# EFFECTS OF DIFFERENT FERTILIZATION STRATEGIES SUPPLEMENTED WITH FEED ON FISH YIELD, POND WATER QUALITY AND PRODUCTION ECONOMICS.

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## Abstract

This study was designed to compare the performance of different fertilizers and feeding strategies as nutritional input options in fish farms. Twelve earthen ponds 1000 m2 each were assigned randomly into four treatments, with triplicates per treatment. The four fertilization treatments were: compost (T 1); cow manure (T 2); compost and urea plus superphosphate (T 3); and cow manure and urea plus superphosphate (T4). Trial ponds stocked with mixed sex tilapia fry (0.15 g) at stocking rate 2 fish/$m^2$, and silver carp stocked for maintaining water quality, at rate of 0.025 fish/$m^2$. All treatment feed artificial feed 25% at 2% body weight from week twelve to end of trial.

Mixed fertilizers treatments (T 3 and T 4) achieved significantly higher ($P<0.05$) fish yield than organic fertilizers treatments (T 1 and T 2). Total fish yield in decreasing order was T 4, T 3, T 2 and T 1 (1559.3, 1539.3, 1402.7 and 1396 kg/fed/year, respectively. Feed intake and feed efficiency parameters FE%; PER; PPV% were significantly higher in mixed fertilizers (T 3 and T 4) than organic fertilizers treatments (T 1 and T 2). Of water quality (WQ) parameters only available phosphorus was significantly higher in compost only treatment compared to the other treatments. While the other WQ parameter (DO. pH, $NO_3$, $NH_4$, $NH_3$, total alkalinity, and hardness) were not significantly differ among treatments. Partial economic analysis showed that benefit cost ratio was significantly higher ($P<0.01$) in T 3 (54%) and T 4 (49 %) compared to T 1 (36.4%) and T 2 (25.8%).

The result of this experiment concluded that feeding strategy using mixed fertilizers and supplementary feed as feeding strategy performed better than organic fertilizers and supplementary feed, increased fish yield and farm revenue.

**Keywords:** Pond fertilization, Compost fertilization, Organic fertilizers, Organic and chemical fertilizers, Supplementary feed, Nutritional input strategies, Fish yield, Fish Body composition.

## Introduction

There is an economic pressure for maximizing pond production and minimizing production cost for aquaculture crops (Nash and Brown, 1980). Natural food could be produced in ponds at almost no cost, replaces costly supplementary feed (Hepher and Bruginin, 1981). Ponds are fertilized to grow natural food, which in turn are used to grow natural feed, which in turn are used to grow cultured organisms (Knud-Hansen, 1998; Bhakta *et al.*, 2004 and Kumar *et al.*, 2004). Studies on the utilization of organic and inorganic fertilizers in fish ponds for sustained gross primary productivity, production of fish food organisms and fish production have been undertaken in several parts of the world (Garg and Bhatnagar, 1999, Kurten *et al.*, 1999, Veverica *et al.*, 2001, Brumett, 2000, Green *et al.*, 2002, Ali, 2003, Kumar *et al.*, 2004 and Osman *et al.*, 2008). In many parts of the world organic manures and wastes are first biologically stabilized by aerobic composting or by anaerobic fermentation prior to application as pond fertilizers. Both these stabilization processes rely on the controlled microbial decomposition of an organic waste substrate, where former (composting) in the presence of atmospheric oxygen, and the latter (fermentation) in the absence of atmospheric oxygen (Tacon, 1988 and Jacon, 1990). And greater amount of compost than original wastes can be added to the fish ponds without adversely affecting the oxygen levels in the pond (Dalzell *et al.*, 1987). For best management of tropical fish ponds for biologically optimal fish growth requires provision of necessary nutrients in a balanced manner via fertilization and supplementary feeding (Kumar *et al.*, 2004).

This trial was designed to study the effect of the different treatments on fish production, pond water quality and economic performance of the different fertilizers strategies with supplementary feed.

## MATERIALS AND METHODS

**Experimental design.**

The current experiment was conducted at WorldFish Centre research facility at Abbassa, Abou-Hammad, Sharkia. Twelve earthen ponds similar size (1000 $m^2$) each pond were used and selected on random basis. The experiment consisted of four treatments with triplicate as follows:

- T1: fertilization with compost only

- T2: fertilization with cow manure only
- T3: fertilization compost and chemical fertilizers
- T4: fertilization with cow manure and chemical fertilizers

Cow manure used brought from fertilizers supplier while, compost used made compost used made in the site from poultry litter and mixture of cat-tails (*Typha* spp.) and Indian goosegrass (*Eleusine indica*) as described by (Ali, 1995). Fish feed and organic fertilizers samples were sent for analysis at the Central laboratory, Faculty of Agriculture, Zagazig University and the result are summarized in (Table 1 a,b). Quantity of fertilizers applied to each treatment was calculated according to level of nitrogen content in the organic fertilizers (Table 1a) to provide was 10 kg/N/ha/week (Veverica *et al.*, 2001). For T 3 and T 4, half of the organic fertilizers were replaced by urea (45% N) and superphosphate (15% $P_2O_5$) to give the same level nutrients in organic fertilizers (Table 2).

Table 1 a. Organic fertilizers analysis (dry mater basis).

| Sample | Nitrogen % | Phosphorus % | Organic Carbon % |
|---|---|---|---|
| Compost | 1.96 | 0.55 | 16.6 |
| Cattle Manure | 2 | 0.48 | 22.12 |

Table 1 b. Proximate analysis of fish feed used in the study

| **Item** | **Percentage** |
|---|---|
| Protein % | 25.2 |
| Energy Kc | 2584 |
| Fat % | 4.94 |
| Fiber % | 5.7 |

Table 2. Fertilizers application rate in (kg/pond/week).

| Treatment | Compost | Cow litter | Urea | Super phosphate |
|---|---|---|---|---|
| T1 | 51.2 | | | |
| T2 | | 50 | | |
| T3 | 25.6 | | 1.1 | 1.4 |
| T4 | | 25 | 1.1 | 1.4 |

**Ponds preparation.**

Before the start of experiment, the ponds were drained, cleaned and exposed to sun for two weeks. Ponds were assigned to different treatments on random basis. Initial dose (weekly dose), of fertilizers were applied to ponds according their relevant fertilizers application rate (Table 2) prior to pond filling of water. Ponds inlet and outlet pipes were covered with narrow mesh screen to prevent unwanted fish or predators to get into ponds. Partial filling of the ponds to 50% of target level started on the following day after applying the initial fertilization dose from relevant fertilizers. Two days prior to stocking tilapia fry, ponds water level increased and reached the maximum target water depth.

**Tested fish species.**

Nile tilapia (*Oreochromis niloticus*) mixed sex fry were stocked at the rate of 2 fish/$m^2$ (2000 fry/pond) and an average initial mean body weight of 0.15 g. Nile tilapia fry were obtained from private hatchery. In order to maintain water quality in ponds and avoid cyanobacteria bloom, silver carp (*Hypophthalmichthys molitrix*) was stocked at stocking rate 0.025 fish/$m^2$ (25 fish/pond) and an average initial body weight of 50 ± 5 g. Silver carp fingerlings were obtained from General Authority for Fisheries Resources Development (GAFRD) hatched during previous year and reared at the WorldFish Centre earthen ponds.

**Pond management.**

The trial lasted for 205 days started on the 19$^{th}$ of May and harvested on 10$^{th}$ of December 2006. Ponds were fertilized for the first twelve weeks as shown in Table 2. Fertilizers application was done once a week by broadcasting the organic fertilizers and urea at pond surface, while superphosphate was dissolved in a bucket and spread over water. Twice a week water inlet pipes were adjusted to allow for new water to get into ponds to maintain water level in pond throughout the experiment duration.

In order for determining the average weight of fish, monthly samples were taken by seining where 100 tilapia fish from each pond were collected and then released again in the pond after individual weight and length of 100 tilapia fish recorded. While for silver carp because of difficulty in getting it in with the sample from earthen ponds, no attempt was done to make growth curve for it. A commercial artificial fish feed 25 % protein floating was bought from local producer and delivered to fish at rate of 2% of their body weight for 6 days a week. The daily amount of feed required for Fish in each pond was weighed and delivered to the fish by hand twice a day (equal portion) at 10.00 am and 2.00 pm. Feed quantity was adjusted according to average body weight of the sample in each pond. Feed ingredient as listed on the feed sack labels were; fish meal, meat meal, corn gluten, soybean meal, yellow corn, wheat bran, rice bran, calcium die phosphate, and a mixture of vitamins and minerals. Sample of fish feed was collected from several sacks and send for proximate analysis (Table 1b). At harvest ponds were drained and fish Yield were collected and sorted to different marketing size classes (Table 3). Fish yield of each size class was weighed and counted then the survival rate was calculated.

Table 3. Size grade of tilapia at harvest time.

| Size Grade | Super | 1st | 2nd | 3rd | 4th | trash |
|---|---|---|---|---|---|---|
| Weight (g) | >300 | 200 – 300 | 125 - 200 | 50 - 125 | 25 - 50 | >25 |

**Analytical procedures.**

**Water quality measurements.**

Integrated water samples were taken on monthly basis during growing period (at 9.30 am). Water samples were analyzed for pH, alkalinity, total ammonia nitrogen (TAN), nitrate-nitrogen, available phosphorus, chlorophyll a, and Hardness according to APHA, (1998). In addition, biweekly water sample were taken for pH and total ammonia nitrogen analysis. Measurements of dissolved oxygen (DO), temperature, were taken twice a week. DO and temperature were measured in pond water (between 6.00 and 6.30 am) twice a week using Thermo Orion (model 835A, Orion Research Inc) oxygen meter.

**Growth Parameters Used:**

Growth and feed efficiency parameters were calculated according to the following equation:

WG (g) = mean final fish wt (g) - mean initial fish wt (g).

ADG (g/ day) = Final fish wt (g) - Initial fish wt. (g)/ time (days).

SGR% = 100 (Ln W2- LnW1) / T

Where W2 is the fish weight at the end and W1 is the weight at the start and Ln is the natural log.

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

Net yield (kg/feddan) = harvested fish weight (kg) – initial fish stock biomass (kg) / unit area (feddan).

Survival rate % = Nt x 100 / NI

Where: Nt = Number of fish at t days; NI = Number of fish initially stocked.

Condition factor (K) = $(W / L^3) \times 100$

Where: W = Body weight (g) ; L = Body length (cm)

FCR = Dry feed consumed (g) / Total weight gain (g)

PER = (Final body weight (g) – Initial body weight (g))/protein intake (g)

PPV = 100 X (protein retained in tissue (g) /protein intake (g).

**Partial budget analysis.**

A partial budget analysis was conducted to determine economic returns of the different fertilization regime tested (Shang, 1990). The analysis was based on farm-gate prices for harvested fish and current local market prices for all other items expressed in (LE) Egyptian pound as was in 2006 year.

**Statistical analysis.**

Data were analyzed statistically according to Steel and Torrie (1980) using SPSS, 1999 (version 10.0) statistical software package (SPSS, Inc., Chicago, Illinois, USA). Duncan's Post Hoc Multiple Comparisons Test was performed to evaluate the differences among treatments means (Duncan 1955).

# RESULT AND DISCUSSION

## Growth Performance

Table 4. Means (±SE) [1]growth performance parameters for fish reared in the different treatments.

| parameters | Fish Species | Treatments | | | | Sig |
|---|---|---|---|---|---|---|
| | | T 1 | T 2 | T 3 | T 4 | |
| Initial weight (g/fish) | Tilapia fry | 0.15±0.006 | 0.14±0.003 | 0.15±0.007 | 0.15±0.006 | NS |
| | Silver carp | 55.3±1.45 | 55.7±1.67 | 55.3±0.88 | 55.33±1.86 | NS |
| Final weight (g/fish) | Tilapia | 171.2±1.50 [b] | 180.2±3.89 [ab] | 182.8±4.71 [a] | 187.1±3.06 [a] | * |
| | Silver carp | 1863±92.17 | 1853±88.7 | 2043±30.4 | 2080±77.18 | NS |
| Net weight gain (g/fish) | Tilapia | 171.1±1.47 [b] | 180.1±3.89 [ab] | 182.7±4.69 [a] | 186.9±3.09 [a] | * |
| | Silver carp | 1807.6±91.17 | 1797.3±90.2 | 1987.9±31.1 | 2024.6±75.43 | NS |
| Daily weight gain (g/fish) | Tilapia | 0.81±0.007 [b] | 0.86±0.019 [ab] | 0.87±0.022 [a] | 0.89±0.016 [a] | * |
| | Silver carp | 8.63±0.426 | 8.57±0.433 | 9.47±0.145 | 9.63±0.376 | NS |
| SGR | Tilapia | 3.35±0.019 | 3.40±0.017 | 3.39±0.015 | 3.40±0.026 | NS |
| | Silver carp | 1.68±0.018 | 1.67±0.036 | 1.72±0.013 | 1.73±0.058 | NS |
| Survival rate | Tilapia | 90±3.383 | 88±7.506 | 94.3±3.712 | 91.7±1.856 | NS |
| | Silver carp | 58.3±5.46 | 58.3±3.18 | 67.3±7.26 | 79.7±9.39 | NS |
| Yield (kg/feddan) | Tilapia | 1288.33±6.44 [b] | 1294.67±20.87 [b] | 1401.67±33.23 [a] | 1394.3±5.24 [a] | ** |
| | Silver carp | 107.7±4.41 [b] | 108.0±7.37 [b] | 137.7±15.59 [ab] | 164.7±15.02 [a] | * |
| | Total | 1396.0±7.77 [b] | 1402.7±15.30 [b] | 1539.3±18.28 [a] | 1559.3±9.82 [a] | *** |

[1]Values with the same letter within the same row are not significantly different at ($P<0.05$).

In this experiment tilapia growth parameters (final body weight, net weight gain and daily weight gain) affected significantly ($P<0.05$) by the experimental treatments, while in silver carp growth parameters were insignificantly affected. Tilapia growth were significantly higher ($P<0.05$) in mixed fertilizers, compost and chemical fertilizers (T 3) and cow manure and chemical fertilizers treatments (T 4), compared to organic manures treatments, compost (T 1) and cow manure (T 2; Table 4). That result agreed with what was reported by (Teichert-Coddington and Green, 1993 and Ali, 2003), they stated that tilapia yields was higher in ponds fertilized with mixed fertilizers (chicken manure plus inorganic nitrogen) than that received only chicken manure. On the other hand, Schroeder (1980) reported that yields of carp (*Cyprinus* spp.) and tilapia (*Tilapia* spp.) were not statistically different between inorganically fertilized earthen ponds with and without organic fertilizer.

There were no significant differences in SGR for both tilapia and silver carp among treatments (Table 4). Similarly, Ali, 2003 found that ADG and SGR were higher in mixed fertilizers (chicken manure + Urea + superphosphate) than chicken manure treatments with no significant difference between treatments. Garg and Bhatnagar (1999) reported lower SGR value 0.71 %/day, in Indian major carp (*cirrhinus mrigalle*) grown in ponds enriched with mixture of cow dung, triple superphosphate and urea.

The highest tilapia survival was in T 3 treatment (94.3%) and the lowest was in T 2 treatment (88%) with no significance difference among treatments. Similarly there were no significance difference in silver carp survival among treatments and ranged from 58.3 % in T 1 and T 2 to 67.3 and 79.7% in T 3 and T 4 (respectively). Similar result reported by Milstein *et al.* (1995) they found that survival rate of *O. niloticus* in ponds received both organic and mineral fertilization ranged between 77 and 85 % while those percentages for *C. carpio* ranged between 89 and 91 %. The obtained result agreed with what was reported by (Liti *et al.*, 2001 and Al-Kenawy *et al.*, 2008). On the other hand, this result disagree with Sudiarto *et al.* (1990) findings that in common carp survival and fry growth was better in ponds treated with compost than that treated with other fertilizers or used feed alone. Condition factor was significantly different among treatment

(P<0.05) Figure 1. The obtained result shows that condition factor were higher in mixed fertilizers treatments compared to treatment received only organic fertilizers. Obtained results disagree with what was reported by Ali (2003), who stated that K was higher in ponds received chicken manure than the ponds received mixed fertilizers.

Tilapia and silver carp yield were significantly (P<0.05) higher in T 3 and T 4 than that yielded in T 1 and T 2 (Table 4). Mixing fertilizers in T3 and T4, significantly (P<0.001) improved total fish production (1559.3 and 1539.3 kg/fed. respectively) compared to organic fertilizers only in T 1 and T 2 (1396 and 1402.7 kg/fed. respectively), Table 4. This result agreed with what was reported by (Green *et al.*, 2002; Ali, 2003; and Al-Kenawy *et al.*, 2008). On the other hand obtained result disagrees with what reported by Shaker (1998) who reported that organic fertilizers produced higher fish yield than mixed fertilizers or chemical fertilizers ponds.

The increase in fish yield in this experiment may be attributed to the difference in fertilizers nutrients input sources since all treatments offered similar type of fish feed. In mixed fertilizers treatments, nutrients such as N and P compounds from chemical fertilizers dissolve in water in ionic forms available for phytoplankton production (Kumar *et al.*, 2004).

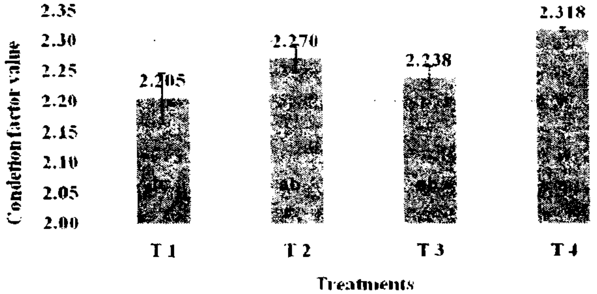


Figure 1. Condition factor value for tilapia reared in different treatments over the experimental period (Mean±SE) [1].

[1] Values with the same letter are not significantly different.

**Feed intake and feed efficiency parameters:**

Stock biomass, fish yield, net fish yield, daily fish weight gain, feed given, food conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV) are presented in Table 5. Fish yield, net fish yield, daily fish weight gain, feed given, food conversion ratio, protein efficiency ratio and protein productive value were affected significantly (P<0.001 or 0.01) by the experimental treatments. Duncan test showed that for both fish yield and net fish yield, T 3 and T 4 were significantly higher than T 1 and T 2. This result are in agreement with what reported by (Shaker 1998) who found that mixed fertilizers or chicken manure treatment were significantly higher in daily fish weight gain as kg/fed compared to feed only or chemical fertilizers only.

In this experiment there were significant different (P<0.01) among treatments in artificial fish feed consumed (Table 5). FCR were significantly differ among treatments (P<0.001) T 3 and T 4 achieved better FCR (1.02 and 1.00, respectively) compared to T 1 and T 2 (1.1 and 1.12, respectively). Similar FCR values were reported by (Al-Kenawy *et al.*, 2008 and Osman *et al.*, 2008) from pond received mixed fertilizers and artificial feed 25% protein. Comparable result were reported by Thakur *et al.* (2004) they reported that FCR from 0.87-1.1 in simultaneous fertilization and feeding or fertilized for 80 days then fed artificial feed 30% protein

There were a significance differences (P<0.001) among treatments in PER Table 5. PPV result showed significant differences (P<0.05) among treatments. It was notable that PPV were significantly higher in T 4 and T 3 (56.1 and 56.01, respectively) compared to T 1 and T 2 (52.9 and 51.8 respectively). Osman *et al.* (2008) reported that there were inverse correlation between level of feeding and efficiency of feed utilization. The authors found that both PER and PPV% were in the following decreasing order 3 month fertilization then 1 month feed, 2 month fertilization then 2 month feed, 1 month fertilization and 3 month feed and feed only (7, 5.25, 4.16 and 3.54, respectively) and (121, 88.9, 60.9 and 44.8, respectively). He explained the higher figure of PPV in restricted feed treatments due to the utilization of natural food in ponds.

Table 5. Means (±SE) [1] feed intake and feed efficiency parameters at different treatments.

| Parameters | Treatments | | | | Sig |
|---|---|---|---|---|---|
| | T 1 | T 2 | T 3 | T 4 | |
| Weight of stock fish (kg/feddan) | 6.79±0.178 | 6.77±0.195 | 6.76±0.142 | 6.79±0.225 | NS |
| Yield (kg/feddan) | 1396.0±7.77[b] | 1402.7±15.30[b] | 1539.3±18.28[a] | 1559.3±9.82[a] | *** |
| Net Fish Yield (kg) | 1389.2±7.68[b] | 1395.9±15.42[b] | 1532.6±18.26[a] | 1552.5±9.82[a] | *** |
| Daily Fish weight gain (Kg/fed/day) | 6.62±0.039[b] | 6.65±0.072[b] | 7.30±0.085[a] | 7.39±0.046[a] | *** |
| Total feed consumed (kg/fed) | 1518.5±3.94[b] | 1556.3±6.33[a] | 1560.0±4.08[a] | 1554.5±6.44[a] | ** |
| FCR | 1.1±0.003[a] | 1.12±0.009 [a] | 1.02±0.015[b] | 1.00±0.006[b] | *** |
| PER | 3.66±0.014[b] | 3.59±0.025[b] | 3.93±0.057[a] | 3.99±0.009[a] | *** |
| PPV% | 52.87±0.233[b] | 51.83±0.56[b] | 56.01±1.328[a] | 56.10±0.341[a] | * |

[1]Values with the same letter within the same row are not significantly different at (P<0.05).

**Water quality**

The water temperature recorded in the morning at 6.30 hr, mean water temperature fluctuated from 24.79 in T 1 to 24.62 in T 4, with no significance difference among treatments (Table 6). Water temperature is one of the most influential environmental factor affecting the metabolism and growth of fish (Boyd, 1990). DO measured on the morning at 6.30 hr, varied between treatments, with no significant difference among treatments at (P<0.05). The lowest DO was in T 2 (1.97) and the highest was in T 3 (2.13), with no significant difference between treatments. Green *et al.* (1990) reported that mean early morning DO (1.2 mg/L) in organically fertilized ponds in Honduras was significantly less than in chemically fertilized pond (2.3 mg/L).

Mean water pH values were not significantly different among treatments (Table 6). Kurten *et al.* (1999) reported that pH values in only organic fertilizer inputs ponds were significantly lower than those recorded in ponds received both organic and inorganic fertilizers. Available phosphorus varied significantly among treatments at ($P<0.05$). The highest available phosphorus level in pond water was T 1 (0.47), compared to the other treatments T 2, T 4 and T 3 (0.31, 0.25 and 0.24 mg/l). In organically fertilized ponds organic P level in pond water was relativity high due to dissolving of inorganic fertilizers in water, after word the nutrient release rate governed by quality of manure (Kumar *et al.*, 2004).

Table 6. Mean (±SE) [1]water quality parameters at different treatment over the culture period.

| Parameters | N | Treatments | | | | Sig |
|---|---|---|---|---|---|---|
| | | T 1 | T 2 | T 3 | T 4 | |
| **Temperature©** (Mean) | 52 | 24.47±0.051 | 24.65±0.108 | 24.72±0.055 | 24.62±0.055 | NS |
| **DO** (mg/l) | 52 | 2.09±0.321 | 1.97±0.249 | 2.13±0.157 | 2.11±0.097 | NS |
| **pH** | 11 | 8.41±0.010 | 8.47±0.108 | 8.48±0.003 | 8.57±0.048 | NS |
| **Available phosphorus** (mg/l) | 6 | 0.47±0.047 a | 0.31±0.043 b | 0.24±0.067 b | 0.25±0.030 b | * |
| **Nitrate** (mg/l) | 6 | 0.50±0.090 | 0.57±0.104 | 054±0.068 | 0.43±0.105 | NS |
| **$NH_4$** (mg/l) | 11 | 0.26±0.012 | 0.22±0.013 | 0.23±0.019 | 0.23±0.010 | NS |
| **$NH_3$** (mg/l) | 11 | 0.05±0.002 | 0.05±0.012 | 0.04±0.003 | 0.05±0.010 | NS |
| **Alkalinity** (mg/L as $CaCO_3$) | 6 | 178.2±6.87 | 183.5±7.52 | 164.4±2.79 | 171.3±14.59 | NS |
| **Chlorophyll a** (µg/L) | 6 | 34.89±12.45 | 26.28±3.13 | 21.78±2.27 | 28.70±4.97 | NS |
| **Hardness** (mg/L as $CaCO_3$) | 6 | 212.9±10.91 | 208.1±9.72 | 179.5±0.58 | 199.9±14.96 | NS |

[1]Values with the same letter within the same row are not significantly different at ($P<0.05$).

Nitrate nitrogen ranged between 0.43 in T 4 and 0.57 in T 2, with no significant difference among treatments. These results are in agreement with Ali (2003) who reported that there were no significant difference in $NO_3$ concentration in ponds received mixed organic and inorganic fertilizers or that received only organic fertilizers. Lower $NO_3$ mean value were reported by Shaker in (1998) for mixed fertilizers plus feed; chicken litter for 60 days then feed; mineral fertilization and feed only treatments (0.19; 0.26; 0.19 and 0.19 mg/L, respectively). Ammonium and Ammonia nitrogen ranged were not significantly different among treatments. Ammonia nitrogen values were similar 0.05 mg/l in T 1, T 2 and T 4, and 0.04 in T 3. Un-ionized ammonia at a concentration of 0.06 mg/L had no effect on growth at water temperature between 28 and 33 °C (Boyd, 1990). In this experiment $NH_3$ values were within the acceptable limit for optimum tilapia growth.

**Partial economic analysis.**

Economic evaluation for fish production performance under different treatments inputs are presented in Table 7. In this experiment it was notable that mixing chemical fertilizers with organic fertilizers reduced fertilization cost significantly ($P<0.001$). Due to the difference in fish growth and quantity of fish given there were a high significant difference in fish feed costs ($P<0.01$) among treatments. The difference among treatments in fertilizers and feed cost contributed to significance differences among treatments ($P<0.001$) in total variable cost. It was notable that production cost in T 3 and T 4 (6101 and 6257 LE/fed, respectively) were lower than T 1 and T 2 (6239 and 6620 LE/fed, respectively). Progressively increasing nutrient inputs resulted in the increased fish yields, and also caused corresponding increases of production cost Yi and Lin (2000). Feed cost per kg fish yield were significantly ($P<0.001$) different among treatments Table 7. Yi and Lin (2000) reported that when pelleted feed was supplemented to inorganically fertilized ponds, the feed cost accounted for more than 85% of the total production cost. But for the "feed alone" input, the feed cost reached 96% of the total production cost.

Growth revenue varied significantly among treatments ($P<0.05$). Both T 3 and T 4 (9402 and 9328 LE/fed, respectively) were significantly higher compared to T 1 and T 2 (8513 and 8330 LE/fed, respectively). Net farm income showed a high significance difference among treatments ($P<0.01$) following the same pattern of growth revenue. Benefit cost ratio were high significantly ($P<0.01$) higher in T 3 and T 4 (54 and 49 %) compared to T 1 and T 2 (36 and 26 %). Comparable result were reported by Green *et al.* (2002) who reported that fertilization then feed strategy was more economical compared to feed only or chemical fertilized pond.

Obtained result of this experiment are in agreement with what was reported by Yi and Lin (2000) who mentioned that when chicken manure was supplemented with urea, net revenues increased with increasing rates of both chicken manure and urea. Moreover the net revenue reached 5,029 $/ha/year when ponds fertilized initially with urea and TSP, then fed at 50% satiation level starting feeding at 100 g size. While in "feed alone" input ponds was not profitable. The higher economic return found in mixed fertilizers treatment in this experiment may be explained by increasing nitrogenous nutrients availability for primary productivity and consequently increasing fish yield and thus increase farm revenue at low production cost.

Table 7. Means (±SE) [1] Economic evaluation for fish performance under different treatments.

| Items | Treatments | | | | Sig |
|---|---|---|---|---|---|
| | T 1 | T 2 | T 3 | T 4 | |
| Fry | 445 | 445 | 445 | 445 | |
| Fertilizers | | | | | |
| Compost | 638.8 | | 319.4 | | |
| Cow manure | | 956.6 | | 484.8 | |
| Urea | | | 29.9 | 29.9 | |
| S. Phosphate | | | 82.4 | 82.4 | |
| Subtotal fertilizers | 638.8±0.00 [b] | 956.6±4.78 [a] | 431.7±2.52 [d] | 596.8±2.52 [c] | *** |
| Feed Cost (LE/feddan) | 2505.5±6.49 [b] | 2567.9±10.45 [a] | 2547±6.74 [a] | 2565±10.63 [a] | ** |
| Working Capital | 1900 | 1900 | 1900 | 1900 | |
| Harvest | 750 | 750 | 750 | 750 | |
| Production Cost (LE/feddan) | 6239.3±6.51 [b] | 6619.6±7.96 [a] | 6100.7±8.74 [c] | 6256.8±12.68 [b] | *** |
| Revenue /fish sales (LE/feddan) | 8513.3±29.88 [b] | 8330.2±347 [b] | 9402.3±242.1 [a] | 9327.9±44.93 [a] | * |
| Net Income (LE/feddan) | 2274.0±23.40 [b] | 1710.6±339.6 [b] | 3301.5±250.72 [a] | 3071.1±45.40 [a] | ** |
| Benefit Cost Ratio | 36.4±0.32 [b] | 25.8±5.00 b | 54.1±4.18 [a] | 49.1±0.74 [a] | ** |

[1]Values with the same letter within the same row are not significantly different at ($P<0.05$).

In conclusion the result of this experiment concluded that feeding strategy using mixed fertilizers and supplementary feed as feeding strategy performed better than organic fertilizers and supplementary feed, in terms of increasing fish yield and generating higher income to producer.

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# الملخص العربى

## أثر استخدام استراتيجيات تسميد مختلفة مع التغذيه على الانتاج وجودة المياه والجدوى الاقتصادية فى المزارع السمكية

تهدف هذه الدراسة التعرف على افضل استراتيجية تسميدية بمقارنة الكفاءة الانتاجية للتسميد بالاسمدة العضوية او استبدال ٥٠% من السماد العضوى بسماد كيماوى مع التغذيه بألاعلاف من الاسبوع الثانى عشر وكانت معاملات التجربة كالتالى (١ تسميد بالكمبوست، ٢ تسميد بسبلة المواشى، ٣ تسميد بخليط كمبوست + يوريا + سوبر فوسفات ، ٤ تسميد بخليط من سبلة المواشى + يوريا + سوبر فوسفات). وتم اجراء التجربة فى احواض ترابية مساحتها ١٠٠٠ م$^{٢}$ زرعت بزريعه بلطى نيللى ٠،١٥ جم بمعدل ٢ سمكة للمتر مع اضافة ٢٥ اصبعيات مبروك فضى (٥٥ جم) لكل حوض لتفادى النمو الغزير للطحالب الذى قد يظهر مع التسميد.

اظهرت الدراسة ان التسميد بخليط السماد العضوى والكيماوى مع التغذية بعد ذلك ادى الى زياده الانتاج معنويا (٠،٠٥%). وكانت انتاجية الفدان مرتبة تنازليا كالتالى، معاملة ٤ ثم ٣ ثم ٢ ثم معاملة ١ ( ١٥٥٩ ، ١٥٣٩، ١٤٠٣ ثم ١٣٩٦ كجم/ للفدان، على التوالى). وكذلك تحسين الاستفادة من الغذاء وكانت المعاملة ٤ يليها معاملة ٣ اعلى عند مستوى معنوية (٠،٠٥%) من المعاملات ١ و ٢. وزاد معدل الاستفادة من وحدة البروتين فى المعاملات ٤ و ٣ زيادة معنوية عند مستوى (٠،٠٠١%) مقارنة بالمعاملات ١ و ٢. و لم تظهر نتائج تحاليل جودة المياه اختلافات معنوية بين المعاملات باستثناء الفوسفور الذائب الذى كان أعلى عند مستوى معنوية (٠،٠٥%) فى معاملة ١ مقارنتا بالمعاملات الاخرى.

التقيم الاقتصادى اظهر انخفاض تكاليف الانتاج عند التسميد بالسماد العضوى والكيماوى معا عند مقارنتة بالتسميد العضوى فقط. بينما زادت الايرادات معنويا فى المعاملات ٣ و ٤ مقارنتا بالمعاملات ١ و ٢ . وأظهرت الدراسه ان أعلى عائد على مصروفات الانتاج كان فى المعاملة ٣ يليها معاملة ٤ (٥٤% و ٤٩% على التتابع) حيث كانت اعلى معنويا عند مستوى (٠،٠١%) من معاملة ١ و ٣ والتى حققت نسبة ايرادات (٣٦ و ٢٦%، على التوالى).

خلصت الدراسة الى ان استراتجية التغذية التى تعتمد على التسميد بخليط من السماد العضوى والكيماوى مع التغذية الصناعيه لاحقا حققت انتاجية افضل وخفضت مصروفات الانتاج وزادت ربحية النشاط مقارنتا بتلك الاستراتجية التى تعتمد على التسميد بالسماد العضوى مع التغذية.