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A comparison between the fixed input and on demand methods for optimizing fertilization requirements, minimizing costs and increasing fish production in polyculture ponds

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Abstract

To determine the appropriate fertilization method that optimizes nutrient inputs, minimizes financial/environmental costs and ultimately maximizes fish production, this work was conducted in twenty earthen ponds of 2000 m^2 each, at the WorldFish Center, Egypt, for 195 days. A polyculture of Nile tilapia (*Oreochromis niloticus*), silver carp (*Hypophthalmichthys molitrix*) and African catfish (*clarias gariepinus*) were used in this study. Urea (46% N) and chicken litter (3.4% N and 1.75% P) were used to achieve the concentration of the required nutrients through two fertilization methods, 1) fixed input method, (the use of 20 kg N and 5 kg P/ha/week) either for six months (Fixed-6) or three months (Fixed-3). 2) On demand method (quantities of fertilizers given to ponds were determined according to water analysis to maintain 2 mg N and 0.5 mg P/l level in pond water, for six months (Demand-6) or three months (Demand-3), the fifth treatment was control (without fertilization). All ponds were fed with the rate of 50% of satiation level after 3 months of stocking. Water quality parameters (DO, Temp., SD, pH, TAN, NO_3-N, PO_4, Chl. "a", Alk. and TH) were measured weekly, they were at suitable levels for the growth of all cultured fish. Fixed-6 treatment had the highest fish production (4.8 ton/ha) and the highest tilapia class (size) followed by Fixed-3, Demand-6 and Demand-3 treatments, while control came the last, the revenue values were 57.54, 23.36, 21.25, 20.43 and 11.87 thousand LE/ha respectively. Fixed-6 treatment had also the highest production cost (20.05 thousand LE/ha) and control had the lowest (15.09 thousand LE/ha). There was no significant difference between both fixed treatments in either net profit (7.50 and 5.33 thousand LE/ha) or B/C ratio (0.37 and 0.29 for Fixed-6, and Fixed-3, treatments respectively). This study demonstrates that the use of fertilizers for six months could gain bigger fish and higher fish production than its use for three months but economically, it was not significantly different. While from water quality (environmental) point of view, the use of fertilizers for three months was better. Thus the final results of the present study recommended the method of fixed inputs for the first three months of the experiment with the use of fish feed at 50% of satiation level after three months of stocking (Fixed-3) treatment. This will save the loads of more than 4 ton chicken litter/ha and about 70 kg urea/ha, while achieving almost the same return and will may provide fish farmers a fertilization strategy that allow them to achieve higher economic returns with reducing nutrient inputs which also provide an environmentally-friendly fish culture.

Keywords: African catfish, Fertilization requirements Nile tilapia, and polyculture.

Introduction

Egypt has emerged as one of the leading countries in freshwater aquaculture production in recent years. Total Egyptian fish production was 1.008 million metric tons, 63% of which comes from aquaculture. Despite this fact, fish production still needs to increase to fill the gap between fish production and consumption, that estimated by 259 metric ton (GAFRD, 2007).

Polyculture production system is based on the principle that each species stocked has its own feeding niche that doesn't completely overlap with feeding niches of other species. Therefore, a more complete use is made of the food resources and space available in polyculture than in monoculture. Furthermore in some cases, one species enhances the food availability for other species and thus increases the total fish yield per unit area (Miah *et al*., 1993; Azad *et al*., 2004; Rahman *et al*., 2006 and 2008).

Future use of artificial fish feed is expected to be reduced as a consequence of increasing economical and environmental issues (Amaya *et al*., 2007). Some fish species can grow better with the availability of both natural and artificial food, for instance, tilapia and silver carp have the capacity to utilize naturally available foods in green water systems where they are commonly cultured. This means that fish growth in ponds could be achieved through the simultaneous consumption of feed and endogenously produced food organisms such as micro-algae and microbial-detrital aggregates, that produced by fertilizers (Moss *et al*., 2001; Forster *et al*., 2002; Tacon *et al*., 2002).

Knud-Hansen *et al*. (2003) stated that the practical purpose of pond fertilization is to help farmers get the most out of their resources (i.e., material, financial and time) to achieve predictability high yields with minimal environmental costs. The best fertilization strategy is the one that provides the necessary nutrients for cultured fish, minimizes environmental degradation, and requires the least amount of effort and resources from the farmer. In choosing a particular fertilization strategy, the specific primary concerns for the farmer are the relative: 1) ability to stimulate algal and fish production; 2) nutrient utilization efficiencies; and 3) costs to the farmer.

Diana *et al*. (1994) found that the addition of urea and triple superphosphate at a rate of 28 kg N and 7 kg P/ha/week (for 160 day grow-out period) was optimal in Nile tilapia ponds fed at 50% satiation level of 25% crude protein artificial feed. While this fertilization rates is recommended when fertilizer serves as the sole nutrient input for Nile tilapia culture in the tropics (Knud-Hansen *et al*., 1991), the nutrients may become excessive in ponds with supplemental feeding, as substantial amounts of nutrient are also released from feeding wastes to pond water for phytoplankton production (Lin and Diana, 1995; Yi and Lin, 2001 and Yi *et al*., 2003). Thus, it is ecologically and economically important to maintain adequate production of natural foods in fed ponds with balanced nutrient inputs from both external fertilization and internal wastes. The rate of external fertilization should be adjusted according to the amount of nutrients derived from feeding. This will result in more efficient utilization of nutrients, better water quality, lower production cost, and reduced nutrient load in pond effluents (Yi *et al*., 2004).

Thus, the authors aimed in this study to find a proper fertilization method to optimize nutrient requirements and a proper fertilization strategy through determining the amount as well as the period of fertilizers addition.

Materials and Methods

This work was conducted in 20 earthen ponds of 2000 m^2 in surface area each, at the WorldFish Center, Egypt, for 195 days. All ponds were rectangular in shape with an average depth of 1.2 m. water was added periodically to compensate water loss due to seepage and evaporation to maintain water depth at 1 m. prior to the experiment, ponds were drained, aquatic vegetation was removed and wild fishes were eradicated then ponds were left for two weeks to be completely dry.

Nile tilapia (*Oreochromis niloticus*) were stocked at a rate of 5600 fish/pond at a size of 0.1 g. After one week, silver carp (*Hypophthalmichthys molitrix*) were stocked at a rate of 60 fish/pond at a size of 107 ± 10 g. After two months of the beginning of the experiment and when individual weight of tilapia became more than 50 grams, African catfish (*Clarias gariepinus*) were stocked at a rate of 40 fish/pond at a size of 100 ± 14 g. The final average stocking rate was 2.85 fish/m^2.

Urea (46% N) and chicken litter (3.4% N and 1.75% P) were used in this study to achieve the concentration of the required nutrients through the following methods:

1) Fixed input method:

Fertilizer inputs in this method were based upon fertilization rate reported by Ibrahim (1997 and 2001); Nagdi *et al*. (2003); Ibrahim and Nagdi (2006) and El-Naggar *et al*., (2008), who recommended to use the rates of 20 kg N and 5 kg P/ha/week throughout the whole experimental period along with artificial feed at 50% of satiation level. These rates of fixed fertilization were applied either for six months (and called Fixed-6) or for three months (and called fixed-3).

2) On demand (water analysis) method:

In this method, quantities of fertilizers given to ponds were determined according to the available level of nitrogen and phosphorus in water samples taken from ponds one day before fertilization. Fertilizers inputs were given to maintain 2 mg N and 0.5 mg P/l level in pond water as recommended by Ibrahim (1997 and 2001); Nagdi *et al*. (2003); Ibrahim and Nagdi (2006) and El-Naggar *et al*. (2008). For this trial, feed was given at the same rate as fixed- 6 and fixed-3 to reduce production costs and nutrient leaching to surrounding water bodies with pond effluent.

The quantity of required fertilizers were determined by subtraction (i.e. the required nitrogen amount to be added = (2 – total nitrogen concentration in pond water as mg/l) X pond water volume). Thus the third treatment was the use of these calculated amounts for six months (Demand-6). The fourth treatment was the use of the calculated amounts for the first three months of the experiment (Demand-3).

The fifth treatment was the control (without fertilization and fed the same rate at 50% satiation after 3 months of stocking). Table (1) summarizes total amounts of fertilizers (chicken litter and urea) and artificial feed used for each treatment during the whole experimental period with the feed conversion ratio (FCR).

Twenty 2000 m^2 earthen ponds were randomly assigned for the five fertilization strategies (treatments) mentioned above with four replicates each. Artificial fish feed 25% crude protein was applied in all ponds (all treatments) after three months from the beginning of the experiment at 50% satiation level 6 days a week. Satiation feeding level was determined for each pond by estimating the total amount of feed consumed during two feeding sessions (morning session "1000 – 1100 h" and afternoon session "1400 – 1500 h") every Sunday. The 50% of consumed amount by each pond (using a separate bucket) considered the 50% of satiation level then applied to the same pond from Monday to Saturday except Fridays.

Random fish samples from each fish species from each pond were monthly collected and weighed to monitor changes of fish growth, and then fish were returned back to their ponds. After 195 days of culture all fish were harvested counted and weighed.

Pond water column samples were taken weekly using water-column sampler (Boyd, 1990). Dissolved oxygen (DO), water temperature (Temp) and Secchi disk depth (SD) were measured at the pond, then one liter of pond water was collected from different five spots in each pond and mixed together, then one liter of mixed water was taken as a representative water sample. Water samples then were taken to the laboratory for the following analyses: pH, total ammonia nitrogen (TAN), nitrate nitrogen (NO_3-N), available phosphorus (PO_4), Chlorophyll "a" (Chl. "a"), total alkalinity (Alk) and total hardness (TH). DO and Temp were measured at 10 cm below the water surface using dissolved oxygen meter model Orion 835 A. The pH values were measured using pH meter model Accumet 25. TAN, NO_3, PO_4, Alk and TH were measured according to Boyd (1990) and APHA (1985). Chlorophyll "a" was determined according to Boyd (1990) and calculated according to Vollenweider (1969) equation.

Simple economic analysis was conducted to determine net profits and benefit/cost ratio (B/C ratio) of fish cultured at different fertilization strategies. The analysis was based on farm-gate prices for harvested fish and current local prices for all other items in Egypt expressed in Egyptian pounds (US$ 1 = 5.6 Egyptian pounds).

Data were analyzed statistically by one-way analysis of variance (Steele and Torrie, 1980), Pearson correlation and linear regression analyses were performed too using SAS package ver. 9.1 (2005). Differences were considered significant at an alpha level of 0.05 using Duncan (1955) new multiple range test.

Results and Discussion

Water quality parameters throughout the 195-day experiment were maintained at suitable levels for the growth of all cultured fish (Boyd, 1990; Table 2). There were no significant differences among all treatments in the mean values of pH, nitrate, available phosphorus and chlorophyll "a". Water temperature was higher in Fixed-6 treatment than that in the other treatments. Although control ponds were not fertilized at all, it had the highest concentration of chlorophyll "a" (74.71 µg/l) which was higher with about 75% than that in the Fixed-6 treatment (43.02 µg/l) which was fertilized with highest inputs of chicken litter and urea through six months, this may refer to the grazing rate of fish, where fish production was higher in the Fixed-6 treatment (4.80 ton/ha) with about 80% higher than that in control (2.66 ton/ha). This increased fish biomass in the Fixed-6 treatment produced an increased amount of TAN concentration compared to the other treatments. The mean TAN concentration followed this order Fixed-6, Fixed-3, Demand-6, Demand-3 and control treatments (0.45, 0.39, 0.35, 0.28 and 0.27 mg/l, respectively). Fish biomass followed almost the same order Fixed-6, Demand-6, Fixed-3, Demand-3 and control being 4.80, 4.19, 4.16, 3.93 and 2.66 ton/ha, respectively).

Table (3) showing correlation analysis of the mean values of water quality parameters with the production of different fish species used in this study and different nutrient inputs (chicken litter, urea and feed). Correlation analysis indicated a positive significant ($P \leq 0.05$) correlation between water temperature with tilapia, silver carp and total fish production with correlation coefficients (r) of 0.56, 0.56 and 0.51, respectively. On the other hand, catfish production was not correlated with any of water quality parameters. Water temperature also positively correlated with fertilizer inputs either for chicken litter (r = 0.58) or urea (r = 0.84), which may explain the significantly increased water temperature in the Fixed-6 treatment (Table 2) than that in the other treatments, as a result of the higher inputs of chicken litter and urea in this treatment (6.37 ton/ha and 126.59 kg/ha, respectively, Table 1), compared to the other treatments. On the contrary, DO concentration had a negative correlation with tilapia and total fish production (the increase in fish biomass, the decrease in DO concentration because of fish respiration). The addition of chicken litter had also a reverse significant correlation with the concentration of DO as a result of the fermentation occurred in the bottom of water column, which consumes oxygen. Correlation analysis declared that fish fed on artificial feed consumed an amount of oxygen negatively correlated (-0.71) with the amount of feed consumed, since DO concentration was negatively correlated with the addition of artificial feed.

Feed conversion ratio (FCR) was the lowest (i.e. the best) in the Fixed-6 treatment (0.69) and the highest (i.e. the worst) in the control treatment (0.99), the other treatments were intermediate (0.79, 0.78 and 0.82 for Fixed-3, Demand-6 and Demand-3 respectively, Table 1). These decreased FCR's could be explained by the fact that fish cultured in fertilized ponds and fed with supplemental feed, depend on both natural food (that enhanced by fertilization) and artificial feed. Same results were obtained by Diana *et al*. (1994) and Yi *et al*. (2004) who stated that the natural foods in fertilized ponds increase efficiency of supplemental feeds significantly as indicated by lower FCR.

The production of different fish species used in this study is presented in Table (4). The Fixed-6 treatment produced highest total production through the 195-day growing period (4.80 ton/ha), the highest tilapia production (3.91 ton/ha) and the highest silver carp production (679.2 kg/ha), while catfish production was not significantly different in all treatments. Control ponds produced the lowest ($P \leq 0.05$) total production (2.66 ton/ha), tilapia (1.92 ton/ha), catfish (139.4 kg/ha) and silver carp (587.8 kg/ha). This declares the effect of fertilization on fish production which increased by about 70% when fertilizers were used for six months and 50% when fertilizers were used for only three months. Research on pond fertilization to increase yields of planktivorous fish, particularly Nile tilapia, has received considerable attention during recent decades (Yusoff and McNabb, 1989; Schroeder *et al*., 1990, Ibrahim, 1997 and 2001; Azim *et al*., 2002; Knud-Hansen *et al*., 2003; Nagdi *et al*., 2003 and Ibrahim and Nagdi, 2006).

Production of tilapia, silver carp and total production were quite similar for the three treatments, Fixed-3, Deman-6 and Demand-3 (Table 4) which means that, fertilization with the fixed input through six months significantly improved fish production than that with fixed inputs for three months or demand estimations through either three or six months.

Table (5) indicates the strong positive correlation between both of tilapia and total production with the nutrient inputs either fertilizers (chicken litter and urea) or feed. While silver carp production was only correlated significantly with fertilizer inputs, since silver carp is phytoplankton feeder (phytoplanktivorous) where fertilizers stimulates phytoplankton growth. Bardach *et al*. (1972) stated that the rationale use of silver carp in water quality management stems from the widespread belief that silver carp is phytoplanktivorous. Spataru *et al*. (1983) found that phytoplankton formed 88-95% of silver carp's gut contents. On the other hand catfish production was not correlated either with fertilizers or feed inputs since it's omnivorous fish, it can grow better on different kinds of food and/or fish fry (El-Naggar, 2007 and Nieuwegiessen, *et al*. 2009).

Regression analysis that describe the relationship between total fish production with the addition of chicken litter (Figure 1), with the addition of urea (Figure 2) and with the addition of feed (Figure 3) illustrated that the addition of all of them were positively and significantly correlated with total fish production, and their determination factors (r^2) and P-values were 0.76, 0.49 and 0.78; 0.0001, 0.002 and 0.0001, respectively, which means that the addition of these three factors significantly increases fish production and could be used as predictable factors for fish weight with an accuracy of 76%, 49% and 78%, respectively.

Figure (4) illustrated that 80% and 75% of tilapia produced by Fixed-6 and Fixed-3 treatments, respectively were in the higher (i.e. the most economically) three fish classes (super ">300 g/fish", first "200-300 g/fish" and second "80-199 g/fish"). While these three classes represented 70% and 68% of tilapia production of Demand-6 and Demand-3 treatments respectively. On the other hand, it represented only 38% of control production of tilapia. This led to increase the average fish price in the Fixed-6 and Fixed-3 treatments to be 5.73 and 5.61 LE/kg, respectively and to reduce it to 4.48 LE/kg in the control, while it was intermediate in Demand-6 and Demand-3 treatments (5.10 and 5.19 LE/kg, respectively), which enhanced net profit in both fixed treatments than in both demand treatments and reduced it in control as the following 7.50, 5.33, 2.81, 2.88 and -3.21 thousand LE/ha for Fixed-6, Fixed-3, Demand-6, Demand-3 and control treatments respectively (Table 6).

Partial economic analysis was performed to analyze the economic viability of different fertilization input systems (Table 6). Value of fish sales was function of the quantity of fish yield and their size distribution. So, it was the highest in Fixed-6 treatment which had the highest fish production (4.8 ton/ha) and the highest tilapia class (size) followed by Fixed-3, Demand-6 and Demand-3 treatments, while control came the last, the revenue values were 57.54, 23.36, 21.25, 20.43 and 11.87 thousand LE/ha respectively. From the main items of production costs, artificial fish feed was the most expensive one, it represented about 70% of total variable cost (Yi *et al*., 2004; El-Naggar *et al*., 2008; Ibrahim and El Naggar, 2010), for this reason, Fixed-6 treatment had the highest production cost (20.05 thousand LE/ha) and control had the lowest cost (15.09 thousand LE/ha). There was no significant difference between both fixed treatments in net profit (7.50 and 5.33 thousand LE/ha for Fixed-6, and Fixed-3, treatments respectively). Their difference in net profit was about 2 thousand LE/ha. On the other hand their difference in total cost also was about 2 thousand LE/ha which appear in the B/C ratio as it was not significant in both treatments (0.37 and 0.29, respectively). Thus, from economical and environmental points of view for such production system and similar stocking rate, the use of fixed input is recommended for only the first three months (Fixed-3 treatment) was better than its use for the whole six months of the experiment, this will save the loads of more than 4 ton chicken litter/ha and about 70 kg urea/ha (Table 1) while achieving almost the same return (net profit and B/C ratio). Both of demand treatments also emphasize the same idea of using fertilizers for three months instead of six months, since net profit was higher in Demand-3 (2.88 thousand LE/ha) than that in Demand-6 (2.81 thousand LE/ha) however it was not significant. On the other hand, control gave negative net profit (-3.21 thousand LE/ha) and B/C ratio (-0.21).

This study demonstrates that the use of fertilizers for six months could gain bigger fish and higher fish production than its use for three months but economically, it was not significantly different, while from water quality (environmental) point of view, the use of fertilizers for three months was the best. Thus, the final results of the present study recommended the method of fixed inputs for the first three months of the experiment with the use of fish feed at 50% of satiation level (Fixed-3) treatment. This will may provide fish farmers a fertilization strategy allow them to achieve higher economic returns with reducing nutrient inputs which also provide an environmentally friendly fish culture.

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Table 1. Summary of total amounts of fertilizers and feed used for different fertilizer treatments with feed conversion ratio (FCR) during 195-day study.

Treatment	Chicken litter (Ton/ha)	Urea (kg/ha)	Feed (Ton/ha)	FCR
Fixed-6	6.37 a	126.59 a	2.80 a	0.69 c
Fixed-3	2.25 c	56.74 b	2.80 a	0.79 bc
Demand-6	3.97 b	20.97 c	2.76 ab	0.78 bc
Demand-3	2.06 c	7.29 d	2.74 b	0.82 b
Control	-----	-----	2.05 c	0.99 a

Means in the same column followed by different letters are significantly different

Table 2. Average water quality parameter values measured over a 195-day grow-out period treated with different fertilization treatments.

Treatment	Temp (^oC)	DO (mg/l)	SD (cm)	pH	TAN (mg/l)	NO_3-N (mg/l)	PO_4 (mg/l)	Chl "a" (µg/l)	Alk ($mgCaCO_3$)	TH ($mgCaCO_3$)
Fixed-6	25.42 a	2.23 b	29.0 a	8.66	0.45 a	0.25	0.11	43.02	250.0 a	204.00 ab
Fixed-3	25.28 b	2.50 ab	26.7 ab	8.72	0.39 ab	0.28	0.10	38.58	259.17 a	228.00 a
Demand-6	25.15 b	2.38 b	19.3 b	8.80	0.35 b	0.25	0.12	54.32	207.50 b	162.25 b
Demand-3	25.14 b	2.18 b	19.7 b	8.78	0.28 c	0.26	0.12	58.48	245.83 a	199.00 ab
Control	25.14 b	2.96 a	19.8 b	8.84	0.27 c	0.26	0.09	74.71	273.75 a	193.25 ab

Means in the same column followed by different letters are significantly different

Table 3. Pearson correlation matrix between water quality parameters with different fish production and nutrient inputs

Variables	Temp	DO	SD	pH	TAN	NO_3-N	PO_4	Chl "a"	Alk	TH
Tilapia	**0.56**	**-0.55**	0.44	-0.23	**0.74**	0.05	0.16	-0.45	-0.39	0.17
Catfish	0.02	-0.33	-0.13	-0.21	0.07	-0.10	0.06	-0.16	-0.07	-0.09
Silver	**0.56**	-0.17	0.33	0.03	0.26	-0.19	0.26	-0.18	-0.18	0.10
Total	**0.51**	**-0.62**	0.37	-0.23	**0.71**	0.03	0.16	-0.42	-0.43	0.12
C. litter	**0.58**	**-0.57**	0.38	-0.32	**0.75**	-0.08	0.12	-0.36	-0.45	-0.08
Urea	**0.84**	-0.362	**0.66**	-0.41	**0.81**	0.00	0.03	-0.40	0.01	0.26
Feed	0.37	**-0.71**	0.32	-0.32	**0.54**	0.00	0.21	-0.46	**-0.50**	0.07

Values in bold are significantly different from 0 with a significance level alpha = 0.05

Table 4. Tilapia, catfish, silver carp and total production under different fertilization treatments after 195 days

Treatment	Tilapia (ton/ha)	Catfish (kg/ha)	Silver carp (kg/ha)	Other (kg/ha)	Total production (ton/ha)
Fixed-6	3.91 a	200.8	679.2 a	-----	4.80 a
Fixed-3	3.40 ab	165.8	597.1 ab	-----	4.16 b
Demand-6	3.22 b	210.3	624.1 ab	136.3	4.19 b
Demand-3	3.05 b	251.7	600.0 ab	33.3	3.93 b
Control	1.92 c	139.4	587.8 b	13.1	2.66 c

Means in the same column followed by different letters are significantly different

Table 5. Pearson correlation matrix of fish production and nutrient inputs

Variables	Tilapia	Catfish	Silver	Total	Manure	Urea	Feed
Tilapia	1						
Catfish	0.19	1					
Silver	**0.52**	0.13	1				
Total	**0.98**	0.31	**0.53**	1			
Manure	**0.83**	0.27	**0.58**	**0.87**	1		
Urea	**0.72**	0.04	**0.52**	**0.70**	**0.81**	1	
Feed	**0.84**	0.38	0.31	**0.88**	**0.75**	**0.52**	1

Values in bold are significantly different from 0 with a significance level alpha = 0.05

Table 6. Comparison between different fertilization treatments concerning some economical parameters

Treatment	Mean Sales price (LE/kg)	Production cost (LE/kg)	Revenue (1000 LE/ha)	Total cost (1000 LE/ha)	Net profit (1000 LE/ha)	B/C ratio
Fixed-6	5.73 a	4.21 b	57.54 a	20.05 a	7.50 a	0.37 a
Fixed-3	5.61 ab	4.34 b	23.36 b	18.03 c	5.33 a	0.29 a
Demand-6	5.10 c	4.44 b	21.25 b	18.44 b	2.81 b	0.15 b
Demand-3	5.19 bc	4.47 b	20.43 b	17.54 d	2.88 b	0.16 b
Control	4.48 d	5.69 a	11.87 c	15.09 e	- 3.21c	- 0.21 c

Means in the same column followed by different letters are significantly different

FIGURE 1. Linear regression analysis of total fish production with the addition of chicken litter

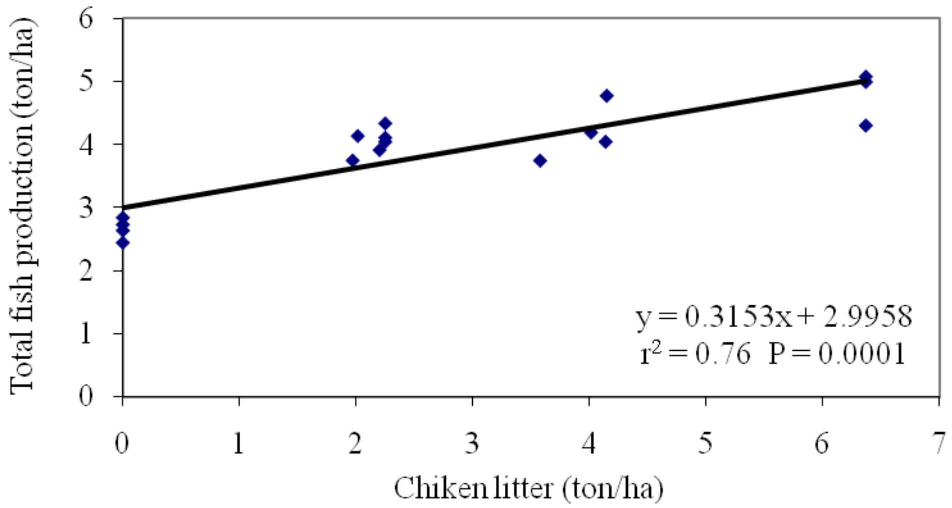


FIGURE 2. Linear regression analysis of total fish production with the addition of urea

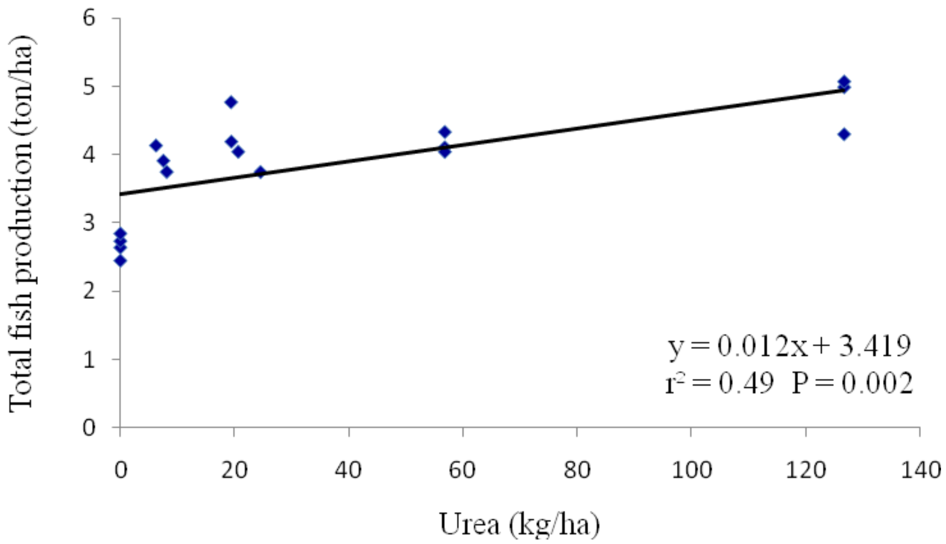


FIGURE 3. Linear regression analysis of total fish production with the addition of artificial fish feed

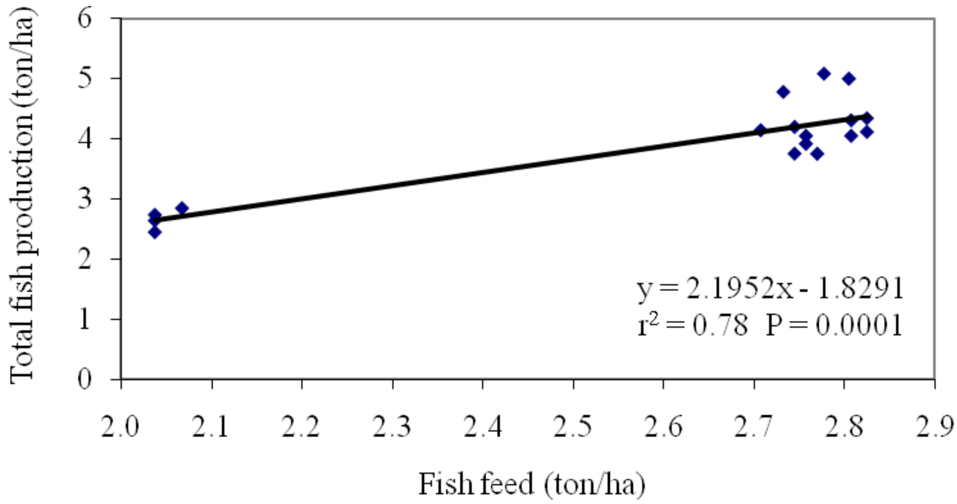
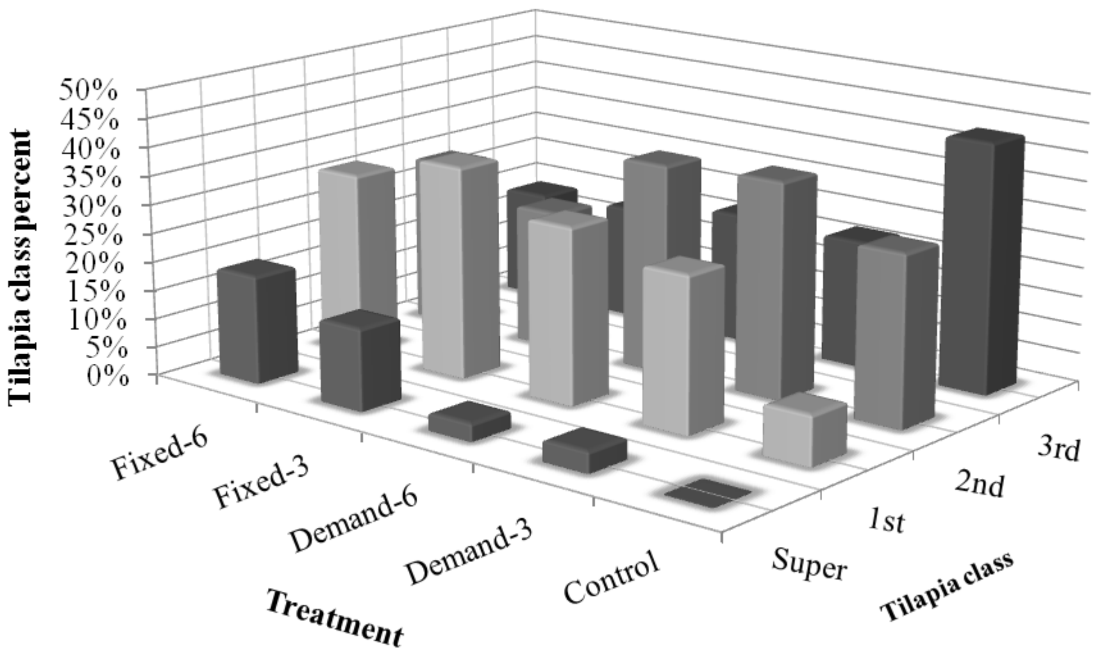


FIGURE 4. Percentages of tilapia classes, super (≥ 300g), first (200-299 g), second (83-199 g) and third (41-82 g) treated with different fertilization treatments.



مقارنة بين طريقتى الإضافات الثابتة و الإضافة عند الحاجة لتوفير الاحتياجات المناسبة من التسميد وتقليل التكاليف ورفع الانتاج السمكى فى أحواض الاستزراع السمكى المختلط

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الملخص العربى

تمت هذه الدراسة فى عشرين حوضاً ترابياً مساحة كل منها ٢٠٠٠ متر مربع فى المركز الدولى للأسماك بهدف تحديد طريقة التسميد الملائمة التى تمد الأحواض السمكية بما تحتاجه من العناصر الغذائية وتقلل تكاليف التشغيل وكذا التأثيرات البيئية الضارة (وذلك بتحسين خواص المياه) وترفع فى النهاية محصول الأسماك.

استخدمت أسماك البلطى النيلى والمبروك الفضى والقراميط بنظام الاستزراع المختلط. واستخدمت اليوريا (٤٦% ن) وفرشة الدواجن (٣,٤% ن و ١,٧٥% فو) لتسميد الأحواض لتحقيق التركيزات المطلوبة من المواد المغذية وذلك من خلال طريقتين للتسميد الأولى طريقة الإضافات الثابتة وفيها يتم وضع ٢٠ كجم ن و ٥ كجم فو/هكتار/اسبوع وذلك لمدة ستة أشهر (Fixed-6) أو لمدة ثلاثة أشهر (Fixed-٣)، أما الطريقة الثانية فكانت التسميد عند الحاجة بعد تحليل مياه الأحواض للوصول إلى تركيز ٢ ملجم ن و ٠,٥ ملجم فو/لتر لمدة ستة أشهر (Demand-6) أو لمدة ثلاثة أشهر (Demand-3)، أما المعاملة الخامسة فكانت الكنترول (بدون تسميد).

علفت كل الأحواض فى كل المعاملات بعد ثلاثة أشهر من بدء الاستزراع وبنسبة ٥٠% فقط من مستوى الشبع. وتم قياس خصائص جودة المياه الاتية اسبوعياً: الاكسجين الذائب، درجة الحرارة، قرص الشفافية، درجة الحموضة، نيتروجين الأمونيا الكلى، نيتروجين النترات، الفوسفور المذاب، كلوروفيل "أ"، القلوية الكلية و العسر الكلى. وكلها كانت فى المستوى المناسب لنمو الأسماك.

سجلت معاملة Fixed-6 أعلى إنتاجية سمكية (٤,٨ طن/هكتار) وكذلك أعلى درجات البلطى (الوزن الفردى) تبعتها المعاملات التالية على الترتيب Fixed-3، Demand-6، Demand-3، بينما جاءت معاملة الكنترول فى ذيل القائمة وكان العائد من المعاملات الخمسة السابقة على النحو التالى ٥٧,٥٤، ٢٣,٣٦، ٢١,٢٥، ٢٠,٤٣ و ١١,٨٧ ألف جنيه / هكتار على الترتيب. كما كانت معاملة Fixed-6 صاحبة أعلى تكاليف إنتاج (٢٠,٠٥ ألف جنيه/هكتار) بينما كانت أقل التكاليف فى معاملة الكنترول (١٥,٠٩ ألف جنيه/هكتار). ولم تكن هناك فروق معنوية بين معاملتى الإضافة الثابتة لا فى صافى الربح (٧,٥ و ٥,٣٣ ألف جنيه/هكتار) ولا فى نسبة العائد على التكاليف (٠,٣٧ و ٠,٢٩) لمعاملتى Fixed-6 و Fixed-3 على الترتيب.

أوضحت هذه التجربة أن استخدام الأسمدة لمدة ستة أشهر ربما ينتج أسماكاً كبيرة الحجم وكذلك إنتاج سمكى أكبر منه عند استخدامها لمدة ثلاثة أشهر فقط. ولكن من وجهة النظر الاقتصادية لم يكن هناك فرق بينهما ومن وجهة النظر البيئية (خصائص جودة المياه) كان استخدام الأسمدة لمدة ثلاثة أشهر فقط أفضل. لذا فإن هذه الدراسة توصى باستخدام طريقة الإضافة الثابتة لمدة ثلاثة أشهر مع تغذية الأسماك ب ٥٠% فقط من مستوى الشبع بعد مرور الثلاثة أشهر الأولى بدون تغذية (معاملة Fixed-3). هذا سوف يوفر أحمال بيئية تصل لأكثر من ٤ أطنان من فرشة الدواجن/هكتار و حوالى ٧٠ كجم يوريا/هكتار مع الحصول على نفس الربح تقريباً. مما يعطى المزارع السمكى طريقة تسميد يستطيع بها الحصول على أعلى ربح بتكاليف أقل نسبياً عن طريق تخفيض المدخلات (الأسمدة والأعلاف) وبالتالى إنشاء مزارع سمكية صديقة للبيئة.