69
Ostracoda	7.08	4.14	6.21

Abdel-Mageed (1997) obtained similar results, where in different organic and inorganic fertilization treatments; Rotifera dominated other taxa, while Ostracoda represented the lowest percentage of the community.

The dominance of Rotifera over other zooplankton taxa in the present study, accords with other authors (Aboul Ezz *et al.*, 1996; Ahmed, 2000, El-Bassat, 2002). Such dominance is assumed to be the result of fish consuming of larger zooplankton as well as to their short generation time (pourrioto *et al.*, 1997).

CONCLUSION

It could be concluded from the present study that water quality characterestics of ponds that received agricultural by-products, had been improved in comparizon to ponds those received chemical fertilizers only. This improvement demonstrated by the decrease in all nitrogenous compounds and the increase of orthophosphate values.

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تقييم إستخدام المخلفات الزراعية كأسمدة على جودة المياه في أحواض أسماك المياه العذبة

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استخدم في هذه الدراسة مجموعة من الأحواض الطينية بحجم ٦٠٠ م^{3} وتم تقسيمها إلى ثلاث مجموعات حيث تلقت المعاملتان الأولى والثانية خليطا من المخلفات الزراعية والتسميد المعدني بنسب مختلفة بينما تلقت المعاملة الثالثة تسميدا معدنيا فقط.

أوضحت هذه الدراسة أن إستخدام المخلفات الزراعية في تسميد الأحواض السمكية يؤدي إلى إنخفاض قيم كل من الأكسجين المذاب وأيون الهيدروجين بالمقارنة بالأحواض المسمدة تسميدا معدنيا ولكن ظلت جميع القيم في الحدود المثلى للإستزراع السمكي ، بينما لم تتأثر درجات الحرارة بنوعية التسميد. وكانت شفافية المياه أعلى في حالة التسميد بالمخلفات الزراعية وكذلك إرتفعت قيم كل من العسر الكلي والقلوية الكلية. وكانت تركيزات جميع المركبات النيتروجينية أعلى في حالة التسميد المعدني عنها في حالة التسميد بالمخلفات الزراعية ، بينما لم تظهر فروق ذات دلالة إحصائية بين المعاملتين الثانية والثالثة بالنسبة لصور الفوسفور المختلفة.

كما أوضحت الدراسة أن تركيزات الكلوروفيل كانت أعلي في حالة التسميد المعدني بينما سجلت الأحواض المسمدة بالمخلفات الزراعية أعلى كثافة لكل من الهائمات النباتية والحيوانية.

وتوصي نتائج هذه الدراسة باستخدام المخلفات الزراعية في تسميد الأحواض السمكية بالاستبدال الجزئي للأسمدة المعدنية مما يقلل من تراكم صور مركبات النيتروجين الضارة بالأسماك ويزيد من الهائمات التي تعتمد عليها الأسماك في تغذيتها ، كما أن زيادة العسر الكلي للماء يقلل من سمية العناصر الثقيلة للأسماك.