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Effect of Fertilization on Production of Nile Tilapia in Earthen Ponds
I) Evaluation of untraditional organic fertilizer in earthen ponds

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ABSTRACT

The experiment was conducted to examine the potential of an untraditional organic fertilizer (Abis organic fertilizer) and fish feeding rate on the fish yield. Mixed–sex Nile tilapia were stocked in 9-one feddan ponds at 6000 fish per fadden in 3 treatments. Treatments were Abis organic fertilizer plus 2% feeding rate; Abis organic fertilizer plus 3% feeding rate, and chicken litter plus 3% feeding rate (as control). The experiment lasted for 78 days. Water quality parameters were monitored weekly throughout the experiment. Tilapia growth, total yield, total gain, daily net yield, and feed conversion ratio and net return were achieved the highest values with Abis fertilizer plus 3% feeding rate treatment, and the lowest values with Abis fertilizer plus 2% feeding rate. The effect of the treatments on water parameters was discussed.

Key words: organic fertilization, fish production, Nile Tilapia, earthen ponds, water quality, feeding rate.

INTRODUCTION

Tilapia culture in tropical and subtropical countries is practiced at either extensive or semi-intensive levels. The semi-intensive level of tilapia is particularly ideal in developing countries because it provides a wide variety of options in management and capital investments. Fish yields from such techniques have been found to be higher than those from natural unfertilized systems (Hickling, 1962; Hepher, 1963; Green, 1992; and Diana *et al.,* 1994). 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 combinations, 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). Manipulation of pond water quality is a major management way in the semi-intensive production system of tilapia and

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may become an important limitation factor in intensive production (Diana *et al*., 1997). That is dramatically influenced by pond management practices, such as stocking density of fish, fertilization strategy, and supplemental feeding.

The present study was carried out to evaluate an untraditional organic fertilizer, produced by Abis Factory Onyx Co., Alexandria Governorate, on fish production. Also to study the effect of the feeding rate on the yield of mixed-sex Nile tilapia *Oreochromis niloticus* in an attempt to reduce the production's costs as well as maximize the fish production.

MATERIALS AND METHODS

Nine 1-feddan earthen ponds, located at the International Center for Living Aquatic Resources Management (ICLARM), Abbassa, Sharkia governorate. Ponds were drained and dried prior to the experiment. All ponds were fitted out with saran screen to prevent wild fish from entering the ponds during filling them with fresh Nile water from Ismailia Canal. Water losses, due to seepage and evaporation, were compensated to maintain the average depth of 0.9 m.

Mixed–sex Nile tilapia *Oreochromis niloticus* fingerlings, produced at ICLARM with a mean weight of 18.73 ± 1.3 gm, were stocked into ponds, at an average density of 5995.7 ± 8 fry per feddan, on Sept. 12th 2000. The fish were cultured for 78 days and sampled in two occasions by seining about 10% of the initial number stocked.

A commercial fish feed pellets (18.99% crude protein, produced by EL-Manzalah Factory, General Authority for Fish Resources Development, GAFRD) was introduced to fish throughout the experiment. Daily feed amount was divided into two meals daily, at 8:00 and 15:00 o'clock. Feed amonuts were recalculated and adjusted monthly after fish sampling depending on the basis of fish biomass change.

Two fertilizers and two feeding rates were used in three treatments: 1) Abis organic fertilizer, at a rate of 85 kg / feddan / wk, with 2% of total biomass daily feeding rate, 2) Abis organic fertilizer, at a rate of 85 kg / feddan / wk, with 3% of total biomass daily feeding rate, and 3) Chicken litter, dispersed into the pond at a rate of 85 kg / feddan / wk, with 3% of total biomass daily feeding rate. The Abis organic fertilizer was packaged in polypropylene bags and dropped into the ponds (to prevent glass pieces from spreading over the pond bottoms). These bags were settled in a new place every week. The chicken litter and Abis fertilizer were analyzed for N%, P%, O.C%, Zn ppm, Cu ppm and Pb ppm. The values were 0.87, 0.431, 11.64, 146, 15.42 and 0.42 for chicken litter and 1.06, 0.2, 27.04, 115, 18.5 and 1.2 for Abis fertilizer, respectively. All ponds received mono-superphosphate (15.5% P_2O_5) at a rate of 17.5 kg/ feddan / wk. The chemical fertilizer was mixed with pond water in a bucket and swirled then splashed over the pond surface.

For physical 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 fertilizers application. Pond water analyses include temperature; Dissolved oxygen (DO); pH; Secchi Disk (SD); total hardness; total alkalinity; total and unionized ammonia; nitrate; nitrite; total phosphorus and orthophosphate; chlorophyll "a" and zooplankton were determined according to Boyd and Tucker (1992). Ponds were harvested on November 29th 2000. Total yield (TY) and final fish number were determined. Overall total gain (TG); daily net yield (DNY); specific growth rate (SGR); daily gain (g/fish/day) and Food Conversion Ratio (FCR) were calculated.

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

At the beginning and end of the experiment, samples of fish were taken randomly and frozen for proximate analysis. The used commercial feed was sampled and chemically analyzed (moisture; crude protein; lipids; total phosphorus and organic carbon, according to APHA *et al.* 1989. Also, organic fertilizers were analyzed for (total nitrogen and total phosphorus) according to APHA *et al.* 1989 and organic carbon according to Golueke 1977.

Statistical analysis

The data of water quality parameters; fish production and FCR were statistically analyzed 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.

RESULTS

Water quality

The general trend of the temperature showed that, the temperature decreased from 25.45ºC at the beginning of the experiment to 14.95 ºC at the seventh week, and again increased to reach 21.35ºC by the end of the experiment.

Total ammonia increased in all treatments from 0.09 mg/L at the beginning of the experiment to 0.587 mg/L at the end of the experimental course and showed significant differences among treatments (Fig 1E). Generally, the total ammonia concentrations in the third treatment (chicken litter) were higher, significantly in many occasions, than those in the other two treatments (Abis fertilizer), almost over the whole experimental period. unionized ammonia in Fig. (1F) increased gradually from 0.01mg/L at the beginning of the experiment to 0.053 mg/L at the end of the experiment and showed significant differences among treatments. The statistical analysis revealed that there were significant differences among treatments in the nitrate concentration since the first week of the experiment (Fig. 1G). The nitrate concentrations in the chicken litter treatment were higher than those in the other two treatments (Abis fertilizer) over the whole experimental period. Generally, the nitrate concentration was below 0.5 mg/L in the chicken litter treatment, while below 0.4 mg/L in the Abis fertilizer treatments. With respect to nitrite, it was noticed that, its peaks came before the nitrate peaks (Fig. 1H).

Total phosphorus concentration (Fig 2A) increased gradually from 0.435 to 1.971 mg/L in the Abis fertilizer treatments (means of T1 and T2), while it increased from 1.117 to 2.087 mg/L in the chicken litter treatment (T3). In most of the time, chicken litter was higher, significantly in total phosphorus concentration than those of Abis fertilizer treatments (T1 & T2). The second treatment had in its turn significantly higher total phosphorus concentration than the first treatment in some occasions. With regard to the ortho-phosphate (Fig 2B), means of T1 and T2 (Abis fertilizer treatments) increased gradually from 0.286 to 0.807 mg/L, while in the chicken litter treatment (T3), it increased from 0.418 to 0.812 mg/L. The highest concentration of ortho-phospate was found to be in the third and second treatments in a mutual manner. Some significant differences among treatments were found in ortho-phosphate concentration. The chlorophyll-"a" concentration showed significant differences among treatments since the first week after the treatment application (Fig. 2C). During the experimental period, the first treatment kept having the lowest chlorophyll-"a" concentration. The readings of secchi disk (Fig. 2D), dramatically decreased from (15.5-25.0 cm) at the beginning of the cultivation to (8.5- 15.5 cm) after one week of the treatments application, then the readings gradually decreased in narrow ranges until the termination of the experiment. Statistical analysis revealed that, there were significant differences among treatments in the secchi disk readings only in three occasions, fourth, seventh and eleventh weeks. The trends of chlorophyll-"a" were reflected in zooplankton density among treatments (Fig. 2E). There were significant differences among treatments in zooplankton density after the first week of treatments application. The third treatment kept having the highest, significantly in several occasions, zooplankton density than the other two treatments.

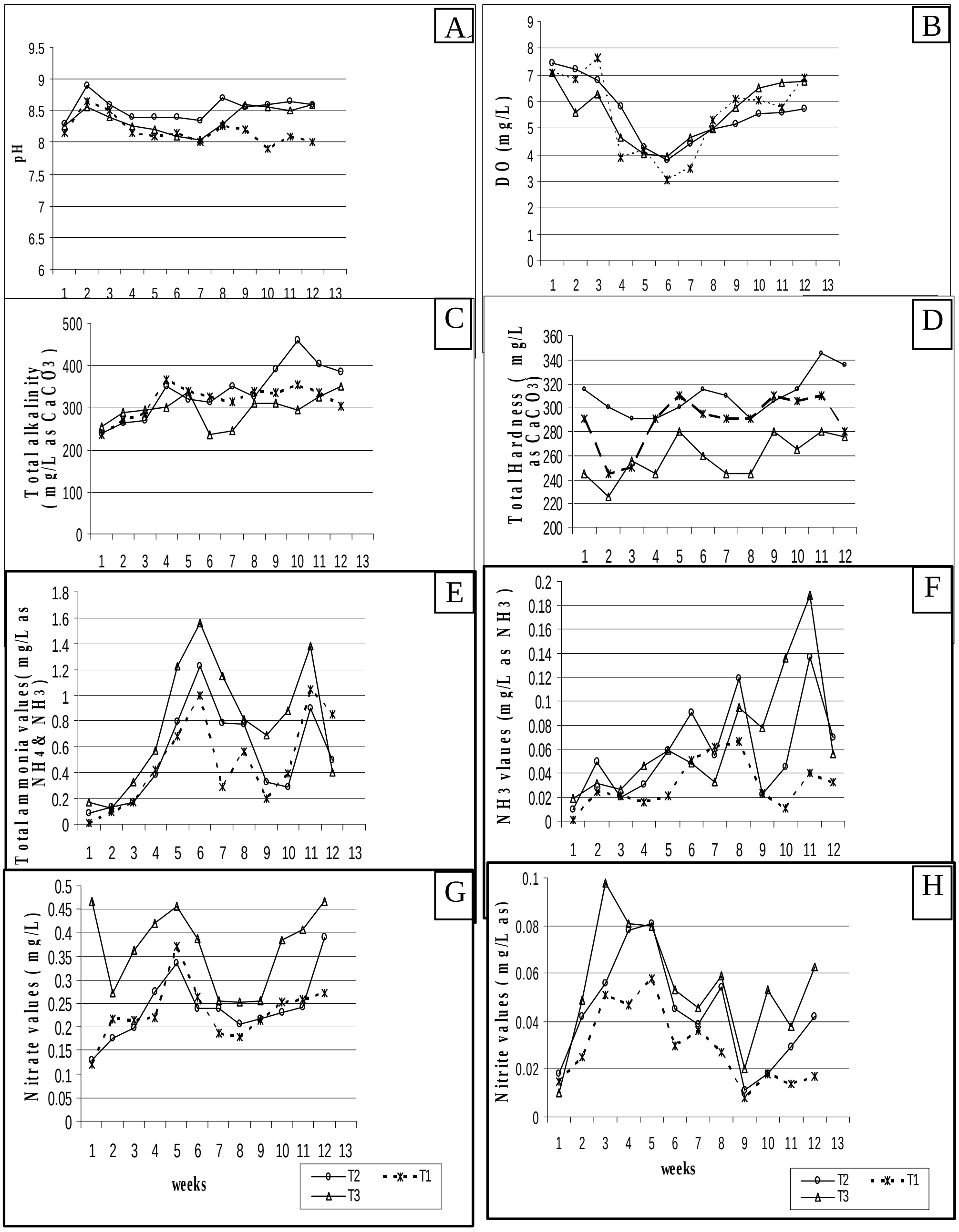

Fig (1): *The relationship between Time (in weeks) and A)pH, B)dissolved oxygen(mg/l), C)Total alkalinity(mg/l), D)Total hardness(mg/l) , E)Total ammonia (mg/l), F)Unionized ammonia (mg/l) G)Nitrate (mg/l), and H)Nitrite (mg/l)*

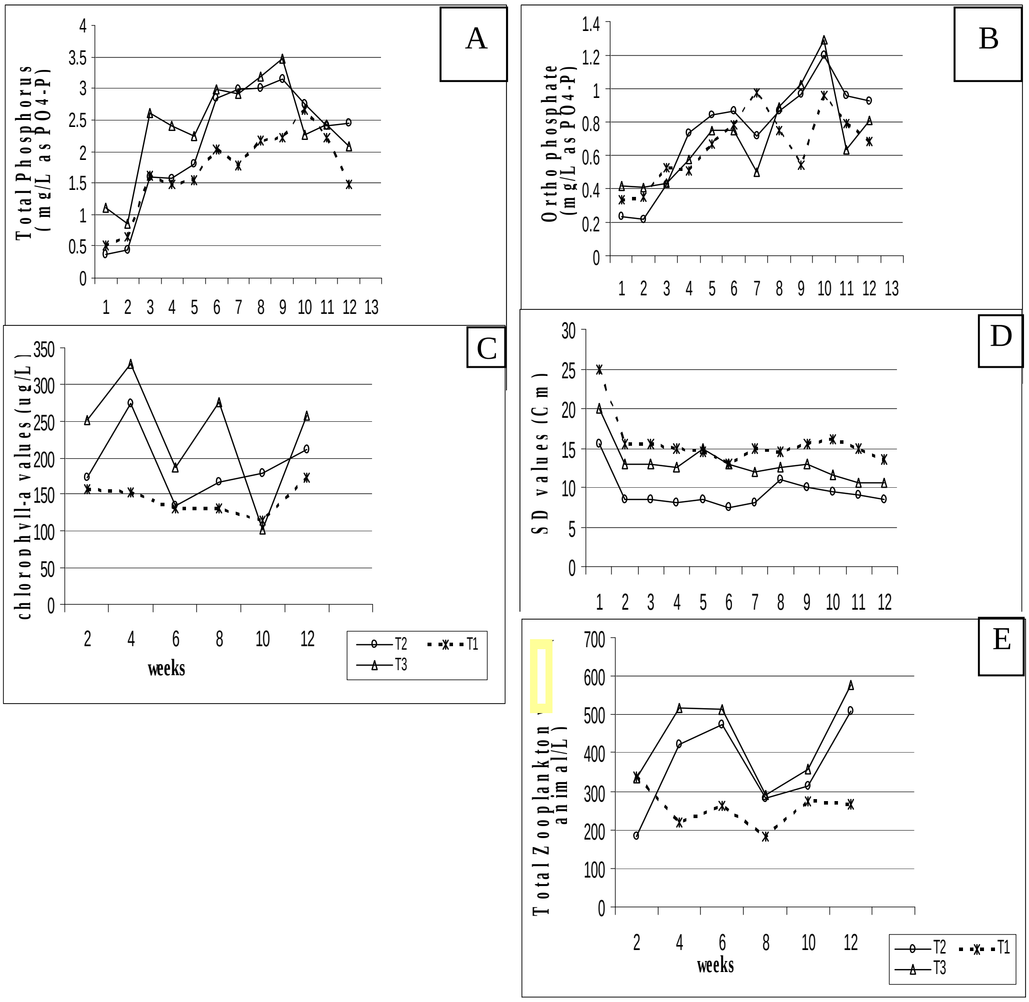

Fig (2): *The relationship between time (in weeks) and A)Total phosphorus(mg/l), (B)Orthophosphate (mg/l), C)Chlorophyl a (µg/l), and D) SD (Cm) and E) Total zooplankton number (animal/l).*

Fish performance

Fish specific growth rate (SGR, %/d) and daily gain (g/fish/day) were not significantly affected by treatments. Final body weight (FBW) showed significant differences among treatments ($P < 0.01$). The highest and lowest values of FBW were observed in the second treatment, 69.23 ± 1.4 g/fish, and in the first treatment, 58.21 ± 0.12 g/fish, respectively (Table 1).

Monthly body weight (BW) of Nile tilapia showed significant differences ($P < 0.01$) among treatments over the course of the experiment (Table 1). The highest BW was achieved in the second treatment, Table (1): *Monthly (mean ± S.E.) body weight, Specific growth rate and daily gain of Nile tilapia reared under different treatments.*

Treat g/m²/wk	Initial body weight (g/ fish) M ±S.E.	body weight after 30 days (g/ fish) M ± S.E.	body weight after 60 days (g/ fish) M ± S.E.	Final body weight (g/ fish) M ± S.E.	SGR M ±S.E. (%/d)	Daily gain (g/ fish/day) M ±S.E.
		**	**	**		
Abis + 2%[1]	17.23 ± 2.04	31.94 ± 1.26 c	47.7± 0.43 c	58.21 ± 0.12 c	1.58± 0.2	0.53 ± 0.03
Abis + 3%[1]	19.4 ± 0.38	37.26 ± 0.74 a	56.44± 1.13 a	69.23 ± 1.4 a	1.63± 0.003	0.64± 0.01
C.L. + 3%[2]	19.6± 1.67	35.03± 1.08 b	51.56± 0.44 b	62.58± 0.01 b	1.5± 0.12	0.55± 0.02

[1]Abis= Abis fertilizer [2]C.L.= Chicken litter fertilizer
Each treatment was represented in triplicates.
*In each column, means followed by different letters are significantly different. ** P< 0.01.*

37.26 ± 0.74 and 56.44 ± 1.13 g/fish after 30 and 60 days respectively. While the intermediate and the lowest fish BW were found in the third the first treatment, respectively. The trends of BW continued in a linear manner throughout the experiment. These trends were similar to those of total yield, total gain, and daily net yield with the same significance (Table 2).

Tilapia survival percentage (Table 2) differed significantly among treatments ($P < 0.01$). The first treatment had the lowest survival percentage 69.85 ± 1.82 %, and the highest survival percentages, 81.65 ± 0.78 % and 82.07 ± 1.13 % in the second and the third treatment, respectively. The survival percentage did not differ significantly between the later two treatments. This indicates that the survival percentage significantly affected by the feeding rate ($P < 0.01$).

Feed and Nutrient Utilization

The food conversion ratio (FCR) didn't reveal any significant differences among treatments (Table 2). The best FCR was noticed in the first treatment (1.27 ± 0.104), while the highest and intermediate FCR were recorded in the third and second treatment, 1.47 ± 0.029 and 1.46 ± 0.012, respectively. FCR showed an opposite trend of that showed in final body weight, total yield, total gain and daily net yield.

Table (2): *Harvest results and feed conversion ratio (mean ± S.E.) from 1 feddan ponds.*

Treat $g/m^2/wk$	Initial biomass (Kg fish/fd)	Total yield (Kg fish/fd)	Total gain (Kg fish/fd) .	Daily net yield ($g/m^3/day$)	Survival M ± S.E. %	Offered feed (Kg/fd)	FCR
		**	**	**	**		
Abis+2%[1]	103.3 ± 12.2	243.8± 5.84 c	140.45 ± 6.38 c	0.451 ± 0.002 c	69.85 ±1.82 b	179.0 ± 6.64	1.27 ± 0.104
Abis+ 3%[1]	115.5± 2.31	337.9± 4.13 a	222.35 ± 5.2 a	0.713 ± 0.006 a	81.65 ±0.78 a	324.5 ± 4.9	1.46 ± 0.012
C.L.+ 3%[2]	117.6± 10.6	308.62± 4.61 b	191.02± 5.55 b	0.612 ± 0.081b	82.07± 1.13 a	380.8 ± 15.4	1.47± 0.029

*[1]Abis= Abis fertilizer [2]C.L.= Chicken litter fertilizer. fd = feddan (4200m^2). Each treatment was represented in triplicates. In each column, means followed by different letters are significantly different. ** P< 0.01*

Yield in classes

The overall means of the yield in classes are showed in Table (3). The second treatment produced higher amount of fish under the second class than that in the third treatment, 78.7 ± 2.83 and 55.87 ± 8.4 kg/feddan which presented 23.3% and 18.1% of their total yield, respectively. The first treatment had fish under the third and fourth classes only. Under the fourth class, the second treatment had higher fish amount than the third and first treatment, 141 ± 9, 135.4 ± 0.7 and 102.1 ± 21.91 kg/feddan with the percents of 41.7, 43.9 and 41.88% of their total yield, respectively.

Body composition

Table (4) presents the means of proximate analysis of commercial feed and body composition of mixed-sex tilapia *Oreochromis niloticus* at the commencement and harvest of the experimental fish. Moisture, protein and organic carbon contents of fish significantly differed (P < 0.05) among treatments. The third treatment had the highest organic carbon content, while the lowest organic carbon content was in fish of the first treatment. The lowest fish organic carbon percentage didn't differ significantly in fish of the first and second treatment. The results of fish lipid and total phosphorus of the fish content didn't show any significant differences among treatments.

Partial budget

The partial budget analysis (Table 5) indicated that all treatments in this study were profitable. The second treatment produced higher net return than the other two treatments, 640.2 L.E/feddan/78 days. The first treatment showed the lowest net income, 325.4 L.E/feddan/78 days. The net income of the second treatment was higher than those in the first and third treatments by 96.7% and 40.5%, respectively.

Table (3) *: Tilapia yield (mean ± S.E.) in classes as Kg/ feddan and %.*

Treat	Total yield (Kg fish/fd)	2nd (167-100gm)	3rd (90 – 63gm)	4th (60 – 40gm)
Abis + 2%[1]	**243.8 ± 5.84 c	00	141.67± 16.1	102.1 ± 21.91
%		00	58.1	41.88
Abis + 3%[1]	337.9 ± 4.13 a	78.7 ± 2.83	118.17± 7.7	141.0 ± 9.0
%		23.3	35	41.7
C.L. + 3%[2]	308.62± 4.61 b	55.87 ± 8.4	117.38± 4.49	135.4 ± 0.7
%		18.1	38	43.9

*[1]Abis= Abis fertilizer [2]C.L.= Chicken litter fertilizer, fd = feddan (4200m^2). Each treatment was represented in triplicates. In each column, means followed by different letters are significantly different. ** P< 0.01*

Table (4): *Mean ± S.E. of moisture, protein, lipid, organic carbon and Total phosphorus (%) of artificial feed, initial and final fish samples.*

Treat	Moisture	Protein	Lipid	Organic carbon	Total phosphorus
Artificial feed	8.04	18.99	3.3	52.19	0.205
Initial fish	75.36	13.8	2.95	10.39	0.247
Abis + 2%[1]	* 74.16 ± 0.34 a	* 13.81± 0.52 b	4.04 ± .34	* 11.07 ± 0.15 b	0.316 ± 0.12
Abis + 3%[1]	74.23 ± 0.12 a	13.38 ± 0.2 c	4.2 ± 0.13	11.12 ± 0.08 b	0.249 ± 0.08
C.L. + 3%[2]	71.64 ± 1.07 b	15.53 ± 0.71 a	4.59± 0.4	12.65 ± 0.59 a	0.236 ± 0.002

*[1]Abis= Abis fertilizer [2]C.L.= Chicken litter fertilizer , Each treatment was represented in triplicates. In each column, means followed by different letters are significantly different. * P< 0.05*

Table (5) : *Partial budget analysis for mixed-sex Nile tilapia Oreochromis niloticus mono-cultured in one feddan ponds received combinations of Abis fertilizer with 2 or 3 % of total biomass feeding rates or chicken litter with 3% feeding rate for 78 days.*

Item fish classes by individual weight (g)	Unit	Price L.E.	Abis+2% Quantity (Kg)	Abis+2% Value L.E	Abis+2% %of total return	Abis+3% Quan.	Abis+3% Value L.E	Abis+3% %of total return	Chicken +3% Quan.	Chicken +3% Value L.E	Chicken +3% %of total return
Income, L.E											
2nd class	Kg	6	00.00	00.00	00.00	78.7	472.2	42.13	55.87	335.22	34.51
3rd class	Kg	3.4	141.67	481.68	72.94	118.17	401.78	35.85	117.38	399.1	41.09
4th class	Kg	1.75	102.1	178.68	27.06	141.0	246.75	22.02	135.4	236.95	24.4
Total				660.36			1120.73			971.27	
Variable costs, L.E					%of total costs			%of total costs			%of total costs
Feed	Kg	1.00	179	179	53.43	324.5	324.5	67.53	280.75	280.75	54.45
Chicken Litter	m^3	55.00	00.00	00.00	00.00	00.00	00.00	00.00	1.98	108.9	21.12
Abis fertilizer	m ton	30.00	1.02	30	8.96	1.02	30	6.24	00.00	00.00	00.00
Super-phosphate	Bag (50Kg)	25.00	4.2	105	31.34	4.2	105	21.85	4.2	105	20.36
Labor cost	Day	8.00	2.6	21	6.27	2.6	21	4.37	2.6	21	4.07
Total costs, L.E				335			480.5			515.65	
Net return, L.E				325.4			640.2			455.62	

1 m^3 of chicken litter = 510-520 Kg

DISCUSSION

Water quality

The chicken litter used in this study had a mean nitrogen content of 0.87 % N and 0.43 % P by dry weight. These values are lower than the 2.8 % N and 4.5 % P (by dry weight) measured in Thailand (Diana ***et al.,*** 1990 and 1991b), 2.9–3.5 % N and 2.0–2.2 % P in Panama and 2.3–2.2 % N and 1.2–1.3 % P in Honduras (Teichert-Coddington *et al* .,1992). But approximated concentrations were found in chicken manure 1.03 % N and 0.64 % P by dry weight (knud-Hansen *et al*., 1993) in Thailand. While Abis fertilizer used in this study had relatively higher nitrogen content (1.06 % N) but lower phosphorus content (0.2 % P) than those in the chicken litter. Diana and Lin (1998) determined that weekly fertilization is much more generally applicable to fish ponds. Therefore we applied this fertilizing regime in the present study.

Water temperature ranged between 15 and 25.45°C, with an average of 20.5 °C, among treatments during the experimental period from September until late November 2000. The high temperature (about 30°C in grow-out period) leads to much faster growth in fish, the appetite of fish increases as the temperature rises. This may be attributed to the activity of the digestive enzymes. *Oreochromis niloticus* in tropical feeding is very active at 28-30°C (Hickling,1962; Beamish, 1970; Gui *et al.*,1989 and Popma *et al.*, 1993). With increasing temperature, the carrying capacity of fertilized pond increase from near 2000 Kg ha $^{-1}$ in the cool season to 2000 – 2500 Kg ha $^{-1}$ in the warm season. This may be due to that, the warmer temperatures near to 30°C increases the fertilizers decomposition rate, which facilitates nutrients metabolism (Mitamura, 1986; Knud-Hansen and Pautong, 1993 andLin *et al*., 1999). Generally, for most commonly cultured tilapias feeding activity is minimal below 20°C (Burns and Stickney, 1980; Popma, 1982 and Pruginin, 1983). This explains the reason for low growth rate of the fish in the present experiment.

Water dissolved oxygen never went below 3 mg/L during the experimental period. Denzer (1968); AIT (1986), and Hassan *et al.* (1997) reported that 2.3 mg DO/l is above the normal tolerance level of tilapia. The water pH values ranged between 7.9 and 8.9 in this study. Ponds treated with chicken litter and Abis fertilizer had water pH range of 8.05–8.6 and 7.9–8.9, respectively. Boyd (1998) reported that water with a pH range of 6 - 9 is the most suitable for fish production.

Alkalinity and total hardness showed an increase trend over time in all treatments. Concentrations were higher in the ponds treated with Abis than those with chicken litter fertilizer. This alkalinity is similar to that found in Philippines cultivate Nile tilapia applying inorganic fertilization plus feeding (Brown *et al.*, 2000). Several studies demonstrated that organic fertilization induces high alkalinities and total hardness (Lin 1986, Green *et al*. 1990, Diana *et al*. 1991a and Knud-Hansen 1998).

Total ammonia concentrations increased in all treatments with time but never surpassed 1.6 mg/l with an over all average 0.48, 0.53, and 0.77 mg/l in the first, second treatments (Abis fertilizer treatments), and the third treatment (chicken litter treatment) of the present experiment, respectively. Unionized ammonia was lower than 0.2 mg/l in all treatments throughout the experimental period. Total ammonia at higher level (2.4-7.3 mg/l) was reported when poultry waste or inorganic fertilizers weekly (urea and TSP at different rates) was applied in *T. aurea* and mixed-sex Nile tilapia ponds (Burns and Stickney, 1980 and Newman *et al*., 1993). However, fish survival had not been affected by these unionized ammonia concentrations.

Nitrite was consistently below 0.1 mg/l in all ponds throughout the experimental period. Nitrate averaged 0.2308, 0.2413, and 0.366 mg / l in the Abis fertilizer treatments (plus 2% or 3% feeding rate) and in the chicken litter treatment in this experiment, respectively. Diana and Lin (1998) noticed nitrite and nitrate concentrations ranging between 0.374–0.410 mg/l and 0.438–0.461 mg/l, respectively, in ponds fertilized with both chicken manure and inorganic fertilizers.

Dissolved inorganic nitrogen (DIN, sum on Total ammonia, nitrite and nitrate) in this experiment were 0.7371, 0.8136, and 1.1943 mg/l in ponds received Abis fertilizer plus feed (2 or 3% feeding rate) and chicken litter plus feed, at 3% feeding rate, respectively. DIN value in the third treatment is comparable to those 1.157 and 1.276 mg DIN/l in ponds received chicken manure and inorganic fertilizers weekly (Diana and Lin, 1998). Knud-Hansen *et al*. (1991) reported that there is a linear relationship between net primary productivity (NP) and DIN. However, at high DIN 0.142 $mg/m^2/day$ concentration this linearity is broken down either by self shading phytoplankton or other nutrients limitation. Veverica *et al.* (1999) achieved DIN of 2.3 mg/l with high N inputs (30KgN/ha wk^{-1}). But the tilapia yield was similar at 20 and 30KgN/ha wk^{-1} input, although (20kgN/ ha wk^{-1}) resulted in lower DIN (1.7mg/l) than that of 30 kg N/ha wk^{-1}.

Total phosphorus level was higher in the chicken litter treatment than the Abis fertilizer treatments. It also increased in direct proportion with feeding rates. Orthophosphate level had different trend; the higher level was in Abis fertilizer plus 3% feeding rate followed by chicken litter treatment. Although chicken litter had more than two-folds of Abis fertilizer phosphorus content (0.43 and 0.2% P by dry weight respectively), besides all ponds received mono-super-phosphate fertilizer at the same rate (17.5kg/feddan/wk) in the present experiment. Similar situation was reported by Lin *et al.* (1998), who found that although ponds received TSP at the same rate (8 kg P ha^{-1} wk^{-1}), yet they measured different total phosphorus in water ponds after fortnight of that experiment initiation. Masuda and Boyd (1994) found a high positive correlation between water- total phosphorus concentration and turbidity, since suspended matter contain 63% of the total phosphorus. Soluble reactive phosphorus (SRP), which reacts with ammonium molybdate in undigested samples, concentrations are usually less than 10% of TP concentrations. The high SRP concentrations probably occurred because algal productivity in the ponds was limited by nitrogen and light in the present study. Similar findings were reported by Knud-Hansen *et al.* (1993b) who noticed high SRP concentrations in both inorganically fertilized ponds and manured ponds, ranging from about 2.5 to 5.1 mg/l. They reported that ponds which are relatively new may exhibit substantial inorganic turbidity which results in light limitation. They also showed that N-limited pond showed high SRP concentration of (2.12mg/l). These findings are consistent with McNabb *et al*. (1990), Diana *et al*. (1991a) and Knud–Hansen *et al.* (1991) who determined that surplus of phosphorus some-times causing the ponds to become nitrogen-limited. Gomaah (1997) also noticed relatively high mean SRP level in ponds received chicken manure then feed (0.8 mg/l) with a range of (0.5 – 1.08 mg/l) in adjacent ponds to these of the present study.

Secchi disk readings decreased dramatically in all treatments during the first fortnight, then remained semi-steady in all treatments until the termination of the experiment. The overall means of secchi disk reading were 15.7 ± 0.9, 9.4 ± 0.6 and 13 ± 0.7 cm in Abis fertilizer plus 2 or 3% feeding rates, and chicken litter plus 3% feeding rate, respectively. Secchi disk reading less than 20 cm indicates that pond is too turbid due to either phytoplankton or suspended soil particles (Boyd, 1998). Since these ponds did not show low dissolved oxygen, which is usually coincident with phytoplankton blooming (Boyd, 1998), so suspended soil particles appear to be the principal factor in lowering secchi disk readings in thisexperiment. Organic material is commonly used to remove clay turbidity from water (Boyd, 1982). However, Teichert–Coddington *et al.* (1992) noticed high clay turbidity in manured ponds that resulted in light-limited phytoplankton growth. These findings confirm the present findings.

The chicken litter treatment had higher chlorophyll "a" than the other two treatments of Abis fertilizer throughout the experiment, except in one occasion in the 10th week. The highest overall mean of chlorophyll "a" was in the chicken litter treatment, 233.95±31.9 µg/l. There were fluctuations in chlorophyll “a” between sampling dates. Similar fluctuations in concentration of chlorophyll "a" in different treatments between sampling dates were reported (Boyd, 1976 and Gomaah, 1997). Teichert-Coddington *et al.* (1990) stated that chlorophyll "a" concentration showed distinct patterns during the season, which indicated that climate is the determining factor. Knud-Hansen *et al*. (1993) reported that differences in algal productivities in ponds, which are fertilized at the same rate of N and P, may due to differences in inorganic turbidity.

Zooplankton population was the highest in the chicken litter treatment. While the lowest zooplankton population was found in the Abis fertilizer plus 2% feeding rate. This indicates that increasing the rate of artificial feed addition decreased the dependency of fish on natural food. Also there were fluctuations in zooplankton population between sampling dates, similar to chlorophyll "a" fluctuations. Similar zooplankton population densities and fluctuations were reported by (Gomaah1997).

Fish survival and growth

Fish survival rate was significantly affected by feeding rate in the present experiment. The higher feeding rate (3%) had the higher survival rate (81.65 – 82.07%). The lowest survival in this experiment (69.85%) was associated with 2% feeding rate. This survival rate is considerably higher than those (57±22 and 65±20 %) of sex-reversed Nile tilapia genetically improved farmed tilapia (GIFT) strain fed at 100 and 67% of satiation (28.6 % protein) in fertilized ponds (Brown *et al*. 2001), and those 50 ±2.5 and 50 ±5 % of mixed-sex tilapia fed on experimental diets in fertilized ponds (Perschbacher and Lochmann, 1994). But it is comparable to those (84-86.4%) of sex-reversed Nile tilapia in ponds fertilized in different regimes (Diana and Lin, 1998; Knud-Hansen *et al*., 1993 and Knud-Hansen and Lin 1996). However, higher survival rates were reported in some studies, (88.1–90.8%) of sex-reversed *O. nilsticus* fed experimental diets in fertilized ponds (Liti *et al*., 2001), and 83.64 - 95.47% of mixed-sex tilapia in monoculture or polyculture with snakehead fish as a predator in different ratios (Yi *et al.,* 2001).

Daily gain did not differ significantly among treatments, as they were lower in all the treatments than those were achieved in similar experiments (Green, 1992; Diana *et al.*, 1995; 1996a; b, and Liti *et al.*, 2001). These lower daily gain values may be attributed to low water temperature during the grow-out period, and the inorganic turbidity which affected negatively fish growth. Similar notice was reported (Knud-Hansen *et al.* 1993 and Cole *et al.* 1997). Ardjosoediro and Ramnarine (2002) demonstrated the effect of turbidity on growth, feed conversion and survival of Jamaican red tilapia, and recommended that turbidity in tilapia ponds should not exceed 100 mg/L. However, the daily gain are comparable to that 0.73 ± 0.08 and 0.75 ± 0.07 – 0.78 ± 0.8 g / fish d^{-1}) of mixed-sex tilapia cultured in mono culture and polyculture (with predatory snakehead fish) systems in fertilized ponds, respectively (Yi *et al.* 2001).

Specific growth rate (SGR) did not significantly differ among treatments. But, there was a positive relationship between feeding rate and SGR. Tidwell *et al.* (2000) reported specific growth rate between 1.74 and 2.13 for mixed-sex tilapia fed on experimental feed (22.5-30.7% crude protein) in cages. 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% of total weight of fish in recirculating system in summer.

The food conversion ratio (FCR) did not differ significantly among treatments. However it had been affected by the feeding rate, the lower the feeding rate (2%), the lower the FCR (1.29). Both the two treatments with higher feeding rate (3%) had almost similar FCR, (1.46). FCR in the present experiment was lower than that observed by (Brown *et al.*, 2001), who found that sex-reversed Nile tilapia of the GIFT strain, stocked at a rate of 4 fish / m^2 in fertilized ponds, had FCR 2.38 and 3.4 when fed at 67% and 100% of satiation of experimental diet (28.6% protein) respectively. Diana *et al.* (1994) noticed that FCR increase from (0.7) through (1.42) with the increase of feeding input from 25 to 100% of satiation for sex-reversed Nile tilapia stocked at 3 per m^2 and fed 30% protein floating feed in fertilized ponds. Also, Green (1992) reported that FCR increased from 0.95 to 1.83 when (23% protein) feed was applied at a rate of 1.5% of fish biomass/ day with organic manure, and feed only at 3% feeding rate, respectively.

The total yield in all treatments (243.8-337.9Kg fish/feddan/78days) was lower than those in other studies due to low temperature throughout the experiment and to the noticed inorganic turbidity in all ponds which had a negative effect on the fish growth. Burns and Stickney (1980) and Ardjosoedirs and Ramnarine (2002) reported a similar conclusion.

Partial budget

The partial budget of this experiment showed that net returns were positive for all treatments but varied among them. The treatment of Abis fertilizer plus 3% feeding rate was the highest profitable treatment. It achieved net return over the chicken litter plus 3% and Abis fertilizer plus 2% treatments by 43.5 and 92.9% respectively. This showed the potential of use the Abis fertilizer instead of chicken litter in Aquaculture ponds. It also showed that 3% feeding rate of 18.9% protein feeds was more economically efficient than 2% feeding rate. However, the lower net return in the Abis fertilizer plus 2% feeding rate may be attributed to the lower survival rate in this treatment than the other two treatments. The difference between the Abis fertilizer and chicken litter at 3% feeding rates treatments, occurred as a result of, on one hand the higher yield in the Abis fertilizer treatment and on the other hand, the high cost of chicken litter in comparison with the Abis fertilizer one.

The net returns of the present study were somewhat lower than those reported (14,494 L.E. / 2.1 ha per 145 days) using mixed-sex tilapia, urea, superphosphate, chicken litter, and 25% protein pelleted feed (Hebicha *et al.*, 1994). Gomaah (1997) achieved net returns of 763, 8068, and 134 L.E./0.1ha per 145 days, using male Nile tilapia, in feed only (25% protein at 3% feeding rate), chicken litter for the first 60 days then feed (25% protein at 3% feeding rate), and inorganic fertilizer (54.3 kg/ha/wk urea and 92.4 kg/ha/wk mono-super phosphate) treatments, respectively. The low net return of the present work may be attributed to the lower daily gain of fish as a result of low water temperature and using feed with low protein content.

This study revealed that the Abis fertilizer produce higher fish yield and is more cost- effective than the chicken litter for *O.niloticus* mono-culture system.

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تأثير التسميد على إنتاج لأسماك البلطى النيلى فى الأحواض الترابية
١. تقييم سماد عضوى غير تقليدى فى أحواض الاستزراع المائى

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أجريت هذه التجربة لإختبار إمكانية إستخدام سماد عضوى غير تقليدى (سماد ابيس العضوى) فى أحواض الاستزراع السمكى، و كذلك لدراسة تأثير معدل التغذية على الإنتاج السمكى. تم تخزين أسماك بلطى مختلط الجنس فى (٩) أحواض بسعة فدان/حوض و بمعدل ٦٠٠٠ سمكة / فدان فى ثلاث معاملات . كانت المعاملات كما يلى: سماد أبيس و معدل تغذية ٢% ، سماد أبيس ومعدل تغذية ٣% ، فرشة دواجن ومعدل تغذية ٣% (كنترول). استمرت التجربة ٧٨يوما . تم تقدير مواصفات المياه إسبوعيا خلال فترة التجربة. تم تحقيق أعلى معدل نمو، إنتاج سمكى، زيادة فى الوزن ، كفاءة تحويل الغذاء ، صافى عائد فى معاملة سماد ابيس و معدل تغذية ٣%، بينما كانت أقل قيم فى معاملة سماد ابيس مع معدل تغذية ٢% . كما تم مناقشة تأثير المعاملات على خواص جودة المياه