EFFECT OF FERTILIZATION ON PRODUCTION OF NILE TILAPIA REARED IN EARTHEN PONDS: III) EFFECT OF NON-TRADITIONAL ORGANIC FERTILIZER ON THE FISH YIELD OF MIXED-SEX NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

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Abstract

This experiment was designed to determine the optimal fertilizing rate of Abis organic fertilizer in mixed sex Nile tilapia reared in earthen ponds. Six ponds (200 m^2) were assigned for 3 treatments: 50, 75 and 100 g fertilizer/m^2/wk. Fish in this experiment were fed a restricted level of 20.93% protein diet for fourteen weeks and 17.4% protein diet for another four weeks. The experiment lasted for 126 days. Water quality parameters were monitored weekly during the experimental period. Tilapia growth rate, specific growth rate, gross yield of initial stock and net yield of initial stock were significantly different among treatments, with the highest at fertilizing rate of 75 g / m^2 wk^{-1}, and the lowest at fertilizing rate of 100 g / m^2 wk^{-1}. The highest recruitment was produced at the highest fertilizing rate (100g / m^2 wk^{-1}). Highest net return was achieved at the fertilizing rate of 75g / m^2 wk^{-1}, while the lowest was at the fertilizing rate 100 g / m^2 wk^{-1}. The effect of the treatments on water quality parameters was discussed.

INTRODUCTION

Recently, Tilapias become one of the most important domesticated fish around the world. Studies have documented yields of Tilapia in different locations with different production systems, from extensive to super-intensive practices at small-scale as well as large-scale level. FAO (1999) reported that farmed production of tilapia has risen at an average annual rate of 12% from 1984 to 1996.

Tilapia display high plasticity in its food habits and tolerate a wide range of environmental conditions that enable farmers to rear tilapia from extensive to super-intensive farms, and from very simple technology to high and sophisticated tech. Tilapia can be cultivated in mono-culture system or poly-culture system as they can be cultivated as mixed-sex or mono-sex (Fitzsimmons 1997, Alceste and Jory 2000, Zachrtiz and Rafferty 2000). The semi-intensive culture of tilapia is particularly ideal in developing countries because it provides a wide variety of options in management and capital investments. Management strategies in the lower levels of intensification involve the use of fertilizer to encourage natural productivity and to improve the levels of dissolved oxygen. Fish yields from such techniques have been found to be higher than those from natural unfertilized systems (Hickling 1962, Hepher 1963, Diana *et al.*

1991 and Green 1992). Moreover, increases in fish yields above those attained by fertilization only can be achieved by using of feed-fertilizer combinations, which result in higher critical standing crop (Hepher 1978).

A number of studies have been done on feed and fertilizer combinations. Such combinations may be very effective because fertilization rates can be reduced due to enrichment gained from fish excreta. In such combination, rapid growth rate of tilapia and large size could be attained in shorter time than in fertilizer alone (Green 1992, Diana *et al.* 1996a, Diana 1997, and Brown *et al.* 2000).

The continually changing pricing and availability of diet ingredients and processing costs will affect how diets are manufactured. In addition, fertilizers costs will affect the nutrition in extensive systems. Growth must be compare to the costs incurred to achieve that growth (Fitzsimmons 1997).

The present study aimed to reduce the production costs by applying feed-fertilizer combination strategy in an attempt to define the optimum fertilizing rate in the presence of artificial feed.

MATERIALS AND METHODS

Six -200 m^2 earthen ponds, with depths of 80 – 90 cm at the fish farm of The Faculty of Agriculture (Saba–Basha) Alexandria University, were assigned for the three treatments for eighteen weeks from 17^{th} May to 20^{th} September 2003.

Before starting the experiment, the ponds were drained and left to dry for a week before refilling. All ponds were equipped with inlet pipes covered with a fine saran screen to prevent the entry of wild fish. Water source was a mixture of freshwater and agricultural drainage water. Throughout the experimental period, there was an adjusted daily water flow rate to replace the whole water volume every week. That water flow continued from 08:00 until 15:00 o'clock 6 days a week.

At the beginning of the experiment mixed–sex, Nile tilapia *Oreochromis niloticus* fingerlings, with an average initial weight of 30.33 ± 0.203 g, were stocked in six ponds at a rate of 1400 fish per 200m^2.

A commercial floating fish feed, produced by Joe Trade Co., was used in this experiment. A restricted feeding rate of 3% of fish biomass was applied using 20.93% crude protein feed in the first fourteen weeks and 17.4% crude protein feed in the last four weeks. Feeding rate was dividing two meals daily, at 8:00 and 15:00 o'clock 6 days a week.

The Abis organic fertilizer was added at three different rates, 50, 75, and 100g`` /m^2/wk. Each rate was applied in two ponds. It was package in numbered polypropylene bags, dropped into the ponds and resettled in new places weekly. At the termination of the experiment after 18 weeks, the bags were remove out of ponds and left to dry. An amount of fertilizer from each bag was kept away to determine the fertilizer leaching out. All ponds received chemical fertilizers urea and monosuperphosphate at a rate of 1.22 and 0.903 kg/200m^2/wk, respectively. The chemical fertilizers were mixed with the pond water in a bucket before splashing them over the pond surface.

For physical parameters and chemical analysis, water samples were collected at 07.00 – 08.00 o'clock using Van Dorv bottle (1 L), from each pond weekly at the third day after application of fertilizers. Pond water analyses included total alkalinity, dissolved inorganic nitrogen (DIN), total phosphorus, ortho-phosphate, chlorophyll "a" and zooplankton according to Boyd and Tucker (1992).

The experiment was terminated on 20th September 2003.after 126 days of the initiation. Total yield (TY) and final number were determined. Overall total gain (TG); daily net yield (DNY); individual specific growth rate (SGR) and daily gain (g/fish/day) were calculated. In addition, the FCR was calculated.

At the beginning and end of the experiment, samples of fish were taken randomly and frozen for proximate analysis. The commercial feed that used in the experiment was also sampled and kept for chemical analysis (crude protein; Lipids; total phosphorus and organic carbon, according to the methods described by APHA *et al.* (1989). Initial and weekly bags samples of the organic fertilizers were taken kept for the chemical analysis too (total nitrogen; total phosphorus (APHA 1989) and organic carbon (Golueke 1977).

Statistical analysis

The data of fertilizer analysis, water quality and fish production were analyzed statistically according to the SAS statistical package (SAS 1998). The least significant difference test was utilized to evaluate the difference among treatments means for all variables.

Economic evaluation

Preliminary economic evaluation of the experiment was done to define the most efficient treatment according to (Diana *et al.* 1996a, 1996b and Yi *et al.* 2001). Local market prices were use to estimate costs and income.

RESULTS

1. Water quality:

Overall means of total alkalinity (Fig 1A) were 344.9 ± 17.4, 338.9 ± 15.6 and 340.8 ± 17.8 mg/L in the first, second and third treatments respectively. Total phosphorus (Fig 1B) showed significant differences among treatments since the 3rd week. The second treatment had higher total phosphorus than the other two treatments from the 4th week until the 15th week. Also in the period between the 4th

and 11th, the third treatment showed higher total phosphorus than the first treatment. The highest overall mean of total phosphorus was recorded in the second treatment and followed by that in the first treatment and then the third treatment. They were 3.277 ± 0.27, 2.806 ± 0.249 and 2.774 ± 0.268 mg/L, respectively. This indicates that, increasing the fertilizer rate up to a rate of 75 g/m^2/wk resulted in a positive effect on the total phosphorus. The fertilizing rate at a rate of 100 g/m^2/wk had a negative impact on the total phosphorus. With respect to the ortho-phosphate (Fig 1C), it showed significant differences ($P < 0.01$) among treatments since the 3rd week. Overall means of ortho-phosphate showed a positive relationship between the fertilizing rate and water ortho-phosphate. Similar to the total phosphorus, the second treatment had the highest overall mean of ortho-phosphate.

Overall means of chlorophyll "a" (Fig 1D) showed that, the second treatment had the highest overall mean followed by third treatment then the first treatment. However, there were not significant differences among treatments. With respect to the zooplankton population (Fig 1E), the highest overall mean was in recorded the second treatment followed by that in the third treatment and the lowest one was in the first treatment.

2. Growth performance:

A) The first period : From start to 14th week

Specific growth rate (SGR) of the fish did not show any significant differences among treatments (Table1). Fish in the second treatment had higher SGR, but not significantly different, than in the first and the third treatments. The third treatment had in its turn higher, but not significantly SGR than the first treatment. Similarly, tilapia daily gain was not significantly different among treatments. It showed similar trend to that of SGR. With regard to the fish final body weight (FBW), they did not show any significant differences among treatments. The highest FBW was found in the fish maintained at the second treatment, intermediate FBW in the fish maintained at third treatment, and the lowest FBW in the fish maintained at the first treatment.

B) The second period: From the 15th week until the end at 18th week

Tilapia specific growth rate (SGR) did not show any significant differences among treatments (Table2). Surprisingly, the highest value of SGR was recorded in the first treatment, intermediate SGR in the second treatment, and the lowest SGR in the third treatment. Daily gain trends reflected those of SGR with similar results. In regard to the final body weight, there were significant differences among treatments ($P < 0.01$). The highest final body weight was achieved with the second treatment. The first treatment had a significantly higher final body weight than the third treatment.

Food conversion ratio (FCR) showed significant differences among treatments, the highest, significantly, was in the third treatment in the first period (Table1). In the second period, it did not reveal any significant differences among treatments (Table 2). It increased as the fertilizing rate increased. Overall FCR did not show significant differences among treatments (Table 3). However, there was a clear trend in a positive manner with increasing the fertilizing rate. The highest FCR was noticed in the third treatment and the lowest FCR in the first treatment

Overall fish yield differed significantly among treatments. Yield was lowest in the first treatment, and higher in both the second and third treatment (Table 4). The yield in the second treatment in its turn was higher than that in the third treatment. It is clear that the increase in fertilizing rate improved fish yield. The trends in yield were also observed in total gain and daily net yield, with similar results. The highest total gain and daily net yield, but not significantly different, were recorded in the second treatment.

The gross yield of initial stock, by deducting the amount of recruitment from the total yield, (Table 4), showed significant differences among treatments, ($P < 0.01$). The highest gross yield of initial stock was achieved in the second treatment, intermediate in the first treatment and the lowest in the third treatment. Likewise, net yield of initial stock showed significant differences ($P < 0.01$) in similar trends to those in gross yield of initial stock.

Surprisingly, recruitment showed significant differences among treatments ($P < 0.01$) in an opposite trend of these in both gross yield and net yield of initial stock. The third treatment produced the highest amount of recruitment, while the second treatment produced intermediate amount and the first treatment produced the lowest amount of recruitment. The recruitment showed a positive relationship with fertilizing rate, the higher fertilizing rate the higher amount of recruitment produced. This led to increase the fish density in the third treatment over 11fish/m^2.

3. Yield in classes:

The results showed (Table 4) that second treatment had the highest amount of the first and second grade fish, about 72.2% of the total yield of this treatment. While this percent was 54.5 and 53.4% of the total yield of first and the third treatments, respectively. On the other hand, the third treatment had the highest amount of fish that could not be market for consumption, 23% of the total yield in this treatment.

4. Economic evaluation:

This evaluation considered only the amount of marketable fish size. It showed that all treatments were profitable in this experiment. The second treatment achieved the highest net return among the treatment, 1197.3 L.E. /200-m^2/126 day. The first treatment had the intermediate net return, and the third treatment had the lowest net return. They achieved 958.2 and 850.9 L.E/200-m^2/126 day respectively.

5. Fertilizer analysis rate:

Figure (2) showed the weekly decomposition rate of Abis fertilizer during this experiment. As it is clear, after 6 weeks, around 23% of the total nitrogen and total phosphorus had been released while organic carbon had been released in a greater rate around 36%. At the end of the experiment, after 18 weeks, around 51%, 65% and 71% had been released of the total nitrogen, organic carbon and total phosphorus respectively regardless of treatments applied. A curvilinear model could be proposed for the releasing rate of the nitrogen, organic carbon and total phosphorus from the Abis fertilizer. They are as follows:

Total nitrogen releasing rate

$Y_1 = -0.0269x + 0.9377$ $r^2=0.9699$

Organic carbon

$Y_2 = -0.5796x + 18.095$ $r^2=0.8147$

Total phosphorus

$Y_3 = -0.0077x + 0.2316$ $r^3=0.8996$

Where:

Y_1 = Total nitrogen content Y_2 = Organic content

Y_3 = Total phosphorus X = Time in days

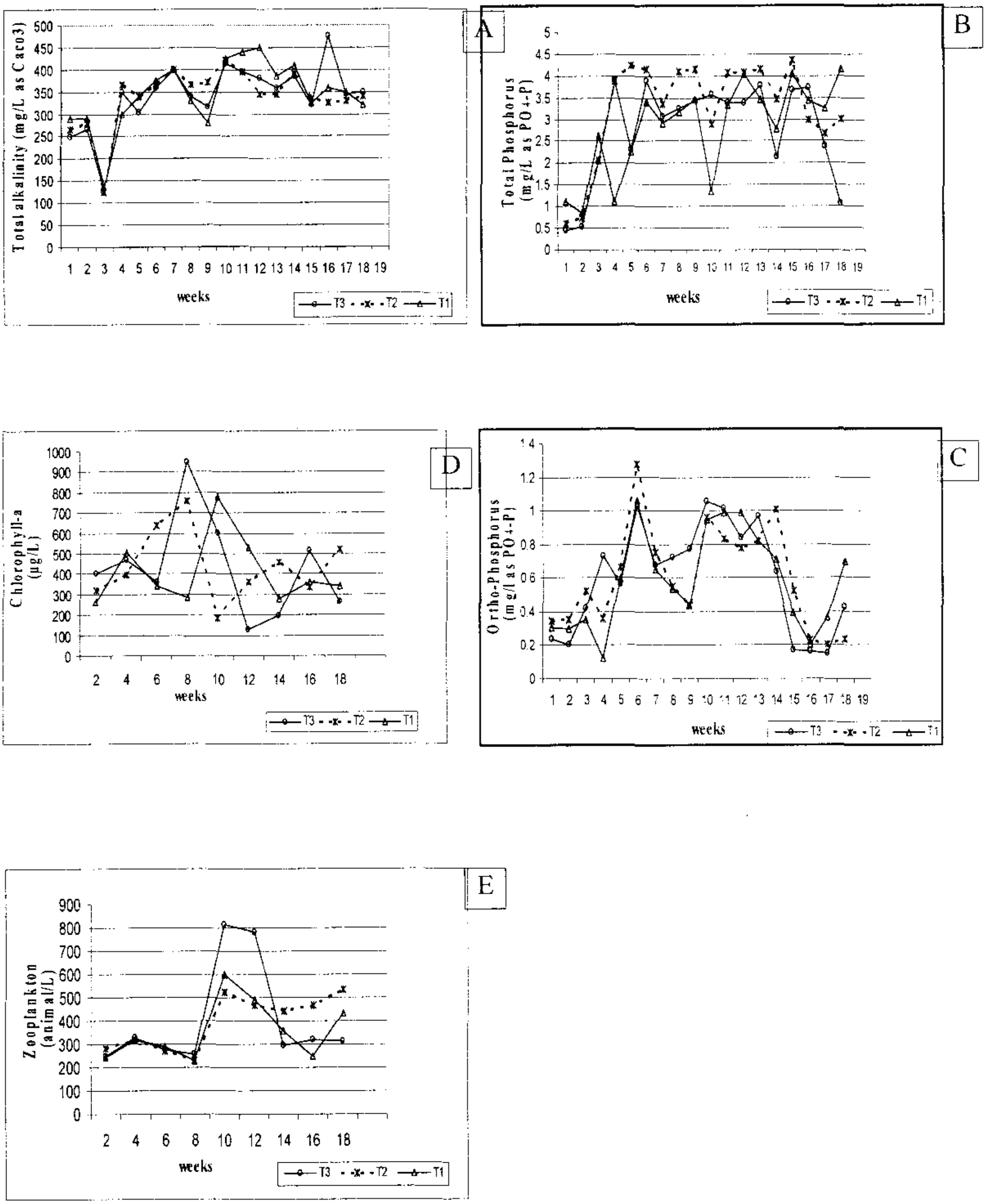

Fig. 1. Mean of (A) Total Alkalinity (mg/L), (B) Total phosphorus (mg/L), (C) Ortho-phosphate (mg/L), (D) Chlorophyll "a"(µg/L) and (E) Zooplankton(org./L) of water treated with untraditional organic fertilizer at rates (50, 75 or 100g/m^2/wk) with stocking density (7fish/m^2) in the present experiment for 126days .

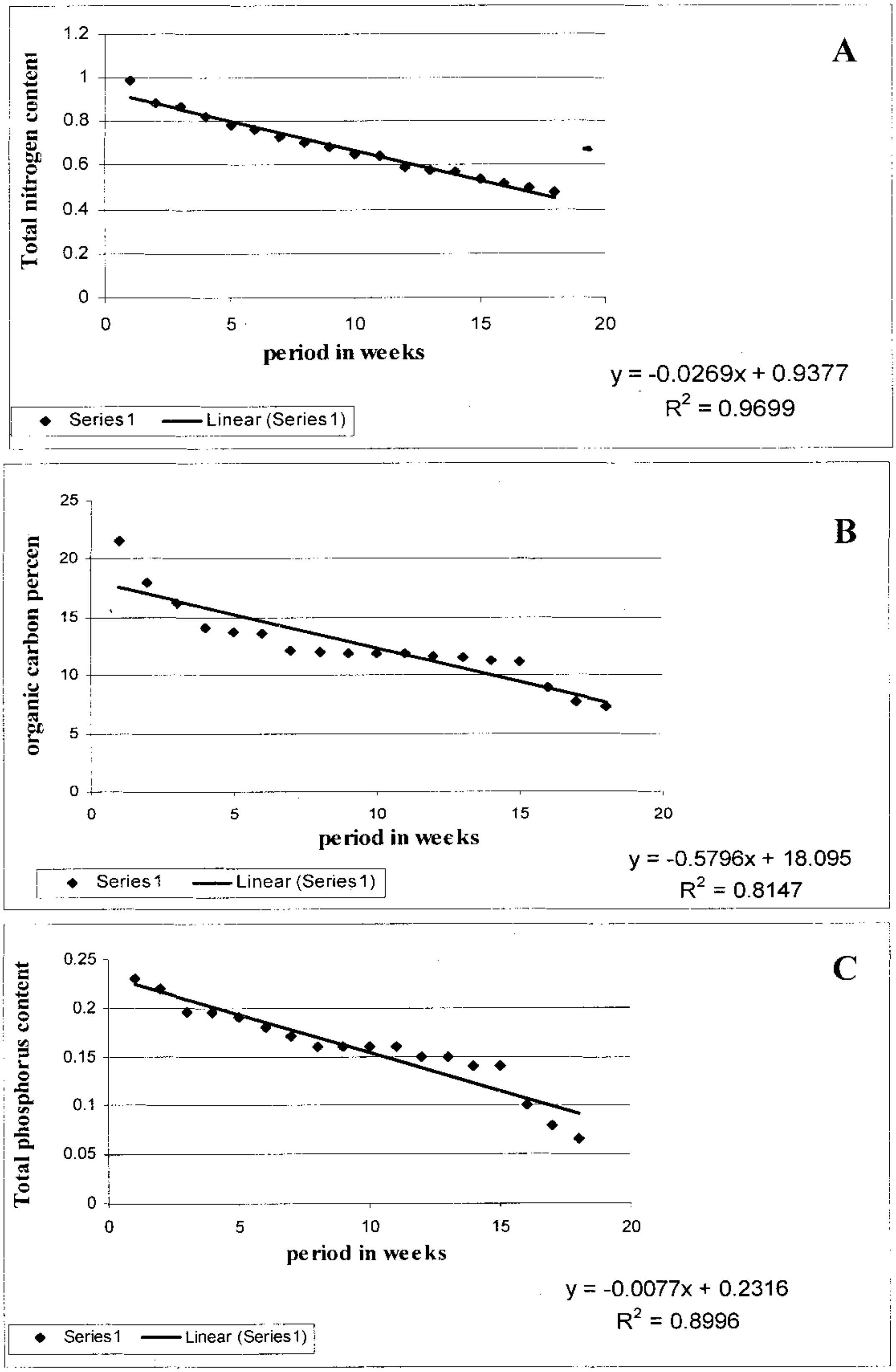

Fig 2. (A) Weekly total nitrogen content, (B) weekly organic carbon content, and (C) weekly total phosphorus content in Abis fertilizer in the present work.

Table 1. Growth performance measurements SGR and daily gain (mean ± S.E.) of mixed- sex Nile tilapia *Oreochromis niloticus* in the first part (from start to the 14^{th} week) .

Treat g/m²/wk	Initial body weight (g/ fish) M ± S.E.	final body weight (g/ fish) M ± S.E.	SGR M ± S.E.	Daily gain (g/ fish/day) M ± S.E.	Offered feed (Kg/200m²) M ± S.E.	FCR M ± S.E.
Treatment (1)	30.34 ± 0.54	88.85 ± 2.63	1.096 ± 0.001	0.6 ± 0.017	102.5 ± 2.8	*1.25 ± 0.09 a
Treatment (2)	30.75 ± 0.38	95.59 ± 3.29	1.160 ± 0.014	0.66 ± 0.027	114.1 ± 0.78	1.25 ± 0.06 a
Treatment (3)	30.3 ± 0.4	92.47 ± 4.62	1.140 ± 0.027	0.63 ± 0.04	127.4 ± 2.92	1.46 ± 0.04 b

(1) = 50 g/m²/week fertilizing rate, (2) = 75 g/m²/week fertilizing rate, (3) = 100 g/m²/week fertilizing rate.
Each treatment was represented in two replicates.
In each column, means followed by different letters are significantly different.

Table 2. Growth measurements (SGR and daily gain) (mean ± S.E.) of mixed- sex Nile tilapia *Oreochromis niloticus* in the second part of the present experiment (from the 15^{th} week until the end at the 18^{th} week).

Treatment g/m²/wk	Initial body weight (g/ fish) M ± S.E.	final body weight (g/ fish) M ± S.E.	SGR M ± S.E.	Daily gain (g/ fish/day) M ± S.E.	Offered feed (Kg/200m²) M ± S.E.	FCR M ± S.E.
Treatment (1)	88.85 ± 2.63	** 103.4 ± 2.9 b	0.55 ± 0.005	0.521 ± 0.008	55.5 ± 3.23	1.5 ± 0.105
Treatment (2)	95.59 ± 3.29	108.9 ± 2.6 a	0.47 ± 0.04	0.477 ± 0.026	56.15 ± 3.26	1.56 ± 0.075
Treatment (3)	92.47 ± 4.62	100.4 ± 2.3c	0.28 ± 0.1	0.264 ± 0.083	62.6 ± 3.29	1.64 ± 0.055

(1) = 50 g/m²/week fertilizing rate, (2) = 75 g/m²/week fertilizing rate, (3) = 100 g/m²/week fertilizing rate.
Each treatment was represented in two replicates.
In each column, means followed by different letters are significantly different.
** $P < 0.01$

Table 3. Overall growth performance measurements (SGR and daily gain) (mean ± S.E.) of mixed- sex Nile tilapia *Oreochromis niloticus* for 126 days in the present experiment.

Treatment g/m²/wk	Initial body weight (g/ fish) M ± S.E.	final body weight (g/ fish) M ± S.E.	SGR M ± S.E.	Daily gain (g/ fish/day) M ± S.E.	Offered feed (Kg/200m²) M ± S.E.	FCR M ± S.E.
Treatment (1)	30.34 ± 0.54	** 103.4 ± 2.9b	* 0.975 ± 0.005 b	** 0.58 ± 0.015 b	157.7 ± 5.93	1.32 ± 0.1
Treatment (2)	30.75 ± 0.38	108.9 ± 2.6a	1.005 ± 0.005 a	0.62 ± 0.015 a	170.5 ± 2.48	1.34 ± 0.025
Treatment (3)	30.3 ± 0.4	100.4 ± 2.3b	0.953 ± 0.000 c	0.56 ± 0.01c	189.5 ± 0.43	1.51 ± 0.050

(1) = 50 g/m²/week fertilizing rate, (2) = 75 g/m²/week fertilizing rate, (3) = 100 g/m²/week fertilizing rate.
Each treatment was represented in two replicates.
In each column, means followed by different letters are significantly different. * P< 0.05 ** P< 0.01

Table 4. Harvest results and yield in classes (mean ± S.E.) of mixed- sex Nile tilapia *Oreochromis niloticus* as affected by Abis fertilizer at 50, 75 or 100 g/m²/week fertilizing rates with restricted feed for 126 days.

Treat g/m²/wk	Initial biomass (Kg fish/200m²) M ± S.E.	Gross yield (Kg fish/200m²) M ± S.E.	Gross yield of initial stock (Kg fish/200m²) M ± S.E.	Net yield of initial stock (Kg fish/200m²) M ± S.E.	% of number increase
Treatment (1)	42.8 ± 0.8	* 162.3 ± 2.6 b	** 145.57 ± 4.1 b	** 102.8 ± 2.8 b	43.4 ± 3.6
Treatment (2)	43.5 ± 0.5	171.4 ± 3.78 a	153.97 ± 3.7 a	110.4 ± 2.7 a	44.7 ± 4.66
Treatment (3)	42.5 ± 0.6	168.1 ± 2.71a	140.97 ± 3.7c	98.50 ± 2.6 c	67.5 ± 4.14

Yield in classes
M ±S.E.

Treat	1st (Kg fish/200m²) M ± S.E.	2nd (Kg fish/200m²) M ± S.E.	3rd (Kg fish/200m²) M ± S.E.	4th (Kg fish/200m²) M ± S.E.	Other (Kgfish/200m²) M ± S.E.	recruitment (Kg fish/200m²) M ± S.E.
Treatment (1)	41.8 ± 6.2	47.2 ± 8.8	43.2 ± 1.5	8.2 ± 2.0	5.1 ± 0.5	* 16.70 ± 1.5 b
Treatment (2)	72.9 ± 5.5	50.8 ± 6.4	22.4 ± 1.2	4.3 ± 0.4	3.6 ± 0.4	17.40 ± 2.9 b
Treatment (3)	34.1 ± 0.4	55.7 ± 4.95	33.3 ± 5.93	6.3 ± 1.1	11.6 ± 1	27.13 ± 1.1 a

(1) = 50 g/m²/week fertilizing rate, (2) = 75 g/m²/week fertilizing rate, (3) = 100 g/m²/week fertilizing rate.
Each treatment was represented in two replicates.
In each column, means followed by different letters are significantly different.
* P< 0.05 ** P< 0.01

Table 5. Economic evaluation for mixed-sex Nile tilapia *Oreochromis niloticus* as affected by Abis fertilizer at 50, 75, or 100 g /m^2/ wk fertilizer rates with restricted feeding rate in 200-m^2 earthen ponds for 126 days in the present work.

Item Classes by weight (g)	Unit	Price L.E.	Treatment								
			50 g/m^2/wk			75 g/m^2/wk			100 g/m^2/wk		
			Quan.	Value L.E	%of total return	Quan.	Value L.E	%of total return	Quan.	Value L.E	%of total return
Income											
1st calss	Kg	12	41.8	501.6	39.75	72.9	874.8	57.34	34.1	409.2	33.73
2nd class	Kg	9	47.2	424.8	33.66	50.8	457.2	29.97	55.7	501.3	41.33
3rd class	Kg	6	43.2	259.2	20.54	22.4	134.4	8.81	33.3	199.8	16.47
4th class	Kg	4	8.2	32.8	2.6	4.3	17.2	1.13	6.3	25.2	2.08
small fish	kg	2	21.8	43.6	3.45	21.0	42.0	2.75	38.73	77.5	6.39
Total				1262			1525.6			1213.0	
Variable costs											
Feed	Kg	1.5	157.7	236.6	77.89	170.5	255.75	77.9	189.5	284.25	78.47
Fertilizer	m. ton	60	.18	10.8	3.56	0.27	16.2	4.93	0.36	21.6	5.96
Superphosphate	Bag	25	.33	8.25	2.72	0.33	8.25	2.51	0.33	8.25	2.28
Urea	Bag	48	.44	21.12	6.95	0.44	21.12	6.43	0.44	21.12	5.83
Labor cost	Day	6.0	4.5	27	8.89	4.5	27	8.22	4.5	27	7.45
Total				303.77			328.32			362.22	
Net return				958.2			1197.3			850.9	

DISCUSSION

Alkalinity did not show a particular trend with fertilizing rate (50, 75 and 100 g/m^2/wk) during the experiment, it remained around 341.5 mg/l with increasing fertilization rate. Alkalinity concentration is considered as evidence of inorganic carbon availability in fish pond waters (Knud-Hansen *et al.* 1993). Organic fertilizers and feeds may provide carbon to increase or maintain alkalinity in spite of carbon use by photosynthesis (Hopkins *et al.* 1993, Diana *et al.* 1994, and Knud-Hansen 1998). Generally, high alkalinity and hardness values explain the stability of pH during the grow-out period in the present study, because of their buffering action.

Orthophosphate showed a positive relationship with increasing the level of fertilization. P acts as a limiting factor for phytoplankton production in this experiment. Newman *et al.* (1993) reported that dissolved orthophosphate ranged between 0.6 and 7.9 mg/l when P was added at rates of 1.0, 2.4, 3.8, and 5.1 kg/ha/d, and N:P ratio 1:1. The highest net fish production occurred in ponds received 3.8 kg / ha/d. However, the best fish growth performance was achieved at N:P ratio of 3.75 : 1 and at N input 30 Kg / ha wk^{-1} (this means 8 kg P/ ha wk^{-1}) in Thailand (Lin *et al.* 1999).

Zooplankton showed a positive trend with fertilization level in the present work. Li and Yakupitiyage (2003) demonstrated that natural food makes up for nutritional deficiencies in prepared feeds and that supplemental feed is required to increase fish yields in fertilized ponds. Wurst (2003) reported that organic fertilizers are found to be effective for zooplankton production and that live plankton and benthic invertebrates are preferred prey for young fish.

Growth did not show any significant differences among treatments. However, it showed a positive trend with fertilization level in the former part of this experiment. The highest daily gain (0.66 g d^{-1}) achieved at the fertilizing rate of $75/m^2$ wk^{-1}. While in the latter part of this experiment, it showed a negative trend with increasing fertilization level. Somewhat higher daily gains have been achieved by employing fertilizer and supplemental feed 0.68–3.1 g / fish d^{-1},), using male sex-reversed Nile tilapia (Green 1992, Diana *et al.* 1996a, b, and Liti *et al.* 2001).

Tidwell *et al.* (2000) noticed that weight gain of mixed–sex tilapia (average weight 26g) was 123.4, 93.4 and 82g/ fish when fish fed on diets containing 30, 25.6, and 22.5 % crude protein, respectively, for 12 week. Liti *et al.* (2001) reported that daily gain increased from 0.9 ± 0.06-to 1.2 ± 0.13 g d^{-1} when protein content of the diets increased from 6.5 to 12.5 %. This indicates that the protein content of feed may affect the growth of fish. This may explain the lower daily gain in the second part than that in the first part of this experiment, where fish fed on 17.4% and 20.93% crude protein feeds respectively. Hanley *et al.* (1997) found that a 28% crude protein diet was better suited than 20, 24, and 32% crude protein diets for feeding adult tilapia in cages. Twibell and Brown (1998) reported that the optimum crude protein level for tilapia was 28 %. However, Gur (1997) suggested that growth and feed utilization improved with the use of 35% crude protein diet for tilapia grow in ponds. In addition, Xie *et al.* (1997) found that feed efficiency, and relative daily gain decline with body size of tilapia.

The lower overall daily gain obtained in the present study than those reported in similar studies (Green 1992, Diana *et al.* 1994, 1996a, and Brown *et al.* 2000) indicates that either phytoplankton may not be enough to met protein requirement of fish or that fish could not efficiently assimilate the produced phytoplankton in these ponds. Similar findings were reported (Colman *et al.* 1990), they noticed poor fish growth in fertilized concrete tank, and attributed it to the predomination of the green algae *Scenedesmus* and its poor assimilation. Moriarty and Moriarty (1973), and

McDonald (1985a) reported substantially reduced assimilation rate of green algae compared to blue-green algae by tilapia. Fertilized tank experiments involving green algae and tilapia have shown low fish productivity (Gaigher 1982, McDonald 1985b, Pierce 1993) or even have shown specifically that fish did not gain nutrition from green algae (Schroeder 1983). The above studies give a plausible partial explanation of low growth of fish in the present experiment although the high chlorophyll "a" concentrations in this experiment. Also the high total alkalinity that recorded in the ponds of the present experiment supports the predominance of green algae in these ponds. Boyd (1983) determined that the ponds, those had higher total alkalinity, had low proportion of blue–green algae and greater proportion of green algae than the ponds those had lower alkalinity.

The second reasonable explanation of low daily gain is the increase of fish density because of reproduction activity during the grow–out period in the present work, in spite of the high initial stocking density in the ponds that was applied as a controlling method of reproduction. The final density reached up to 13.4 fish/ m^2 in some ponds. Hickling (1962) reported that over-crowding inhibits growth. In addition, age and size of fish appeared to influence feeding rate at satiation of fish in aquaria. At an average temperature of 26 °C , maximum feed consumption dropped from 5% BW/day on 8^{th} day of feed offering to only 2.8%BW/d after 28 days (Popma *et al.* 1993). They attributed this drop to territorial behavior of maturing fish.

Specific growth rate did not show significant differences among treatments. However, it increased up to 1.16 at the fertilizing of 75 g/m^2 wk^{-1} then decreased at the higher fertilizing rate (100g/ m^2 wk^{-1}) to 1.14. Generally, there was a positive relationship between fertilizing rate and specific growth rate. Cho and Jo (2002) reported lower specific growth rate (0.52-0.84) of (105g) Nile tilapia fed a 37-35% crude protein diets at 3% rate of total weight of fish in recirculating system in summer.

There was a positive relationship between FCR and fertilization rate in both the first and the second parts of this experiment. However, FCR showed a negative trend with protein content of offered feed. The overall FCR confirms this positive relationship with the fertilization rate, which indicates that natural food, had higher contribution in fish nutrition at the higher fertilizing rates. Siddiqui and Al-Harbi (1999) estimated that 2-2.2 kg (34% crude protein) is required to produce 1 kg of hybrid tilapia. Overall means FCR in the present experiment (using 20.9 and 17.4% crude protein feed) are lower than that reported by using combination feeding and fertilization (applying CL60 culture system) in which male Nile tilapia (18.6g) fed on 23% protein diet (Green 1992).

Total yield showed a positive relationship with fertilization rate. However, the highest total yield was obtained at 75 g/m^2wk^{-1} fertilization rate. Extrapolated yield in this experiment ranged between 7,048.5 and 7,698.5 kg/ha per 126 days which is higher than fish yields in some studies. Green *et al.* (1989) achieved 2075 kg fish / ha per 150 day by applying 500 kg chicken litter/ ha wk^{-1} in ponds stocked with male Nile tilapia (32.9 g) at a rate of (10000 fish/ ha). When Green (1992) applied fertilization (500kg chicken letter/ ha wk^{-1}) plus feed (23% crude protein) in ponds stocked at 2 males Nile tilapia per m^2, he achieved average total yield of initial stock 4,351 ± 38kg / ha per 150 days. This production is 56.5 to 61.7% as high as the total yield of initial stock in the present study. In Thailand, tilapia yields of 3,955 to 15,396 kg ha^{-1} in five to eight months were reported in fertilized and fed (30% crude protein) ponds stocked with 3 sex-reversed Nile tilapia / m^2 (Diana *et al.* 1994, 1996a). Brown *et al.* (2000) achieved gross fish yield of 4,926 – 3,140 kg / ha per 150 day under fertilization and feeding (28.6% crude protein) combination in ponds stocked with sex-reversed Nile Tilapia Genetically Improved Farmed Tilapia (GIFT) strain at 4 fish m^{-2}. Liti *et al.* (2001) achieved gross yield 5,746- 5,823 kg / ha of sex-reversed *O. niloticus* stocked at 2 fish m^{-2} in polyculture system with catfish by applying fertilization and feeding (12.5% crude protein).

Recruitment showed a significantly positive trend with the level of fertilization. The final density at harvest increased up to 11.7 fish / m^2 because of reproduction activity. The offspring comprised between 10.3 and 16.1 % of the total yield.

Economic evaluation

The partial budget analysis of this experiment showed that all treatments are profitable. The second treatment produced the highest net return than the other treatments. This indicates that the fertilizing rate of 75 g/m^2wk^{-1} of Abis organic fertilizer is the economically most efficient fertilization rate under the experiment condition of the present study.

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تأثير التسميد على إنتاج البلطى النيلي في الأحواض الترابية

III تأثير السماد العضوي الغير تقليدي على محصول أسماكَ البلطى النيلي المُختَلَط (*Oreochromis niloticus*)

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صُمّمتْ هذه التجربة لتَقدير نسبةِ التَسميد المثاليةِ لسماد(أبيس) العضوي في الأحواض الترابية لأسماك البلطى النيلى مختلطِ الجنسِ . تم إستخدام ستّة أحواض٢٠٠م٢ ، حوضان لكل معاملة: ٥٠، ٧٥ و١٠٠جم/م٢/إسبوع .تم تغذية أسماك هذه التجربة على مستوى محدّدَ من عليقة ٢٠,٩٣ % بروتينِ لأربعة عشرَ إسبوعٍ ثم عليقة ١٧,٤ % بروتينِ لأربعة أسابيعِ . إستمرت التجربة لمدة ١٢٦ يوم . أثناء الفترةِ التجريبيةِ تم تقدير خواص الماءِ في الأحواضِ إسبوعيا. كان معدل نمو الأسماك، معدل النمو النوعى، إجمالي المحصول من معدل التخزين الأولى وصافيِ الإنتاج من معدل التخزين لأوليِ كَانت مختلفة معنويا بين المعاملات، أعلى قيم كانت في معاملة التَسميد بنسبةِ ٧٥ جم/م٢/إسبوع، والأدنى في معاملة التَسميد بنسبةِ ١٠٠جم/م٢/إسبوع . أنتجت معاملة التسميد الثالثة(١٠٠جم/م٢/إسبوع) أعلى إنتـــــاج من الزريعة. حققــت معاملة التسميد المتوسطة (٧٥جم / م٢ / إسبوع) أعلى صافى عائد، بينما كان أدنى صافى عائد فى المعاملة الثالثة(١٠٠جم/م٢/إسبوع) .كما تم مناقشة تأثير المعاملات التسميدية على خواص المياه.