JOURNAL OF THE
ARABIAN AQUACULTURE SOCIETY

Vol. 2 No 1
June 2007

Effect of Different Types and Rates of Fertilizers, Combined with Supplemental Feeding on Fish Performance, Feed Efficiency and Total Yield of Nile Tilapia.

El-Dahhar A.A[1].; Nagdy Z.A.[2] and El-Tawil N.E.[2]

1.Faculty of Agriculture(Saba Basha) University of Alexandria

2.Central Laboratory for Aquaculture Research, Agriculture Research Center.

ABSTRACT

This study was carried out in two experiments to evaluate and determine the effect of different fertilizer applications [(chemical fertilizer, agricultural by-products (compost) and organic fertilizer (fish reger fertilizer)] in a combination with artificial feed on survival, growth performance, feed efficiency, water quality and total yield of Nile tilapia. Four treatments were carried out in the first experiment each in two replicates with Nile tilapia of initial body weight (21 g) stocked at the rate of 5 fish/m^3 earthen ponds for 120 days. The treatments were: T_1, feed only as a control; T_2, fish reger fertilizer at the rate of 266 kg/feddan /wk plus feed; T_3, compost fertilizer at the rate of 500 kg/ feddan/ wk plus feed and T_4, chemical fertilizer at the rate of 15 kg mono super phosphate /feddan/ wk and 19 kg urea/feddan/ wk. The second experiment was designed to find out the optimal fertilization rate of fish reger and compost on fish performance of Nile tilapia at (34 g initial body weight) which were stocked at the rate of 2 fish / m^3 for 75 days experimental period. Treatments were: (1) mixture of 75% compost and 25% fish reger plus feed, (2) 50% compost and 50% fish reger plus feed, (3) 25% compost and 75% fish reger plus feed,and (4) feed only as a control. Results of the first experiment showed that differences among treatments in final body weight, weight gain, average daily gain and total yield were not significant ($P > 0.05$). Results of the second experiment indicated that there were significant differences ($P < 0.05$) between treatments and control in final body weight, weight gain, average daily gain and total yield. The highest final body weight and total yield were found at treatment (2) with the values of 150 g and 60 kg/ 200 m^3, respectively. While, the lowest values of the same criteria were obtained at the control treatment (4) with the values of 115 g and 46 kg / 200 m^3, respectively. As a conclusion for the present study we can recommend using compost fertilizer combined with supplemental feed or organic fertilizers mixture containing 75% compost and 25% fish reger with supplemental feed, which were more economic and profitable for fish farms.

Corresponding author: nadereltawil@yahoo.com

INTRODUCTION

Needs to increase fish production is considered one of the most important ways to raise animal protein production for provide humans with an essential source of animal protein. In recent years, aquaculture has been the fastest growing primary production industry worldwide, amounting to 39.4 million tons in 1998 (Tacon and Forster, 2000). A lot of farmers in developing nations cannot buy adequate commercial fish feeds or their ingredients (e.g., fish meal, soybean meal, corn meal) because these are either not available locally and must be imported, or other users have higher priority or expensive (Stickney, 2004).

Recently, interest has been centered on the evaluation and use of unconventional protein sources such as aquatic macrophytes, poultry by-products, agricultural by-products, invertebrate feed organism and protein hydrolysates (Olevera-Novoa *et al.*, 2002; Pandit *et al.*, 2003 and Valle *et al.*, 2003).

Fertilization has assumed to play an important role to supplement nutrient deficiency and increase biological productivity. Optimal fertilization rate is the amount of organic matter that can be cost-effective and utilized in a pond ecosystem without having any harmful effect on water quality as well as on fish growth. This is one of the most important aspects of pond management as excess fertilizer is not only expensive but is also responsible for nutrient enrichment in water bodies (Bocek, 1996, Shrestha and Lin 1996 and Alcest and Jory, 2000). Das and Jana (2003) stated that pond fertilization has assumed an important role to supplement nutrient deficiency and augment biological productivity through autotrophic and heterotrophic pathways. Yi and Lin (2000) stated that the low-cost fertilization strategies include the use of animal manure alone, chemical fertilizer alone and the combination of animal manure and chemical fertilizers. While the nutrient input rates and ratios are the most important factors, these fertilization strategies provide wide choices for small-scale farmers with various resources.

The actual requirement of fertilizer dose in a pond system may vary depending upon the type of fish farming, agro-climatic condition and productive history or the residual nutrients in the bottom sediment of the fishponds. Also the type of manure and chemical fertilizer is not of particular importance. The cost of nutrients and their availability are essential factors in selecting which source to choose in a particular locale (Pant *et al.*, 1999).

Huet (1970**)** explained that in some cases organic manures might be eaten directly by aquatic species. It is therefore sometimes difficult to distinguish between the use of organic manure as food or fertilizer.

The rationale behind raising fish on animal manure becomes apparent when it is realized that about 72- 79% of the nitrogen, 61- 87% of phosphorus and 82-92% of potassium in the rations fed to animal are recovered in their excrete (Rancis *et al.,* 2004).

Chicken litter has been used successfully as an organic fertilizer for tilapia production in many parts of the world (Green *et al.,* 1989) because of its easily transport, storage and dispersing over the pond surface. Banerjee *et al.* (1979) considered poultry manure to be a complete fertilizer with the characteristics of both organic manure and inorganic fertilizer. By using poultry manure, they obtained a fish yield of 670 kg /ha through three months without supplemental feeding.

Vegetable matter grasses, garden weeds, spoiled fruits and vegetables and other plant wastes can be used as fish pond fertilizer. They may be chopped into small pieces and mixed together into a compost pile. A mixture of animal and green manures provides a good fertilizer (Bocek, 1996).

Alcest and Jory (2000) suggested that respectable pond yields can be obtained when tilapia are only provided with agricultural byproducts such as rice bran in conjunction with manures of such species as poultry, swine and cattle. Fertilizers high in phosphorous are especially good for phytoplankton production in freshwater ponds (Boyd, 1990).

Standard dose of fertilizer was developed from the finding that waters of fish ponds never contained more than 0.5 mg / liter soluble orthophosphate and 2.0 mg / liter nitrogen (Boyd, 1988).

The nitrogen requirement for ponds is also dependent on the amount of nitrogen fixation by aquatic communities (Lin *et al.,* 1988). Composition requirements for fertilizer may vary widely depending on local conditions.

Sevrin-Reyssac and Plaetikosic (1990) revealed that the limiting factors for production of chlorophycae are the level of nitrogen and phosphorus in a ratio N: P above 5: 8; below this ratio cyanobacteria take over.

Fish in fertilized ponds will grow faster when they are provided with supplemental feed. Yields for all male tilapia monoculture ranged from 23.7 to 33.0 kg /ha per day when fish are fed on supplemental feed (Peralta and Teichert-Coddington, 1989). Also, Green (1992) determined that layer chicken litter can replace 27 to 58 % of pelted supplemental feed without any significant effect on tilapia yield. Moreover, results indicated that highest estimated biomass and average weight were obtained in the fertilizer pond then feed treatment for *O. niloticus* 3,027 kg/ha and 151.4 g/fish, respectively (Green *et al.* 1995).

This study was carried out to evaluate and determine the effect of different fertilizer applications [(chemical fertilizer, agriculture by-products (compost) and organic fertilizer (fish reger fertilizer)] in a combination with artificial feed on survival, fish growth performance, feed efficiency, water quality and total yield of Nile tilapia.

MATERIALS AND METHODS

This study was carried out at the fish farm of the Faculty of Agriculture (Saba-Bacha), Alexandria University, Egypt.

Two experiments were conducted to evaluate the effect of different types of fertilizers, organic fertilizer (fish reger), agricultural by-products (compost) and chemical fertilizer (mono superphosphate and urea) combined with artificial feed on growth performance, feed utilization, water quality of ponds and pond fish yield of mixed-sex Nile tilapia (*Oreochromis niloticus*) in 200 m^2 earthen ponds surface. Ponds water depth was maintained constant along each experimental period. Water flow rate was supplied to compensate the losses by seepage and evaporation and to replace the whole water volume in ponds every week.

One experimental diet Table (1) was used in this study which contains 25% crude protein. Diets were commercially manufactured by Joe Trade Company; Cairo. Diets ingredients were yellow corn, soybean meal, wheat bran, danish fishmeal, meat meal, fish oil, dicalcium phosphate, lim stone, Vit. and Min. mixture. Fish were fed six days per week at satiate rate of feeding twice daily for all experimental periods. Feeds were applied throughout the experiments by broadcasting over pond water surface in the same place and fish were considered satiated when it did not show an interest on the feed. Daily consumption of feed was recorded.

Fertilizer applications

Chemical fertilizer

Mono super phosphate as a source of phosphorus (P) and Urea as a source of nitrogen (N) were used in this study. Both mono super phosphate and urea were mixed with adequate ponds water and sprayed over the pond surface.

Table (1): ***Means ± SE of proximate analysis of the diet used in this study.***

Items	%
Moisture	9.53 ± 0.26
Crude protein	24.17 ± 0.29
Crude fat	8.57 ± 0.19
Ash	8.47 ± 0.41

Organic fertilizer

Two new organic fertilizers were applied in this study, fish reger fertilizer and compost fertilizer.

Fish reger fertilizer

It consists of chicken manure but compressed and heat treated in order to be free from parasites such as *Salmonella*, *Shigella* and *E. coli*. Chemical and physical analysis of fish reger fertilizer is shown in Table (2). Fish reger pellets 4-6 mm diameter were equally distributed on all pond surface weekly.

Agricultural by products fertilizer (compost)

Compost was produced from all plant materials .The weekly amounts of compost applied in the two experiments sprayed over all pond surface. Chemical and physical analyses of compost are presented in Table (2).

Fertilizers were applied with the rate of 0.5 mg P/L and 2 mg N/L/wk to produce a final N : P ratio of 4 : 1 by weight (Knud-Hansen *et al.*, 1993) in ponds.

The first experiment

This experiment was designed to evaluate the effect of different fertilization treatments on fish production, feed efficiency and water quality.

Table (2): ***Chemical and physical analysis of fish reger fertilizer and compost fertilizer used in the study.***

Item	Fish reger	Compost
Density	720 kg/m^3	760 kg/m^3
Moisture	11.6%	10%
Organic matter	59.1%	68%
Organic carbon	34.28%	40%
Total nitrogen	3.15%	1.64%
C : N ratio	15.9 :1	15 : 1
pH	8.47	8.2
Total soluble solids	---	0.2%
Total phosphorus	2.17%	0.26%
Total potassium	1.48%	0.80%
Calcium	5.83%	3.20%
Manganese	574ppm	150 ppm
Sodium	---	1.2%
Iron	0.12%	4600 ppm
Magnesium	---	0.31%
Zinc	671%	400 ppm
Cooper	2ppm	80 ppm

Nile tilapia of initial body weight ± SE (21 ± 0.45 g) were stocked at the rate of 5 fish/m^3. Fish were harvested after 120 days. Four treatments were used each in two replicates.

1. Feed only without any fertilizer (as control).
2. Feed+ weekly fertilization with fish reger at the rate of 266 kg/feddan.
3. Feed + weekly fertilization with compost at the rate of 500 kg/feddan.
4. Feed + weekly fertilization with chemical fertilizer at the rate of 15 kg/feddan of mono super phosphate (15.5% P_2O_5) and 19 kg/feddan of urea (46% N).

Temperatures of ponds water were recorded twice a week and it ranged between 24°C and 32°C.

The second experiment

This experiment was conducted to find out the optimal fertilization rate of a mixture containing fish reger and compost on fish production, feed efficiency and water quality of Nile tilapia fingerlings of initial body weight ± SE (34 ± 0.91 g). Fish were stocked at the rate of 2 fish/m^3 and harvested after 75 days of culture. Fish in all ponds were fed on a diet containing 25% protein at satiate rate of feeding. Four treatments each with two replicates were used in this experiment. Mixture containing fish reger and compost was applied with a different levels at the rate of 0.5 mg P/L and 2 mg N/L/wk to produce a final N: P ratio of 4: 1 by weight (Knud-Hansen *et al.*, 1993) in ponds. Treatments were:

1. Weekly fertilization rate at (75% compost + 25% fish reger) by adding 400 kg compost/ feddan and 84 kg fish reger/feddan.
2. Weekly fertilization rate at (50% compost + 50% fish reger) by adding 262.5 kg compost/feddan and 157.5 kg fish reger/feddan.
3. Weekly fertilization rate at (25% compost + 75% fish reger) by adding 136.5 kg compost/feddan and 231 kg fish reger/feddan.
4. Feed only without any fertilizers (as control).

Analytical methods
Sampling of fish, feed and water

At the beginning and end of both experiments, random samples of fish were taken and frozen for proximate analysis. Also, samples of commercial diet were taken and kept for chemical analysis. Water samples were collected weekly from each pond at the third day after fertilizer application. Water samples were also taken from the source of water supply. Some parameters of water quality measurements were taken outdoor like water temperature, pH values, water visibility using Secchi disk (SD), electrical conductivity (EC) and total dissolved solids (TDS)**.** Other samples were taken directly to the laboratory where chemical analysis take place for total alkalinity, total hardness, total ammonia concentration, unionized ammonia, nitrate, nitrite total available phosphorus and orthophosphate determination. Water samples were subjected to analysis processes according to (APHA, 1989) and Boyd and Tucker (1992). Chemical analysis of homogenized fish and experimental diet were carried out according to the methods described by (AOAC, 1990).

Statistical analysis

The analysis of variance (ANOVA) and least significant differences test were made according to Snedecor and Cochran (1981).

RESULTS

The First experiment
Growth performance

Data indicated that there were insignificant differences ($P > 0.05$) among treatments in final body weight (FBW), weight gain (WG) and specific growth rate (SGR). The highest values were obtained in the third treatment (T_3). Similarly, average daily gain (ADG) was not affected significantly with any of treatments ($P > 0.05$). It ranged between 0.88 ± 0.04 g fish/day at T_2 and 0.93 ± 0.02 g fish/day at T_3 Table (3). With respect to offered feed in Table (3), there was a negative relation between offered feed and fertilization treatments. Ponds received fertilizer (fish reger, compost and chemical fertilizer) had significantly lower ($P < 0.05$) offered feed than control ponds (T_1). Also, feed conversion ratio (FCR) improved significantly with fertilization treatments ($P < 0.05$). The highest improvement in (FCR) was achieved with fish maintained at T_3 1.06 ± 0.02 followed by T_2 and T_4; they were 1.20 ± 0.03 and 1.23 ± 0.04, respectively. The worst (FCR) was found to be 1.69 ± 0.04 with fish maintained at control , T_1.

Protein efficiency ratio (PER) as shown in Table (3) increased significantly with fertilizer treatments than with control treatment ($P < 0.05$). Highest (PER) value was obtained with fish maintained at T_3 3.76 ± 0.04 followed by T_2 and T_4 which were 3.31 ± 0.05 and 3.25 ± 0.03, respectively.

Means of body composition of Nile tilapia reared in the first experiment are shown in Table (4). Fish moisture and lipid contents did not significantly affected by different treatments ($P > 0.05$). On the other hand, protein content in fish body showed that there were significant differences among treatments ($P< 0.05$). Generally, the highest protein content was found at T_2 with the value of 17.28 ± 0.16% followed by T_3, 17.01 ± 0.1% then T_1,16.76 ± 0.11%.

Table (3). ***Means ± SE of final body weight (kg fish/200 m^2), weight gain (kg fish/200 m^2) , average daily gain ADG (g/fish/day), offered feed (kg/200 m^2), feed conversion ratio (FCR) and protein efficiency ratio (PER) of Nile tilapia with initial body weight (21.5 kg fish/200 m^2) treated with different fertilizer treatments in the first experiment.***

Treat ment	Final BW M ± SE	BW gain M ± SE	ADG M ± SE	Offered feed M ± SE	FCR M ± SE	PER M ± SE
T_1	121±6.0 a	99.5 ±4.5a	0.91±0.05a	168.3±7.6a	1.69±0.04a	2.35±0.04c
T_2	118±5.4 a	97.0 ±4.8a	0.88±0.04a	117.2±3.5b	1.20±0.03b	3.31±0.05b
T_3	124±3.6 a	102.5±3.6a	0.93±0.02a	109.2±5.5b	1.06±0.02c	3.76±0.04a
T_4	122±5.5 a	100.0±5.1a	0.91±0.04a	123.5±6.2b	1.23±0.04b	3.25±0.03b

Means in each column followed by different letter are significantly different (P < 0.05).

Water quality

verage of water dissolved oxygen concentrations was 5.04 ± 0.43 mg/l throughout the experiment. Data representing different water quality parameters are summarized in Tables (5and 6). Data of Table (5) revealed that there were insignificant differences among treatments in water pH values, Electric conductivity values (EC), water visibility, total dissolved solids concentrations (TDS), total alkalinity and total hardness, (P > 0.05).

With respect to total ammonia concentrations in Table (6) results indicated that there were insignificant differences among treatments (P > 0.05). Third treatment was found to be the highest in total ammonia than those in other treatments, it was 0.71 ± 0.11 mg/l. Statistical analysis of unionized ammonia concentrations in ponds Table (6) revealed that there were significant differences among treatments. Ponds treated with fertilizers had significantly higher unionized ammonia concentrations than control ponds.

With respect to nitrate concentrations, there were significant differences among treatments. Second treatment had significantly higher (0.386 ± 0.002 mg/l) nitrate concentration than those in other treatments (P< 0.05). Nitrite concentrations are presented in Table (6). Third treatment had significantly the lowest nitrite concentration than those in other treatments while the differences among the rest treatments were not significant.

The highest total phosphorus concentration was found in the fourth treatment 0.89 ± 0.08 mg/l followed by second treatment 0.83 ± 0.06 mg/l. Table (6).

Table (4). *Means ± SE of moisture%, protein %and lipid content% in the fresh matter of the carcass of Nile tilapia reared at different fertilizer treatments in the first experiment.*

Treatments	Moisture % M ± SE	Protein % M ± SE	Lipid % M±SE
Initial	74.12 ± 0.21	15.02 ± 0.46	6.51 ± 0.18
T_1	73.25 ± 0.16a	16.76 ± 0.11 a	7.02 ± 0.26 a
T_2	72.29 ± 0.23a	17.28 ± 0.16 a	7.49 ± 0.30 a
T_3	72.71 ± 0.28 a	17.01 ± 0.10 a	6.95 ± 0.21 a
T_4	73.50 ± 0.35 a	16.38 ± 0.08 b	7.09 ± 0.13 a

Means in each column followed by different letter are significantly different (P < 0.05).

However, differences between the two treatments were not significant. With respect to orthophosphate (OP) concentration; results show that there were significant differences among treatments (P < 0.05). Fourth treatment was found to be significantly higher in (OP) concentration than those in other treatments; it was 0.189 ± 0.04 mg/l. Table (6).

The grading of harvested fish in classes (kg fish/pond) are shown in Table (7). Results revealed that although differences among treatments were not significant (P >0.05) in total yield, grading fish in classes indicated that there were significant differences among treatments (P < 0.05). With regard to first class, results showed that first and third treatments had significantly higher amounts of first class fish than those in second and fourth treatments, they produced 35 and 32 kg/pond, which presented about 29 and 26% of total yield of those treatments, respectively. While the second and fourth treatments produced 22 and 18 kg/pond, which presented about 19 and 15% of the total yield of those treatments, respectively. Similar trends were noticed in the second class fish. With respect to third and fourth class, results showed that fourth treatment had higher amount of fish in third class than those in the rest of treatments.

The second experiment
Growth performance

With respect to survival percentage, there were insignificant differences among treatments (P < 0.05); it ranged between 95 to 97%. Data of Table (8) show that there were significant differences (P < 0.05) among treatments in final body weight FBW and weight gain WG of fish maintained at fertilizers treatments were higher significantly than those of the fish at the control ponds**.** The second treatment was higher in FBW and WG than those in the rest treatments.

Table (5). ***Means ± SE of pH, water electric conductivity (EC) (mmhos/cm), Secchi disk visibility SD (cm) and total dissolved solids TDS (mg/l), total alkalinity (mg/l) and total hardness (mg/l) at different treatments in the first experiments.***

Treatments	pH M ± SE	EC M ± SE	SD M ± SE	TDS M ± SE	Total alkalinity M ± SE	Total hardness M±SE
T_1	9.19 ± 0.26 a	2.82 ± 0.49 a	18.1±2.1a	1920±330a	402.72±35.47 a	486.25 ± 52.9 a
T_2	9.29 ± 0.22 a	2.79 ± 0.47 a	16.6±1.30a	1900±320a	416.36±30.95 a	481.2 ± 40.19 a
T_3	9.25 ± 0.26 a	2.67 ± 0.32 a	16.3 ± 0.65 a	1780±250a	390.90±20.17 a	474.0 ± 50.5 a
T_4	9.56 ± 0.37 a	2.76 ± 0.38 a	17.2 ± 1.12 a	1870±260a	350.00±16.48 a	475.8 ± 40.29 a

Means in each column followed by different letter are significantly different (P < 0.05).

Average daily gain, ADG in Table (8) revealed that there were significant differences among treatments. Fish reared at fertilized ponds had significantly higher ADG than fish reared at control (unfertilized) ponds (P < 0.05). Second treatment had the highest ADG, it was 1.65 ± 0.08 g/fish/day while fourth treatment had the lowest ADG, it was 1.17 ± 0.04 g/fish/day

Obtained data show a positive effect between the rate of compost inclusion in fertilizer mixture and protein efficiency ratio (PER) Table (8), with increasing the rate of compost inclusion in fertilizer mixture from 25% to 75%, PER increased from 3.41 to 3.80. Also FCR in Table (8) was significantly better with fish reared in fertilized ponds than control ponds (P < 0.05). Increasing the compost inclusion rate in fertilizing mixture improved FCR values from 1.17 ± 0.09 to 1.04 ± 0.02 but without significant differences (P > 0.05). Control treatment (T_4) was significantly the worst in FCR values among treatments it was 1.58 ± 0.12.

Data concerning body chemical composition of initial and final fish samples of Nile tilapia reared at different fertilizer treatments are summarized in Table (9). There were no significant differences in moisture content (P > 0.05). Protein content in the fish carcass revealed that there were significant differences between treatments (P < 0.05).

Table (6). ***Means ± SE of total ammonia (mg/l), unionized ammonia (mg/l), nitrates NO_3 (mg/l), nitrites NO_2 (mg/l) concentrations, total phosphorus (mg/l) and orthophosphate concentration (mg/l) at different treatments in the first experiment.***

Treatments	Total Ammonia M ± SE	Unionized Ammonia M ± SE	Nitrates (NO_3) M ± SE	Nitrites (NO_2) M ± SE	Total phosphorus M ± SE	Orthophosphate M ± SE
T_1	0.64 ± 0.22a	0.301±0.04c	0.303 ±0.032b	0.032 ±0.018a	0.651 ± 0.04 b	0.135 ± 0.055 b
T_2	0.68 ± 0.15a	0.35±0.06bc	0.386 ±0.022a	0.029±0.024ab	0.826 ± 0.06 a	0.140 ± 0.061 b
T_3	0.71 ± 0.11a	0.39 ±0.04b	0.296 ±0.082b	0.027 ±0.016b	0.723 ± 0.04 b	0.137 ± 0.053 b
T_4	0.68 ± 0.09a	0.49 ± 0.07a	0.313 ±0.064b	0.0318±0.01a	0.892 ± 0.08 a	0.189 ± 0.041 a

Means in each column followed by different letter are significantly different (P < 0.05).

Table (7): ***The grading of fish in classes (kg fish/ 200 m^2) at different treatments in the first experiments.***

	Treatments *			
	T_1	T_2	T_3	T_4
1st class	35.0 a	22.0 b	32.0 a	18.0 b
2nd class	40.0 a	34.0 bc	44.0 a	27.0 c
3rd class	19.0 b	17.0 b	15.0 c	25.0 a
4th class	6.0 a	12.0 a	8.50 a	12.0 a
Recruitment	21.0 b	33.0 a	24.5 b	40.0 a
Total yield Kg/pond	121± 6.0 a	118 ± 5.4 a	124 ± 3.6 a	122 ± 5.5 a

Means in each rows followed by different letter are significantly different (P < 0.05).
**** First class ≥ 200 g , Second class < 200- ≥ 125 g , Third class < 125 - ≥ 75g , Fourth class < 75 - ≥ 40 g , recruitment < 40 g.***

Third treatment (T3) had the highest protein content, while the lowest protein content was found in the second treatment. Results obtained from Table (9) show that there were a positive relationship between the rate of fish reger inclusion in the mixture of fertilizer and lipid content of the fish body. With increasing fish reger in the mixture from 25 to 75% lipid content increased from 6.68 to 7.51%. Highest lipid content was found at third treatment 7.51% followed by the second treatment 7.35% without significant differences, then first treatment 6.68% and finally the lowest lipid content was found in fish of the fourth treatment (control) which was 6.55%.

Water quality

Average of water dissolved oxygen concentrations was 5.68 ± 0.31 mg/l throughout the experiment. Data representing changes in pH values, Secchi disk readings, electrical conductivity (EC) and total dissolved solids (TDS) are summarized in Table (10).

Table (8). ***Means ± SE of final body weight (g/fish), weight gain (g/fish) , average daily gain ADG (g/fish/day), offered feed (kg/200 m^2), feed conversion ratio (FCR) and protein efficiency ratio PER of Nile tilapia with initial body weight of 34.5g/fish treated with a different fertilizer treatments in the second experiment.***

Treatments	Final BW M ± SE	Weight gain M ± SE	ADG M± SE	Offered feed M ± SE	FCR M ± SE	PER M ± SE
T_1	145 ± 2.42 a	110 ± 1.23 a	1.57 ±0.15a	46.0 ± 1.1a	1.04±0.02b	3.80 ±0.34a
T_2	150 ± 2.56 a	116 ± 0.56 a	1.65 ±0.08a	49.0 ± 0.4a	1.06±0.03b	3.78 ±0.21a
T_3	147 ± 1.95 a	111 ± 0.53 a	1.59 ±0.10a	52.0 ± 1.2a	1.17±0.09b	3.41 ±0.31b
T_4	115 ± 1.87 b	82 ± 0.36 b	1.17 ±0.04b	52.0 ± 2.1a	1.58±0.12a	2.52 ±0.20c

Means in each column followed by different letter are significantly different (P < 0.05).

Table (9). ***Means ± SE of moisture%, protein % and lipid content % in the carcass of Nile tilapia reared at different fertilizer treatments in the second experiment.***

Treatments	Moisture % M ± SE	Protein % M ± SE	Lipid % M ± SE
Initial	73.27 ± 0.02	14.56 ± 0.13	6.73 ± 0.21
T_1	71.52 ± 0.48 a	16.30 ± 0.17 a	6.68 ± 0.13 b
T_2	70.60 ± 0.80 a	15.45 ± 0.10 b	7.35 ± 0.33 a
T_3	70.01 ± 0.92 a	16.62 ± 0.12 a	7.51 ± 0.23 a
T_4	69.50 ± 0.20 a	16.59 ± 0.19 a	6.55 ± 0.27 b

Obtained data show that differences among treatments were insignificant (P > 0.05) in pH values, water visibility, water electrical conductivity (EC), total dissolved solids concentrations (TSD), total alkalinity and total hardness. In relation to total ammonia concentrations (Table 11), there were a positive relation between the change in components of fertilizer mixture and total ammonia concentrations in ponds. Ponds received fertilizer mixtures had significantly higher total ammonia than control ponds. Concerning unionized ammonia concentrations, data show that, there were significant differences among treatments (P < 0.05). Third treatment had significantly the highest unionized ammonia concentration than those in the other treatments. With respect to nitrate concentrations (Table 11) results show that there were significant differences among treatments (P < 0.05).

But nitrites concentrations data show insignificant differences among treatments (P > 0.05) values ranged between 0.026 to 0.045 mg/l. With increasing fish reger inclusion rate in fertilizer mixture treatments, total phosphorus concentrations increased (Table 11), control treatment (T_4) had the lowest total phosphorus concentrations.

Table (10). ***Means ± SE of pH, water electric conductivity EC (mmhos/cm), Secchi disk visibility SD (cm) , total dissolved solids TDS (mg/l) , total alkalinity (mg/l), and total hardness (mg/l), at different fertilizer treatments in the second experiments.***

Treatments	pH M ± SE	EC M ± SE	SD M ± SE	TDS M ± SE	Total Alkalinity M ± SE	Total Hardness M ± SE
T_1	8.72 ± 0.28a	2.87 ± 0.08a	20.2 ± 2.31a	1840 ± 120a	490.0±12.28a	540 ± 38.2 a
T_2	8.80 ± 0.33a	2.93 ± 0.34a	18.6 ± 1.38a	1850 ± 240a	510.0 ±18.76 a	590 ± 47.6 a
T_3	8.97 ± 0.34a	3.04 ± 0.26a	18.6 ± 2.04a	2030 ± 180a	523.3 ± 28.66 a	640 ± 41.0 a
T_4	8.99 ± 0.18a	3.01 ± 0.38a	22.8 ± 1.83a	2010 ± 260a	483.3 ± 45.16 a	650 ± 56.3 a

Means in each column followed by different letter are significantly different (P < 0.05).

Table (11). ***Means ± SE of Total ammonia (mg/l), unionized ammonia (mg/l), nitrates concentration NO_3 (mg/l), nitrites NO_2 (mg/l) total phosphorus (mg/l) and orthophosphate (mg/l) at different fertilizer treatments in the second experiment.***

Treatments	Total Ammonia M ± SE	Unionized ammonia M ± SE	Nitrates M ± SE	Nitrites M ± SE	Total phosphorus M ± SE	Orthophosphate M ± SE
T_1	0.481 ± 0.04 a	0.132 ± 0.003 b	0.304 ± 0.011 b	0.0290 ± 0.003 a	0.774 ± 0.081 b	0.127 ± 0.030 c
T_2	0.404 ± 0.03 a	0.111 ± 0.004 c	0.275 ± 0.014 b	0.0339 ± 0.002 a	0.879 ± 0.110 a	0.187 ± 0.018 ab
T_3	0.456 ± 0.05 a	0.172 ± 0.003 a	0.396 ± 0.021 a	0.0453 ± 0.005 a	0.881 ± 0.151 a	0.205 ± 0.031 a
T_4	0.316 ± 0.06 b	0.119 ± 0.002 bc	0.280 ± 0.030 b	0.0262 ± 0.002 a	0.715 ± 0.140 b	0.143 ± 0.022 b

Means in each column followed by different letter are significantly different (P < 0.05).

While total phosphorus concentrations increased gradually from 0.77 mg/l in water at first treatment to 0.87 mg/l in water of second treatment and the highest concentration was 0.88 mg/l at third treatment. Same trend was shown with orthophosphate concentrations. Results show that there were significant differences among treatments in grading the fish in classes ($P < 0.05$) (Table 12). Fertilizer mixture treatments had significantly increased the amount of fish in first (I) and second fish class (II) than in control treatment.

Partial budget
(Costs and Returns)

Partial budget evaluation of the first experiment show that mean feed cost varied among treatments, it ranged between 185.3 L.E. at third treatment (feed + fertilization with compost) to 286.4 L.E. at first treatment (feed only). Fertilization cost varied among fertilized treatments. It ranged between 36.0 L.E. at fourth treatment and 115.2 L.E. at second treatment. Total income obtained with various treatments, were 835.0, 679.5, 824.25 and 642.0 L.E. for first, second, third and fourth treatment, respectively. The third treatment (fertilizer with compost) resulted in the highest net return, which achieved 570.5 L.E. per pond (11981.5 L.E. per feddan). With respect to second experiment net returns differed among treatments. First treatment achieved the highest net return among treatments which was 183.02 L.E./pond. It was superior by 20% compared to the control treatment. Second treatment had the intermediate net return of 157.0 L.E./pond, while the third treatment showed the

Table (12): ***The grading of fish in classes (kg fish /pond) and total yield (kg fish /pond) of Nile tilapia reared at different fertilizer treatments in the second experiment.***

Fish degree*	T_1	T_2	T_3	T_4
I	13.34 a	10.9 a	10.62 a	7.36 b
II	15.10 a	12.0 b	13.56 ab	9.20 c
III	11.60 c	17.4 a	15.34 b	15.63 b
Recruitment	17.96 b	19.8 a	19.46 a	13.80 c
Total yield (kg / pond)	58 a	60 a	59 a	46 b
Total yield (kg /feddan)	1218 a	1260 a	1239 a	966 b

Means in each rows followed by different letter are significantly different (P < 0.05).
**** First class ≥ 200 g, second class < 200- ≥ 125 g, third class < 125 - ≥ 75g recruitment < 40 g***

lowest net return among treatments, it was 140.0 L.E./pond. This values equal 3843.42, 3297, 2940 and 3105.90 L.E. per feddan for first, second, third and fourth (control) treatments, respectively.

DISCUSSION

Growth performance

In the first experiment of the present study, data show that weight gain among treatments were insignificantly. Similar trend was observed by Green (1992) at monosex Nile tilapia (18.6 g) treated with organic fertilizer and supplemental feed for 150-day experimental period. Weight gain in the second experiment differed significantly among treatments. Control treatment (T4) was significantly (P< 0.05) lowest in weight gain 82.0 g/fish while the other treatments were 110, 116 and 111 g/fish, respectively. Similar findings were reported by Milstein *et al.* (1995) for *O. niloticus* in ponds received manure and inorganic fertilizer where weight gain was 116 g/fish. Tidwell *et al.* (2000) found that weight gain of mixed sex tilapia (26 g) was 123.4, 93.4 and 82 g/ fish when fish were fed on diets contained 30, 25.6 and 22.5% crude protein, respectively. Diana *et al.* (1996) and Liti *et al.* (2001) stated that fish in ponds received fertilizer and supplemental feed were higher in weight gain than fish in other treatments. Similarly, Brumnett (2000) mentioned that weight gain of *Tilapia randalli* treated with organic fertilizer (Napier grass) was significantly higher than in those treated with inorganic fertilizers.

With respect to average daily gain (ADG) results show the same trend of weight gain in experiments. There was a positive effect between fertilization and ADG. In the first experiment ADG ranged between 0.88 and 0.93 g/fish/day without significant differences among treatments (P> 0.05). These values were higher than those found by Yi *et al.* (2001) with tilapia cultured in monoculture and polyculture systems in fertilized ponds, In previous study, Liti *et al.* (2001) found that daily gains were 0.68 and 1.17 g /fish/day in monosex Nile tilapia using combination of chemical fertilizer plus rice bran (6.5% crude protein) or supplemental feed (12.5 crude protein). In the first experiment of the present work, ADG was 0.88 g /fish/day at second treatment in which fish reger fertilizer (poultry litter) was used and 0.91/ g/day at fourth treatment, with chemical fertilizer. These results nearly similar to 0.86 g/day obtained by Diana and Lin, (1998) in tilapia fish ponds. In the second experiment, there were significant differences among treatments in ADG. Fertilizer treatments had higher daily gain values than control treatment These results were almost similar to that obtained by Green (1992) with Nile tilapia where ADG were 1.62, 1.77 and 1.55 g/fish/day for feed only (23% crude protein), chicken litter fertilizer then feed and chicken litter fertilizer plus feed treatments, respectively. Differences among the obtained results and that of Green (1992) may be attribute to using sex reversed Nile tilapia in his trail which has faster daily gain than mixed sex tilapia which used in the present study. Diana *et al.* (1994) reported that daily gains were 1.13, 2.0 and 1.86 g/fish/day with fertilization treatment only, feed only (30% crude protein) and combination of both of them, respectively.

In the first and second experiments of the present study results indicated that PER was significantly higher in ponds received both fertilizer and supplemental diet than those fed on supplemental diet only. These results agree with the results of previous studies(Peralta and Teichert-Coddington, 1989 and Green, 1992), they reported that fish grew faster in ponds received both of fertilizer and supplemental feed than those in ponds received fertilizer only or feed only.

With respect to feed conversion ratio (FCR) results of the present work indicated that, there were significant differences among treatments in the two experiments. Fertilization treatments had a positive effect on FCR. Results indicated that enhancing natural food by fertilization resulted in higher contribution in fish nutrition at all experiments and reduced the amount of supplemental feed required. McNabb *et al.* (1990) reported that fertilization of fish pond actually increases the production of phytoplankton in pond and more food items are available for fish. Lim (1989) indicated that up to half of the food intake of tilapia in intensively fed ponds was natural food, which indicated its substantial contribution to tilapia growth. However, FCR values in the present study were better than many of previous studies. Della Patrona *et al.* (2004) reported that FCR was decreased from 1.79 to 1.37 when ponds were fertilized. At the same time, with increasing feeding rate from 25 to 100% of satiation in fertilized ponds FCR increased from 0.7 to 1.42 with sex reversed Nile tilapia (Diana *et al.,* 1994).

In the present study results of the first experiment reveal that there were differences among treatments in total fish yield but differences were not significant (P > 0.05). The highest total yield was recorded with the third treatment (compost fertilizer plus feed) it was 2604 kg fish/feddan followed by fourth treatment (chemical fertilizer plus feed) 2562 kg fish/ feddan, then first treatment (feed only, control)of 2541 kg/ feddan and finally, second treatment (fish reger fertilizer plus feed)of 2478 kg/ feddan. These results are nearly similar to previous studies and may be higher than some of them (Green, 1992; Diana, 1996; Gupta *et al.,* 1996). In the present study mixed sex Nile tilapia produced lower total yield than sex reversed Nile tilapia, which used in the previous studies. However, Brunson *et al.* (2001) reported that fish harvest of a fertilized pond can be triple that of an unfertilized pond. Also, fish in fertilized ponds grow faster when they are provided with supplemental feed. Knud-Hansen *et al.* (1993) found that fertilization at high input levels can result in yields approaching 3500 kg/ ha over 5 months. Green *et al.* (1989) achieved 1756 kg fish/ ha per 150 days yield of Nile tilapia stocked at 10000 fish/ ha using chicken litter fertilizer and they found this application was greater than dairy cow manure or chemical fertilizer. Teichert-Coddington *et al.* (1990) reported that net fish yields were 1772 and 1896 kg/ ha after 98 day for Nile tilapia stocked at rate of 1 and 1.5 fish/ m^2, respectively in organic fertilizer pond without supplemental feed. Also, fish yield of first experiment was higher than that recorded by Diana *et al.* (1991) in dry season in Thailand with Nile tilapia (30 g) in fertilized ponds. They found that total yields were 1993 and 1601 kg/ha per 150 days with organic and inorganic fertilized ponds, respectively. In the second experiment results indicated that there were a positive relationship between fertilizer and total fish yield. The control treatment (feed only) had significantly lower total yield than the other treatments. Abd El-All *et al.* (2001) reported that organic fertilizer with supplementary feed had higher fish yield in comparison to chemical fertilization or organic fertilization treatments. Li and Yakupitiyage (2003) indicated that supplemental feed is required to increase fish yield in fertilized ponds. Differences between our results and their results may be attributed to the long experimental period or using monosex Nile tilapia in those studies which indicate that male of Nile tilapia grow faster than females (Schreiber *et al.,* 1998). Also, lower stocking density in the second experiment (2 fish/m^3) had a great effect on lowering total yield.

Water quality

Results of the present study revealed that there were no significant differences among treatments in the water pH values of the two experiments. In the first experiment, pH ranged between 9.19 to 9.56 while in the second experiment pH values ranged between 8.72 to 8.99. Boyd (1998) indicated that the optimal pH of most fresh water ponds ranged from 6 to 9. Moreover, Diana *et al.* (1994) found that combination between supplemental feed and fertilization in fish ponds increased water pH in ponds.

With increasing fish reger fertilizer rate in ponds, electric conductivity EC increased at the second experiment. This agree with that found by Santerio and Pinto-Coellio (2000) where water electric conductivity increased significantly at organic fertilizer treated ponds. Data showed that differences among treatments in total dissolved solids TDS were not significant, but TDS increased with increasing fish reger inclusion rate in second experiment, that may be attributed to the increased population of phytoplankton and zooplankton as reported by Coveney (1982).

Total alkalinity in the present study was not affected significantly by different treatments. In the first experiment total alkalinity ranged between 350 to 416 mg/L, while in the second experiment, it increased with increasing fish reger fertilizer rate in treatments but without significant differences, it ranged from 483.3 to 523.3 mg/L. Boyd (1998) reported that with increasing total alkalinity, the natural fertility of pond water increases. Boyd (1990) indicated that hard water which had total alkalinity higher than 40 mg/L is generally, more productive than soft water, which had total alkalinity less than 40 mg/L. In the first experiment the fourth treatment (chemical fertilizers plus feed) had the lowest total alkalinity values.

Similar results were found by Liti *et al.* (2001) who mentioned that total alkalinity values were higher in organic fertilization treatment than those of chemical fertilization one.

Total hardness in the present study showed the same trend of total alkalinity. There were no significant differences among treatments in the first and in the second experiment, it ranged between 474 to 486 and from 540 to 650 mg/L at first and second experiment, respectively. Shrestha and Lin (1996) found that mean total hardness was significantly higher in new ponds (165 mg/L) than in old ponds (140 mg/L). El-Nagaawy (2004) reported that total hardness in ponds treated with both organic and inorganic fertilizer were higher than that in ponds treated with inorganic fertilizer only ,the values were 204.4 and 147.3 mg/L, respectively.

Results show that no significant differences among treatments in total ammonia concentration at first experiment, which ranged between 0.64 to 0.71 mg/L, while unionized ammonia concentrations were differed significantly among treatments, In the second experiment, data showed that control treatment (feed only) was significantly the lowest in total ammonia concentration than fertilizing treatments and the same profile was noticed in unionized ammonia. Generally, unionized ammonia was not affected in the present study and values of total and unionized ammonia were in the safety range and lower than many of previous studies. Burns and Stickney (1980) recorded 2.4 mg/L total ammonia in ***Tilapia aurea*** ponds fertilized by poultry waste. Garg and Bhatnagar (1996) recorded that ammonia ranged between 0.76 and 2.19 mg/L in ponds received different doses of organic and inorganic fertilizer. Qin and Culver (1992) found that averaged of total ammonia concentration in organic fertilized ponds was 0.14 mg/L and the maximum observation was 0.5 mg/L.

In the present work, results show that the highest nitrates and nitrites concentrations were noticed in fish reger fertilizer treatment in the first experiment as well as with the rate of 75% of it in the second experiment. Nitrate ranged between 0.29 and 0.38 mg/L in the first experiment and between 0.275 and 0.396 mg/L in the second experiment, while nitrites concentrations do not exceed 0.05 mg/L within all treatments at both of experiments. Diana *et al.* (1991) reported that in organically fertilized ponds nitrate and nitrite were the predominant nitrogen forms while ammonia predominated in inorganic fertilized treatments. Garg and Bhatnagar (1996) found maximum nitrite nitrogen concentration was 1.6 mg/L during (June-July) in fresh water ponds received the highest dose of fertilizers (cowding and signal super phosphate). Diana and Lin (1998) reported that nitrate concentrations ranged between 0.43 and 0.46 mg/L and nitrite concentration ranged between 0.37 and 0.41 mg/L in Nile tilapia ponds fertilized with both organic and inorganic fertilizers.

Total phosphorus concentrations in the first experiment were differed significantly among treatments. Highest value was recorded at the fourth treatment (chemical fertilizer plus feed) which was 0.892 mg/L while the lowest was in control treatment (feed only) which was 0.651 mg/L. Shrestha and Lin (1996) reported that the level of P fertilization is that gives optimal fish yield in semi–intensive fish ponds as compensated by sediment P saturation level. They found that net fish yield increased significantly in treatment with increasing P saturation in sediments and with higher levels of P fertilization. Qin *et al.* (1995) reported that organic fertilizer alone is unlikely to provide adequate nutrients to pond water. Results showed that in the second experiment with increasing fish reger fertilizer rate, total phosphorus concentration increased. In this connection, El-Ebiary (1998) reported that fertilization with different organic manures increased significantly the phosphorus concentrations in pond than non fertilized ponds. Garg and Bhatnagar (1996) reported that total phosphorus ranged between 1.43 and 1.62 mg/L in freshwater fish ponds treated with different doses of both organic and inorganic fertilizers.

Orthophosphate concentration showed the same profile of total phosphorus. In the first experiment highest orthophosphate concentration was recorded at fourth treatment (chemical fertilizer plus feed) which was 0.189 mg/L while third treatment was the highest concentration in the second experiment (0.205 mg/L). Results indicated that orthophosphate concentrations were significantly higher in fertilized ponds than in control ponds. These values were higher than those obtained by Davidson and Boyd (1981) whose values ranged between 0.015 and 0.025 mg/L. Moreover, they indicated that concentrations of orthophosphate in fertilized ponds were higher than control ponds. Garg and Bhatnagar (1996) found that orthophosphate ranged between 0.03

and 1.2 mg/L with increasing fertilizer application in ponds. Also, Diana and Lin (1998) found that soluble reactive phosphorus ranged from 0.21 to 0.44 mg/L in Nile tilapia ponds treated with both organic and inorganic fertilizers.

Partial budget evaluation (costs and returns) of the first experiment indicated that all treatments were profitable. But profit varied among treatments. Results showed that third treatment (compost fertilizer plus feed) were considered as the highest in net return among treatments, while second treatment (fish reger fertilizer plus feed) was the lowest in net return. This may be attributed to the high cost of fish reger fertilizer (600 L.E/ton compare to 200 L.E/ton for compost). Green (1990) stated that net return was higher in combined organic fertilizer and feed than in feed only treatment.

In the second experiment, net return also, differed among treatments. First treatment was the highest profitable treatment; it was superior by about 20% compared to control treatment. Gupta *et al.* (1996) found that net profits were higher with supplementary feeding than with fertilizer treatment only.

From the results of the present study we can recommend the compost fertilizer as more economic and more profitable for fish ponds than chemical fertilizer or fish reger fertilizer, however this do not mean that fish reger fertilizer is unsuccessful or unprofitable in fish ponds but the problem is its high price. However, under the same conditions of present study we can recommend that using of compost fertilizer combined with supplemental feed or organic fertilizers mixture (containing of 75% compost and 25% fish reger) with supplemental feed are more economic and profitable for fish farms.

REFERENCES

Abd El-All, M.M., El-Hindawy, M.M.; Hafez, F.A., Hassona, M.A. and Ismail, A.A. (2001). Effect of different fertilizers and artificial feeding systems on fish pond productivity. J. Egypt. Acad. Soc. En. Dev., 1, (2): 61-75.

Alceste, C.C. and Jory, D.E. (2000). Tilapia - some fundamentals of tilapia nutrition. Aqua., 26 (3): 74 - 78.

American Public Health Association (APHA) (1989). American water works association and water pollution control federation. Standard methods for the examination of water and waste water, 17th edition, Washington, D.C., 1, 469 PP.

Association of official Analytical Chemists (AOAC) (1990). Official Method of Analysis. Association of official Analytical Chemists.

Washington, D.C.

Banerjee, R.K., Ray, P., Sing G.S. and Dutte B.R. (1979) Poultry droppings and its manural potentiality in aquaculture. Journal of the Inland Fisheries Society, 2:94 –103.

Bocek, A. (1996). Water harvesting and aquaculture, Inroduction to fish pond fertilization, International Center for Aquaculture and Aquatic Environments, ICAAE publications. Swingle Hall, Auburn University, Alabama 36849-5419 USA.

Boyd, C.E. (1988). Water quality in warm-water fish ponds. Alabama Agric., Experiment Station, Auburn Univ., Alabama, U.S.A.

Boyd, C.E. (1990). Water Quality in ponds for Aquaculture. Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama, 482 pp.

Boyd, C.E. (1998). Water quality for pond aquaculture. Research and development series No. 43. pp. 37. International Center for Aquaculture and Aquatic Environments. Alabama Agricultural Experiment Station. Auburn University.

Boyd, C.E and C.S. Tucker (1992). Water quality and pond soil analyses for Aquaculture. Auburn University, 183 pp.

Brumnett, R.E. (2000). Food organism availability and resource partitioning in organically or inorganically fertilized (*Tilapia rendalli*) ponds. Aqua. 183, No. 1-2, 57 - 71.

Brunson, M.W., Stone N. and Hargreaves J. (2001) Fertilization of Fish Ponds, Southern Regional Aquaculture Center Publication No. 471. bass and zooplankton dynamics in fertilized rearing ponds. Prog. Fish-Cult., 47: 213-223.

Burns, R.P. and Stickney R.P. (1980). Growth of (*Tilapia aurea*) in ponds receiving poultry wastes. Aqua. 20: 117 - 121.

Coveney, M.F. (1982). Bacterial uptake of photosynthetic carbon from freshwater phytoplankton. Oikos 38: 8-20.

Das, S.K. and Jana, B.B. (2003). Pond fertilization regimen. State of the art. Journal of Applied Aquaculture 13: 35 - 66.

Davidson, R.G. and Boyd, C.E. (1981). Phytoplankton response to liquid fertilizers. Prog. Fish-Cult. (3): 126-129.

Della Patrona, L., Chim, L., Capo, S., Brun, P., Lemaire, P. and Mortin, J.L.M. (2004). Effect of mineral fertilization on food web development, abundance of ingested prey, growth rate and pelleted feed conversion ratio of the shrimp (*Litopenaeus stylilostris*) reared in earthen ponds in cold season. Page 105. In: Book of Abstracts, Aquaculture 2004, Honolulu, Hawaii, USA.

Diana, J.S. (1996). Feeding strategies. In: C.E. Boyd and H. S. Egna, editors. Dynamics of Pond Aquaculture. Lewis Publishers, Boca Raton.

Diana, J.S., and Lin C.K (1998). The effects of fertilization and water management on growth and production of Nile tilapia in deep ponds during the dry season. J. of the World Aquaculture Society. 29 (4) 405 – 413.

Diana, J.S., Lin, C.K. and Schneeberger

P.J. (1991). Relationships among nutrient inputs, water nutrient concentrations, primary production, and yield of (*Oreochromis niloticus*) in Ponds. Aqua. 92, 323.

Diana, J.S., Lin, C.K. and Jaiyen K. (1994). Supplemental feeding of tilapia in fertilized ponds. J. world Aquaculture. Soc. 25 (4): 497 - 506.

Diana. J.S., Lin, C.K. and Yi Y. (1996). Stocking density and supplemental feeding p 133 – 138, 14th Annual Technical Report, Pond Dynamics / Aquaculture CRSP, Oregon state Univ., Corvallis, Oregon.

El-Ebiary, E.H. (1998). The use of organic manure in polyculture system for tilpia, mullet and carp. Egypt. J. Aquat. Biol. And Fish., Vol. 2, No. 3: 133-147.

El-Nagaawy, A.M. (2004). Impact of using agricultural by-products for fertilization in fish ponds on fish performance and aquatic environment. Ph.D. Thesis. Environmental studies and Research Institute. Ain Shams Univ.

Garg, S.K. and Bhatnagar, A. (1996). Effect of varying doses of organic and inorganic fertilizers on plankton production and fish biomass in brackish water fish ponds. Aqul. Res., 27: 157-166.

Green, B.W. (1990). Substitution of organic manure for pelleted feed in tilapia production. In: Berka, R., Hilge, V. (Eds.), Proceedings of the FAO-EIFAC Symposium on Production Enhancement in Still water Pond culture. Research Institute of Fish Culture and Hydrobiology, Vodnany, Czechoslovakia, pp. 165– 171.

Green, B.W. (1992). Substitution of organic manure for pelleted feed in tilapia production. Aquaculture, 101: 213 - 222.

Green, B.W., Phelps, R.P. and Alvarenga H.A. (1989). The effect of manure and chemical fertilizers on the production of *Oreochromis niloticus* in earthen ponds. Aqua. 76: 37 - 42.

Green, B.W., El Nagdy, Z.A. and El-Gamal A.R.(1995). Yield Characteristics of Two Species of Tilapia under Two Different Pond Environments(1995). CRSP Research Report 95-91. Pond Dynamics/ Aquaculture CRSP, Oregon State University, Corvallis, Oregon. Work Plan 7, Egypt Study 1B.

Gupta, M.V., Akhteruzzaman, M.D., Kahinoor, A.H. and Shah, M.S. (1996). Nile tilapia (*Oreochromis niloticus*) culture in small water bodies under different feeding and fertilization regimes. P. 500-504. In R.S.V. Pullin. J. Lazard. M. Legeadre-J.B. (*Amon kothias*)and D. Pouly (eds.) The third international symposium on tilapia in Aquaculture. ICLARM Conf. Proc. 41: 575 P.

Huet, M. (1970). Textbook of fish culture. Breeding and cultivation of fish. London, Fishing News (Books) Ltd., 436.

Knud-Hansen, C.F., Batterson, T.R. and McNabb. C.D. (1993). The role of chicken manure in the production of Nile tilapia, (*Oreochromis niloticus)* (L). Aquaculture and Fisheries Management 24:483-493.

Li, L. and Yakupitiyage, A. (2003). A model for food nutrient dynamics of semi-intensive pond fish culture. Aquaculture Engineering, 27: 9 – 35.

Lim, C. (1989). Practical feeding –tilapia. In: Lovell R.T. (Ed.). Nutrition and Feeding of fish. A VI Books. Van Nostrand Reinhold, New York, NY pp.163 – 184.

Lin, C.K.,. Tansakul, V. and Apinhapath, C. (1988). Biological nitrogen fixation as a source of nitrogen input in fish ponds, In: R.S.V. Pullin, T. Bhukaswan, K. Tonguthai, and J.L. Maclean (Eds.)The Second International Symp. on Tilapia in Aquaculture, International Center for living Aquatic Resources Management, Manila.

Liti, D.M., MacWere., O.E. and. Veverica, K.L (2001). Growth performance and Economic Benefits of (*Oreochromis niloticus*) and (*Clarias gariepinus)* polyculture fed on three supplementary feeds in fertilized Tropical ponds, p 11. In : P D / A CRSP nineteenth Annual Technical Report, Oregon State University, Corvallis, Oregon.

McNabb**, C.D., Batterson, T.R., Premo, B.J., Kund-Hansen, C.F., Eidman, H.M., Lin., C.K., Jaiyen Hansen, J.E. and Chuenpagdee, R. (1990).** Managing fertilizers for fish yield in tropical ponds in Asia. P. 169-172. In Reijiro Hairano and Isao Hanyu (eds.). The second Asian Fisheries Forum. Proceedings of the Asian Fisheries Society, Manila Philippines.

Milstein, A., Alkon, A., Karplus, I., Kochba, M. and Avnimelech, Y. (1995). Combined effects of fertilization rate, manuring and feed pellet application on fish performance and water quality in polyculture ponds. Aqua. Res., 26: 55-65.

Olvera-Novoa, M., Martines-Palacios C. and Olivera-Castillo, L. (2002). Utilization of torula yeast (*Candida utilis*) as a protein source in diets for tilapia (*Oreochromis massambicus*) fry. Aquaculture Nutrition 8: 257-264.

Pandit, N.P., Shrestha, M.K., Yi, Y., Lin, C.K. and Diana, J.S. (2003). Polyculture of grass carp and Nile tilapia with Napier grass as the sole nutrient input. Page 170 In program and Abstract book, Asian-Pacific Aquaculture 2003, Bangkok,Thailand. World Aqua. Soc. Louisiana USA.

Pant, J., Shrestha, S.M., Lin, C.K., Demaine H. and Diana, J.S. (1999). High-input Green Water On-farm Trials in Northeast Thailand. In: K. McElwee, D. Burke, M. Niles and H. Egna (eds.), Sixteenth Annual Technical Report. Pond Dynamics/Aquaculture CRSP, Oregon State University, Corvallis, pp. 171-181. (*Procambarus clarkii.*) J. World Aquac. Soc. 17, 33–36.

Peralta, M. and Teichert-Coddington, D.R. (1989). Comparative production of (*Colossoma macropomum)* and (*Tilapia nilotica*) in Panama. J. World Aquacult. Soc., 20: 236-239.

Qin, J. and Culver, D.A, (1992). The survival and growth of larval walleye, (*Stizosredion uitreum***)** and trophic dynamics in fertilized ponds. Aquaculture, 108: 257-276.

Qin, J., Culver, D.A. and Yu, N. (1995). Effect of organic fertilizer on heterotrophs and autotrophs: implications for water quality management. Aquacul. Res., 26: 911-920.

Rancis, T., Vathy P.P. and Than, N. R. (2004) Integrated fish farming – A review. World Aquaculture Magazine. 35: (3) 24.

Santeiro, R.M. and Pinto-Coellio, R.M. (2000). Fertilization effects on biomass and nutritional quality of zooplankton in feeding of fry in the furnas (MG, Brazil) hydrobiology and pisciculture station. Acta-Scientiarum (22), 3: 707-716.

Schreiber, S., Focken, U. and Becker K. (1998). Individually reared female Nile tilapia (*Oreochromis niloticus*)can grow faster than males. J. of Applied Ichthyology 14: 43 – 47.

Sevrin-Reyassac, J. and Plaetikosic, M. (1990) Cyanobacteria in fish ponds. Aquaculture, 88: 1- 20.

Shrestha, M.K. and Lin C.K. (1996). Phosphorus fertilization strategy in fish ponds based on sediment phosphorus saturation level. Aquaculture 142: 207 - 219.

Snedecor, G.W. and Cochran, W.G. (1981). Statistical Methods-Iowa State Univ., Ames, J.O., USA. 341 PP.

Stickney, R.R. (2004). Alternative protein sources and feeding practices for tilapia. Page 561 In: Book of abstracts, Aquacualture 2004, Honolulu, Hawaii, USA.

Tacon, A.G. and Forster, I.P. (2000). Trends and challenges to aquaculture and aquafeed development in the new millennium. In: Cruz-Sua´rez, L.E., Ricque-Marie, D., Tapia-Salazar, M., Olvera-Novoa, M.A., Civera- Cerecedo, R. (Eds.), Avances en Nutricio´n Acuı´cola, Memorias del V Simposium Internacional de Nutricio´n Acuı´cola, Me´rida, Yucata´n, Me´xico, pp. 1– 12.

Teichert-Coddington, D.R., Behrends, L.L. and Smitherman, R.O.(1990). Effects of manuring regime and stocking rate on primary production and yield of tilapia using liquid swine manure. Aquaclture. 88: 61 – 68.

Tidwell, J.H., Coyle, S.D., VanArum, A., Weibel, C. and Harkins, S.(2000). Growth, Survival, and body composition of cage-cultured Nile tilapia fed on pelleted and unpelleted distillers grains with soluble in polyculture with freshwater prawn (*Macrobracium resenbergii*) Journal of the World Aquaculture Society, 31 (4): 627 - 631.

Valle, J.B., Pezzato, L.E., Barras, M.M., Silva, A.F., Falcon, D.R. and Kleemann, G.K. (2003). Yeast on practical diets for Nile tilapia (*Oreochromis niloticus*) post larvae. Page 807 In Book of Abstracts, volume 2. World Aquaculture 2003. Salvador, Brazil. World Aquaculture Society, Baton Rouge Louisiana USA.

Yi, Y. and Lin. C.K. (2000). Analyses of Various Inputs for Pond Culture of Nile tilapia (*Oreochromis niloticus*): Profitability and Potential Environmental Impacts. In: K. Fitzsimmons and J.C. Filho (eds.), Proceedings from the Fifth International Symposium on Tilapia Aquaculture, pp. 247-257.

Yi , Y., Lin C. K. and Diana, J.S. (2001) Culture of Mixed sex Nile tilapia with predatory snakehead . In : K. Mcelwee , K. Lewis, M. Nidiffer, and Buitrago (Eds.) , Nineteenth Annual Tichnical Report . Pond Dynamic / Aqua. CRSP, Oregon State University, Corvallis, Oregon: 67- 73.

تأثير أنماط ومعدلات التسميد مع الغذاء الإضافي على أداء الأسماك وكفاءة الغذاء والإنتاج لأسماك البلطي النيلي

علاء الدحار[1] ، زينب عطية نجدي[2] ونادر الطويل[2]

١. قسم الإنتاج الحيواني والسمكي – كلية الزراعة (سابا باشا) – جامعة الإسكندرية

٢. المعمل المركزي لبحوث الاستزراع المائي – وزارة الزراعة

في هذه الدراسة تم إجراء تجربتين لتقييم وتحديد تأثير بعض أنواع من الأسمدة (كيماوية ، عضوية و الكمبوست "مخلفات نباتية") مع التغذية الصناعية على النمو والحيوية والاستفادة من الغذاء لأسماك البلطى النيلى مختلط الجنس، وتأثيرها على جودة المياه.. ففي التجربة الاولى تم تقييم تأثير الأسمدة السابقة مع التغذية باستخدام غذاء محتوي على ٢٥ % بروتين لدرجة الإشباع على إنتاجية الأسماك ذات وزن ابتدائي ٢١ جم بكثافة ٥ أسماك / م^{٣} ، وقد تم استخدام أربع معاملات كل في مكررتين، والمعاملات هي الأولى: تغذية فقط (المعاملة الضابطة)، الثانية : التسميد بسماد فيش ريجر بمعدل ٢٦٦ كجم/فدان/أسبوع، الثالثة : التسميد بسماد كمبوست بمعدل ٥٠٠ كجم/فدان/أسبوع، الرابعة : التسميد بسماد كيماوي بمعدل ١٥ كجم أحادي سوبر فوسفات و ١٩ كجم يوريا/فدان/أسبوع واستمرت التجربة لمدة ١٢٠ يوما. أماالتجربة الثانية فأجريت بهدف تحديد معدل التسميد الأمثل للأحواض باستخدام مخلوط أسمدة مكون من سماد الكمبوست وسماد الفيش ريجر وأثرهم على إنتاجية الأسماك. وقد استخدمت في هذه التجربة أسماك بلطي نيلي مختلط الجنس بمتوسط وزن ابتدائي ٣٤ جم، بمعدل تخزين ٢ سمكة / م٣ لمدة ٧٥ يوما وتمت التجربة بأربع معاملات، بالإضافة إلى التغذية الصناعية باستخدام علف ٢٥ % بروتين حتى الإشباع، وتم إضافة كميات السماد في أربع معاملات لتوفر تركيز ٠.٥ مجم/لتر فوسفور و ٢ مجم/لتر نيتروجين لكل المعاملات. حيث كانت المعاملات هي: الاولى: ٧٥% بسماد الكمبوست و ٢٥% بسماد الفيش ريجر أسبوعيا بما يعادل ٤٠٠ كجم كمبوست و ٨٤ كجم فيش ريجر للفدان، الثانية ٥٠% سماد كمبوست و ٥٠% سماد الفيش ريجر أسبوعيا بما يعادل ٢٦٢.٥ كجم كمبوست و ١٥٧.٥ كجم فيش ريجر للفدان، الثالثة ٢٥% سماد كمبوست و ٧٥% سماد فيش ريجر أسبوعيا بما يعادل ١٣٦.٥ كجم كمبوست و ٢٣١ كجم فيش ريجر للفدان، الرابعة تغذية صناعية فقط (معاملة ضابطة) .

وقد أوضحت النتائج أنه لم تظهر اختلافات معنوية بين المعاملات في التجربة الأولي في كل من متوسط الوزن النهائي، الوزن المكتسب، ومعدل الزيادة اليومية، أو الإنتاجية الكلية، ولكن لوحظ أن المعاملة الثالثة سجلت أعلى القيم لهذه القراءات حيث سجلت ١٢٤ جم/سمكة ،١٠٢ جم/سمكة ، ٠.٩٣ جم/يوم و ٢٦٠٤ كجم/فدان على التوالي ، كما أظهر معدل التحويل الغذائي FCR والكفاءة التحويلية للبروتين PER تحسنا معنويا في المعاملات السمادية بعكس الحال في المعاملة الضابطة، وأعلى صافي ربح لهذه التجربة كان في المعاملة الثالثة (التسميد بالكمبوست + التغذية الصناعية). وفي التجربة الثانية قد اظهرت النتائج اختلافات معنوية في كل من الوزن النهائي للأسماك، والوزن المكتسب، والإنتاجية الكلية بين كل من معاملات مخلوط الأسمدة من جهة وبين المعاملة الضابطة من جهة أخرى وذلك لصالح المعاملات السمادية، فقد لوحظ وجود فرق معنوي واضح في كل من FCR و PER بين المعاملات السمادية وبين المعاملة الضابطة وذلك لصالح المعاملات السمادية. حققت المعاملة الأولى أعلى صافي ربح مقارنة بالمعاملات الأخرى حيث زادت عن المعاملة الضابطة بنسبة ٢٠%. لذا و بناء على النتائج المتحصل عليها من هذه الدراسة يمكن التوصية باستخدام سماد الكمبوست بنسبة ٧٥% مع ٢٥% سماد فيش ريجر مع التغذية الصناعية وذلك للحصول على إنتاجية أكثر اقتصادية وأعلى ربحية وأيضا لتلافى الآثار الضارة الناتجة من جراء استخدام الأسمدة العضوية مثل زرق الدواجن غير المعاملة حراريا والتي يمكن عن طريقها نقل الأمراض والميكروبات.