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# Effect of stocking density and feeding rate on growth performance and total production of Nile Tilapia, *Oreochromis niloticus* reared in earthen ponds

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## ABSTRACT

The present study aimed to analyze the effect of stocking densities and feeding rates on growth performance and fish production of *O. niloticus* reared in earthen ponds. This experiment was conducted for 7 months extended from May to November, 2016 in 12 earthen ponds at Parsik Culture, Idko, Behira Governorate, Egypt. Each pond has 2 feddan with an average depth of 1.0 m. Monosex fries of *Oreochromis niloticus* were divided into 4 treatments {$T_1$: stocking density of 6 fish/$m^3$ with a feeding rate of 2.5%; $T_2$: 6 fish/$m^3$ with a feeding rate of 3.5%; $T_3$: 8 fish/ $m^3$ with a feeding rate of 2.5% and $T_4$: 8 fish/ $m^3$ with a feeding rate of 3.5%}, each treatment had 3 replicates.

Results showed that the highest values of growth performance (growth in length, length gain, daily length gain, growth in weight, total weight gain, daily weight gain and specific growth rate) of *O. niloticus* were recorded in $T_3$(high stocking density and low feeding rate). On the other hand, the lowest values of these parameters were recorded in $T_1$ (low stocking rate with low feeding rate).

The best average of food conversion ratio (1.37± 0.025) was recorded in $T_3$ and its a bad average (1.56±0.034) was recorded in $T_2$. Also, the highest average values of protein efficiency, feed efficiency ratio was recorded in T3, and their lowest values were recorded in $T_2$.

The maximum total costs were calculated for $T_4$ and its minimum values were calculated for $T_1$. But, the maximum net income value was obtained from $T_3$ and the minimum net income value was obtained from $T_1$.

**Conclusion:** The growth performance, the best food conversion ratio, protein efficiency ratio and feed efficiency ratio of *O. niloticus* reared in earthen ponds was positively correlated with high stocking density **(**8 fish/ $m^3$) and not correlated with feeding rates (2.5 or 3.5%). The net income of *O. niloticus* cultured in earthen ponds was positively correlated with high stocking density and low feeding rate **(**8 fish/ $m^3$ with a feeding rate of 2.5%).

**Key words:** *O. niloticus*, stocking density, feeding rate, growth performance, earthen ponds, fish production and economical evaluation.

## Introduction

Fish importance as food source is increases with the increase in demands, especially in animal protein. A great attention has been paid to establishment of fish farms. These farms could contribute partially in producing the demanded on animal protein sources consumed by human (El-Kalla *et al*., 2001 and Azab *et al*., 2005). Fish is a vital source of high-quality protein, providing approximately 16% of the animal protein consumed by the world's population (FAO, 1997). It is a particularly important protein source in regions where livestock is relatively scarce. Fish supplies less than 10% of animal protein consumed in North America and Europe, 17% in Africa, 26% in Asia and 22% in China. The FAO estimated that about one billion people worldwide rely on fish as their primary source of animal protein (FAO, 2000).

In Egypt, the total fish production in 2016 was estimated at 1706273 tons of which 80% from aquaculture and 20% natural fisheries. The production of Nile Tilapia, *Oreochromis niloticus* forms 68.6% from the total aquaculture and natural production in Egypt (GAFRD, 2016).

Tilapia is an ideal candidate for warm water aquaculture. They spawn easily in captivity, use a wide variety of natural foods as well as formulated feeds, tolerate poor water quality and grow rapidly at warm temperatures. These attributes, along with relatively low input costs have made tilapia widely cultured freshwater fish in tropical and subtropical countries (EL-Sayed, 1999; Biswas *et al*., 2005; Borgeson *et al*., 2006; Tahoun, 2007;

Tsadik & Bar, 2007; Al-Abssawy, 2010; Abdel-Ghany, 2013; Soliman, 2015; Abdel-Naby *et al*., 2017 and Samir *et al*., 2017).

Fish stocking density is a key factor in the optimal management of fish culture. It affects the amounts of natural food available per fish, and the level of supplemental feeding required (Moore, 1986; Hepher, 1988 and Milsetein 1992).

Rearing density is an important aspect for fish culture, and it is necessary to find a balance between the maximum profit and the minimum incidence of physiological and behavioral disorders (Ashley, 2007 and Ayyat *et al*., 2011). It has been demonstrated that rearing fish at inappropriate stocking densities may impair the growth and reduce immune competence due to factors such as clustering stress and the deterioration of water quality, which can affect both the feed intake and conversion efficiency of the fish (Ellis *et al*., 2002). However, it is not clear whether the performance of fish is influenced by the stress caused by suboptimal water quality parameters associated with high densities (e.g., low oxygen level, elevated ammonia or carbon dioxide levels) or by the crowding experienced due to high density, which could cause aggressive behavior (Abdel-Tawwab 2012).

The determination of stocking density for cultured tilapia is essential for the maximization of its production, profitability and sustainability. This is because stocking density is one of the factors that could potentially affect fish survival (Houde, 1977) and production performance (Luz & Zanibonifilho, 2002), so it must be considered when determining the economic profitability of production systems (Gomes *et al*., 2000). Furthermore, the use of the appropriate density is a commercially beneficial operation, focusing on maximizing the utilization of the rearing system, water and financial resources (Fairchild & Howell, 2001).

Also, the growth and production of fish depend on regulating the quantity of feeds required to produce the maximum growth and this can be achieved by variations in the feeding rates (Kheir & Mohamed, 2001).

Therefore, the present investigation aimed to analyze the effect of stocking densities and feeding rates on growth performance and production of Nile Tilapia, *Oreochromis niloticus* cultured in earthen ponds.

## Materials and Methods

### Fish experiment:

This experiment was conducted in twelve earthen ponds at Idko, Behira Governorate, Egypt. The ponds have the same area of about 2 feddan with an approximately average depth of 1.0m and filled in with agriculture drainage water from El Khairy drainage. The experiment period was conducted for 7 months extended from May to November, 2016 (214 days). Monosex of *Oreochromis niloticus* fries were cultured in these earthen ponds with different stocking densities {($T_1$&$T_2$): stocking density of 6 fish/$m^3$; ($T_3$&$T_4$): stocking density of 8 fish/ $m^3$}. Each treatment had three replicate. Fish were fed twice daily, six days a week on diet containing 18% protein at feeding rates of 10%, 7%, 5% and 4% of fish biomass during May, June, July and August, respectively. The feeding rates were changed to 2.5% of fish biomass in treatments $T_1$&$T_3$ or 3.5% of fish biomass in treatments $T_2$&$T_4$ during September, October and November respectively. The feeding rate adjusted at monthly intervals, where the fish were randomly sampled by dragging a net in the ponds, weighed; and the average fish weight was obtained and the monthly feed intake (g feed/fish/month) was calculated for each group. Half of the water volume, for all earthen ponds, was weekly replaced.

The environmental factors in all treatments of the experiment were recorded in ranges as the following: salinity (1.634 to 2.10 ‰), pH (8.3 to 8.39), dissolved oxygen (6.2 to 7.61 mg/l) and water temperature (19.46 to 30.73 °C).

**Measurements of growth performance and feed utilization parameters:**

Final body length (L), length gain (LG), daily length gain (DLG), growth in length (GL), final body weight (W), total weight gain (WG), daily weight gain (DWG), growth in weight (GW), specific growth rate (SGR), feed intake (FI), food conversion ratio (FCR) in *Oreochromis niloticus* were determined according to Castell & Tiews, (1980) and Tacon (1987). Protein efficiency ratio (PER) and feed efficiency (FE) were determined according to Cho and Kaushik (1985) as following:

**Final body length (cm):**

The fish length (standard length) of each sampled fish, from each pond, was recorded at the end of the experiment.

**Total length gain (cm/fish):**

The length gain is calculated from the following equation:

$$L\ G = L_F - L_I$$

Where: $L_F$= average of final fish length (cm).

$L_I$ = average of initial fish length (cm).

**Daily length gain (µ/fish/day):**

The average daily length gain is calculated from the following equation:

DLG = total length gain (µ)/ duration period (days)

**Growth in length (%):**

The growth in length is calculated from the following equation:

$$GL = \{LG / L_I\} \times 100$$

Where: LG= Total length gain (cm).

$L_I$ = Initial average length of fish (cm).

**Final body weight (g):**

The fish weight of each sampled fish, from each pond, was recorded at the end of the experiment.

**Total weight gain (g/fish):**

The total weight gain is calculated from the following equation:

$$WG = W_F - W_I$$

Where: $W_F$ = average of final fish weight (g).

$W_I$ = average of initial fish weight (g).

**Average daily weight gain (mg/fish/day):**

The average daily weight gain is calculated from the following equation:

DWG = total weight gain (mg)/ duration period (days)

**Growth in weight (%):**

The growth in weight is calculated from the following equation:

$$GW = \{WG / W_I\} \times 100$$

Where: WG= Total weight gain (g).

$W_I$ = average of initial fish weight (g).

**Specific growth rate (%/day):**

The specific growth rate is calculated from the following equation:

$$SGR = (Ln\ W_F - Ln\ W_I) * 100 / \text{duration period}$$

Where:

Ln= Natural log.

$W_F$ = average of final fish weight (g).

$W_I$ = average of initial fish weight (g).

**Total Feed intake (g/fish):**

The total feed intake is calculated from the following equation:

FI = ∑{monthly average fish weight*(daily feeding rate *25 days)}

**Food conversion ratio:**

FCR = feed intake (g)/ total weight gain (g)

**Protein efficiency ratio (PER):**

PER = total weight gain (g)/ protein intake (g)

Protein intake (PI) = feed intake (g) * Protein% in the diet/100

**Feed efficiency (FE):**

FE = weight gain (g) / feed intake (g)

**Economic evaluation:**

The total coasts were calculated by the following equation:

Total costs (LE) = feed cost (LE) + fish fry cost (LE) + operation cost (LE)

Where:

Feed cost (LE) = FI (g/fish) * No of fish * Feed price (LE/Kg)

Fish fry cost (LE) = No. of fries * Price of fish fry (LE/1000 fry)

Operation costs include workers salary, electricity, service…etc. All experimental diet costs, fish fry cost and operation cost were calculated according to the prices in Egyptian market during the study period.

The economic evaluation was calculated by the following equation:

Net income (LE) = Total fish price (LE) - Total costs (LE)

Where:

Total fish price (LE) = ∑ fish weight of each grade (Kg) * Fish price of each grade (LE/Kg)

Fish weight of grade (Kg) = Total fish weight (Kg) * % of fish grade

**Statistical analysis:**

Results were expressed in Tables as average ± S.D. Statistical analysis and graphics of data was conducted by using Microsoft Excel and Minitab software, Ver. 5.2 under windows programs.

## Results

**Growth in length (cm & %):**

Results in Tables (1&2) and Figure (1) showed that, *Oreochromis niloticus* cultured in earthen ponds with different stocking densities and feeding rates were varied in body length. The highest average body length (21.93±1.97cm) was recorded in $T_3$ (stocking density of 8 fish/ $m^3$ with feeding rate of 2.5%), representing the highest growth in length (795.24± 80.48%). While, the lowest average body length (19.23±3.86cm) was recorded in $T_1$ (stocking density of 6 fish/ $m^3$ with feeding rate of 2.5%), representing also the lowest growth in length (700.0± 157.36%).

**Length gain (cm/fish):**

Results in Table (2) and (Figure1) showed that *O. niloticus* cultured in ponds with different stocking densities and feeding rates were greatly varied in length gain. The greatest average of length gain (19.48± 1.97cm) was recorded in $T_3$ and the lowest average of length gain (17.15± 3.86 cm) was recorded in $T_1$.

**Average daily length gain (µ/fish/day);**

The greatest average of length gain (910.4± 92.14 µ/fish/day) was recorded in $T_3$ and the lowest average of length gain (801.4± 180.16µ/fish/day) was recorded in $T_1$ (Table 2 and Figure 1).

**Growth in weight (g& %):**

Results in Tables (3&4) and Figure (2) showed that, *O. niloticus* cultured in earthen ponds with different stocking densities and feeding rates exhibited great variations in body weight (W). The highest average body weight (224.8±77.1g) was recorded in $T_3$. While, the lowest average body weight (166.5±88.4g) was recorded in $T_1$. Also, the highest ratio of growth in weight (44860± 15424%) was recorded in $T_3$; while the lowest ratio of growth in weight (33200± 17600%) was recorded in $T_1$.

**Total weight gain (g/fish):**

The greatest weight gain (224.3± 77.12g) was recorded in $T_3$ and the lowest weight gain (166.05± 88.4g) was recorded in $T_1$ (Table 4 and Figure 2).

**Average daily weight gain (mg/fish/day):**

Results in Table (4) and (Figure 2) showed that, *O. niloticus* cultured in earthen ponds with different stocking densities and feeding rates were greatly varied in daily weight gain (DWG). The greatest weight gain (1048.1± 360.4 mg/fish/day) was recorded in $T_3$ and the lowest weight gain (775.7± 413.1 mg/fish/day) was recorded in $T_1$.

**Specific growth rate (% / day):**

The specific growth rate (SGR) of *O. niloticus* was nearly varied with the variation in stocking densities and feeding rates. The highest average specific growth rate (2.81± 0.17%) was recorded in $T_3$, and the lowest average specific growth rate (2.64± 0.27%) was recorded in $T_1$ (Table 4).

**Total feed intake (g/fish) and Food conversion ratio:**

Results in Table (4) showed that, the highest average feed intake (305.87± 14.85g) was recorded in $T_2$(stocking density of 6 fish/ $m^3$ with feeding rate of 3.5%) and the lowest average of feed intake (245.33± 10.10g) was recorded in $T_1$(stocking density of 6 fish/ $m^3$ with feeding rate of 2.5%). Accordingly, the best food conversion ratio (1.37± 0.025) was recorded in $T_3$, followed by $T_1$(1.47±0.029).

**Protein efficiency ratio (g) and Feed efficiency ratio:**

Results in Table (4) showed that, the stocking densities and feeding rates affected on protein efficiency ratio of *O. niloticus*. The highest protein efficiency ratio (4.20g) was recorded in $T_3$ and the lowest protein efficiency ratio (3.56g) occurred in $T_2$. The highest feed efficiency ratio (0.76) was also recorded in $T_3$ and its lowest value (0.64) occurred in $T_2$.

**Table (1):** Total fish length (average ± SD) of *O. niloticus*, for different stocking densities and feeding rates, at different treatment periods

| Months | Feed ratio (Treatments) | | | |
|---|---|---|---|---|
| | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** |
| Zero-day (Initial length) | **2.45± 0.07** | **2.45± 0.07** | **2.45± 0.07** | **2.45± 0.07** |
| May | 4.83± 0.38 | 5.42± 0.51 | 5.12± 0.66 | 5.09± 0.53 |
| June | 7.76± 0.76 | 8.34± 1.03 | 7.83± 1.32 | 7.79± 1.06 |
| July | 9.76± 1.06 | 9.30± 3.00 | 9.88± 0.76 | 9.35± 1.25 |
| August | 16.04± 1.34 | 16.13± 1.52 | 16.37± 2.12 | 15.87± 2.04 |
| September | 17.2± 2.73 | 17.91± 2.44 | 17.18± 3.27 | 16.59± 3.14 |
| October | 18.46± 1.57 | 20.08± 2.27 | 21.0± 3.86 | 19.32± 2.69 |
| November (Final length) | **19.23± 3.86** | **20.30± 3.00** | **21.93± 1.97** | **20.77± 2.19** |

Table (2): Growth in length (cm) of *O. niloticus*, for different stocking densities and feeding rates, at the end of experimental period

| **Growth items** | | **Feed ratio (Treatments)** | | | |
|---|---|---|---|---|---|
| | | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** |
| Initial length (cm) | Min – max | 2.40 – 2.50 | 2.40 – 2.50 | 2.40 – 2.50 | 2.40 –2.50 |
| | average ± SD | 2.45± 0.07 | 2.45± 0.07 | 2.45± 0.07 | 2.45± 0.07 |
| Final length (cm) | Min – max | 13.5 – 26.0 | 17.5 – 24.5 | 19.5 – 25.5 | 16.5 – 24.0 |
| | Average ± SD | 19.6± 3.86 | 20.3± 3.00 | 21.93± 1.97 | 20.77± 2.19 |
| Length gain (cm/fish) | Average ± SD | 17.15± 3.86 | 17.85± 3.00 | 19.48± 1.97 | 18.32± 2.19 |
| Daily length gain (µ/fish/day) | Average ± SD | 801.4±180.16 | 834.11±140.13 | 910.4±92.,14 | 855.92±102.56 |
| Growth in length (%) | Average ± SD | 700.0± 157.36 | 728.57± 122.4 | 795.24± 80.48 | 747.62± 89.58 |

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**Table (3):** Total fish weight (Mean ± SD g) of *O. niloticus*, for different stocking densities and feeding rates, at different treatment periods.

| **Months** | **Feed ratio (Treatments)** | | | |
|---|---|---|---|---|
| | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** |
| Zero-day (Initial weight) | 0.45± 0.06 | 0.45± 0.06 | 0.45± 0.06 | 0.45± 0.06 |
| May | 4.32± 0.99 | 5.21± 1.71 | 5.58± 1.58 | 4.43± 1.71 |
| June | 8.24± 2.14 | 9.91± 3.42 | 10.65± 3.16 | 8.37± 3.43 |
| July | 15.64± 4.77 | 14.10± 5.37 | 16.57± 3.82 | 14.28± 5.22 |
| August | 75.14± 11.1 | 78.37± 11.6 | 80.1± 14.78 | 78.62± 19.7 |
| September | 99.4± 35.14 | 111.2± 46.1 | 100.7± 48.2 | 97.1± 42.98 |
| October | 145.9± 26.5 | 165.9± 29.1 | 195.6± 45.7 | 160.3± 39.9 |
| November (Final weight) | 166.5± 88.4 | 196.8± 92.9 | 224.8± 77.1 | 197.0± 68.5 |

Table (4): Weight growth performance items of *O. niloticus*, for different stocking densities and feeding rates, at the end of the experimental period

| Growth items | Treatments | | | |
|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| **Initial weight (g)** | 0.45± 0.06 | 0.45± 0.06 | 0.45± 0.06 | 0.45± 0.06 |
| **Final weight (g)** | 166.5± 88.4 | 196.8± 92.9 | 224.8± 77.1 | 197.0± 68.5 |
| **Weight gain (g/fish)** | 166.05± 88.4 | 196.3± 92.87 | 224.3± 77.12 | 196.5± 68.45 |
| **Daily weight gain (mg/fish/day)** | 775.7± 413.1 | 917.3± 433.9 | 1048.1± 360.4 | 918.2± 319.84 |
| **Growth in weight (%)** | 33200± 17600 | 39260± 18573 | 44860± 15424 | 39300± 13689 |
| **Specific growth rate (%/day)** | 2.64± 0.27 | 2.74± 0.24 | 2.81± 0.17 | 2.76± 0.17 |
| **Feed intake (g/fish)** | 245.33± 10.10 | 305.87± 14.85 | 296.33± 17.62 | 302.33± 12.95 |
| **Feed conversion ratio** | 1.47± 0.029 | 1.56± 0.034 | 1.37± 0.025 | 1.54± 0.116 |
| **Protein efficiency ratio (PER)** | 3.76 | 3.56 | 4.20 | 3.61 |
| **Feed efficiency (FE)** | 0.68 | 0.64 | 0.76 | 0.65 |

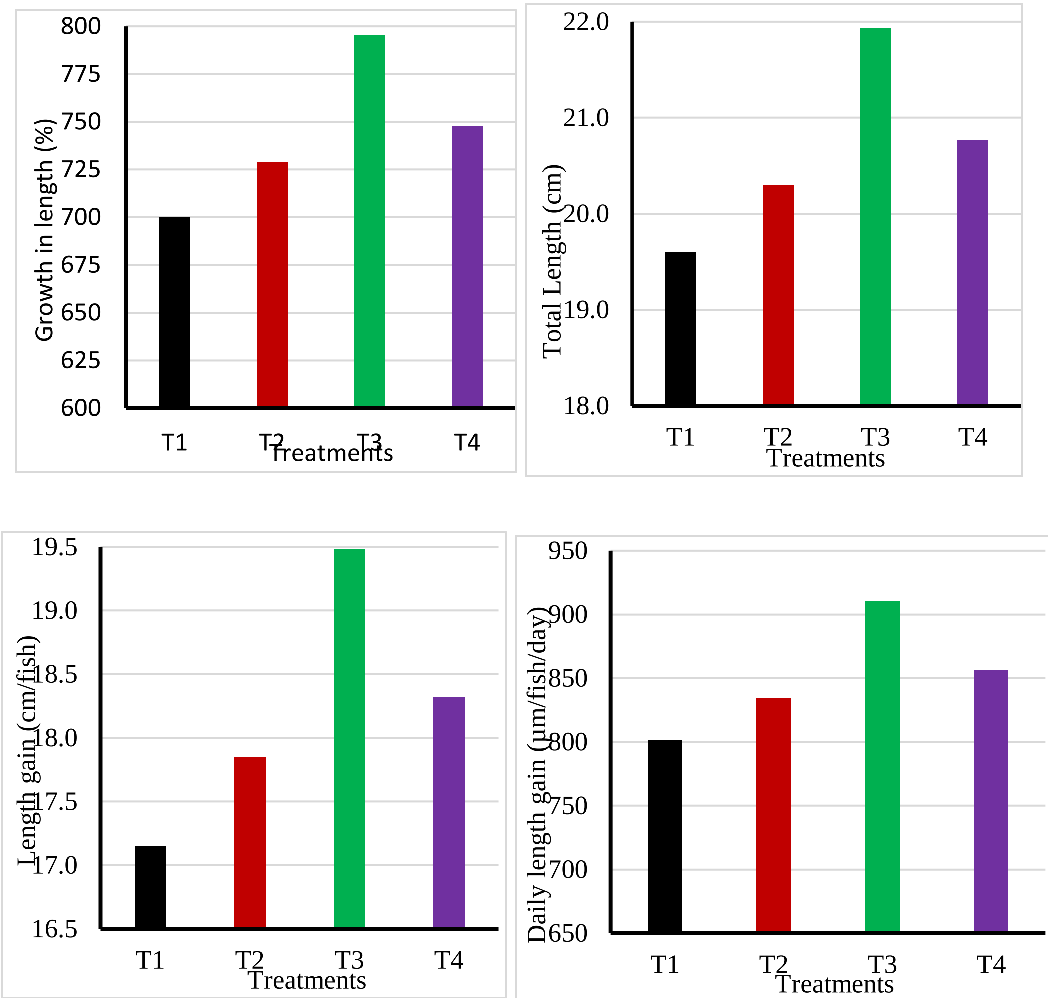


**Figure (1):** Growth performance parameters in length (Final length, cm; growth in length, %; length gain, cm/fish and daily length gain, µm/fish/day) of *O. niloticus*, for different stocking densities and feeding rates, at the end of experiment

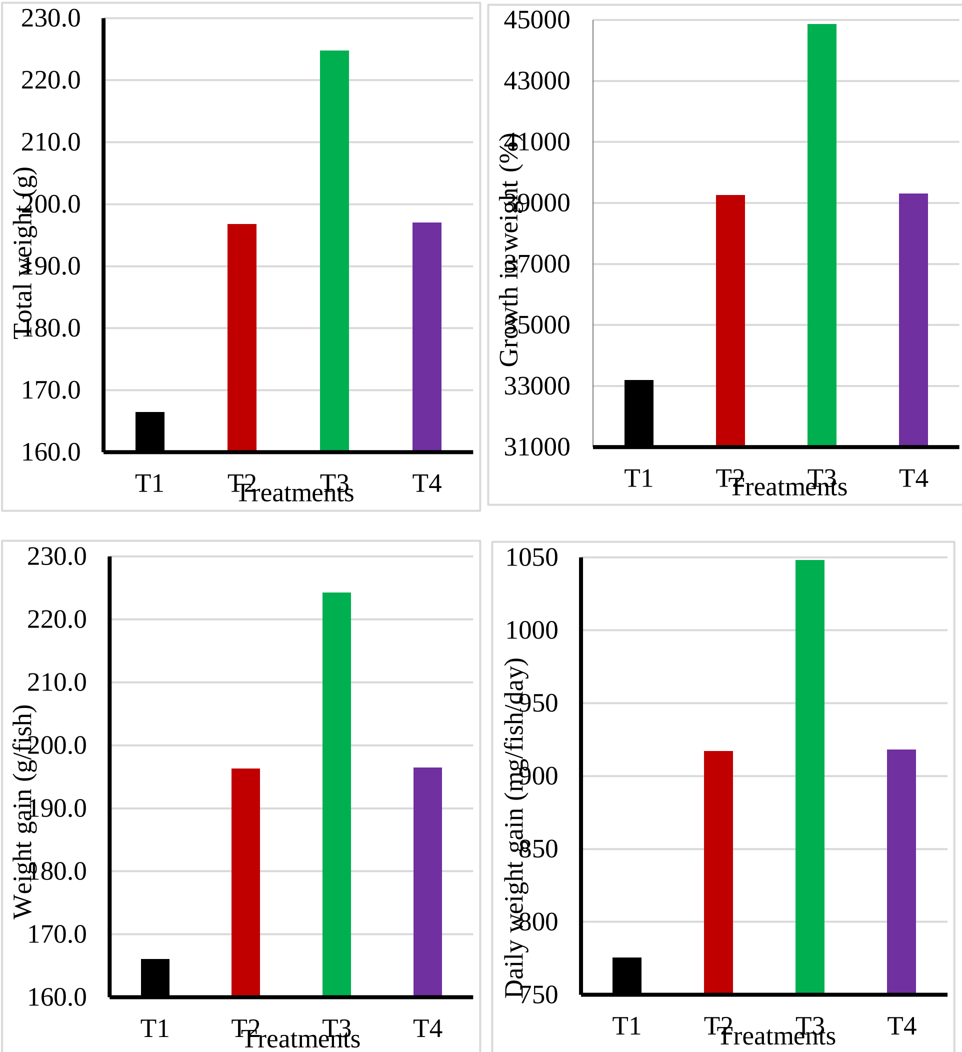


Figure (2): Growth performance parameters in weight (total weight, g; growth in weight, %; weight gain, g/fish and daily weight gain, mg/fish/day) of *O. niloticus*, for different stocking densities and feeding rates, at the end of experiment

## Economical evaluation*:*

Results in Table (5) indicated that, the highest feed intake in the experiment of Nile Tilapia, *Oreochromis niloticus* (59861 kg) was recorded at $T_4$. It gradually decreased to58673 kg at $T_3$, followed by 45880 kg at $T_2$ and reached to its lowest value (36800 kg) at $T_1$.

The total coasts including feed cost (LE), fish fry cost (L.E) and operation cost (L.E). The maximum total costs (319175 L.E) were calculated for $T_4$.They gradually decreased to 313829 L.E for $T_3$, followed by 251460 L.E for $T_2$ and reached to their minimum values (210600 L.E) for $T_1$ (Table 5).

The total income (LE)is calculated by the summation of the prices of fish grads (I, II & III). The maximum total income (501904 LE) was obtained from $T_3$. It decreased gradually to 433384 LE for $T_4$, followed by 329402 LE for $T_2$and reached to its lowest total income of 274115 LE was obtained from$T_1$ (Table 5).

Results showed that the maximum net income value of 188075 LE was obtained from $T_3$; followed by 114209 LE and 77942 LE for $T_4$ and $T_2$, respectively and reached to the minimum net income value (63515 LE) from $T_1$(Table 5).

**Table (5):** The economic evaluation of *O. niloticus* production, for different stocking densities and feeding rates during the period of experiment

| | Subject | | Unit price (LE) | Feed ratio (Treatments) | | | |
|---|---|---|---|---|---|---|---|
| | | | | $T_1$ | $T_2$ | $T_3$ | $T_4$ |
| Costs | Feed intake (Kg) | | 4.5 | 36800 | 45880 | 58673 | 59861 |
| | Feed cost (LE) | | | **165600** | **206460** | **264029** | **269375** |
| | Fish fry used (1000 fries) | | 100 | 150 | 150 | 198 | 198 |
| | Fish fry cost (LE) | | | **15000** | **15000** | **19800** | **19800** |
| | Operation cost (LE) * | | | 30000 | 30000 | 30000 | 30000 |
| | Total costs (LE) | | | **210600** | **251460** | **313829** | **319175** |
| Income | Total fish weight (Kg) | | | 24975 | 29520 | 44510 | 39000 |
| | Fish grades (%) | I | 12 | 63.48 | 59.79 | 66.64 | 58.78 |
| | | II | 10 | 21.10 | 38.35 | 30.49 | 38.10 |
| | | III | 8 | 15.42 | 1.86 | 2.88 | 3.11 |
| | Total income (LE) | | | **274115** | **329402** | **501904** | **433384** |
| Net income (LE) | | | | **63515** | **77942** | **188075** | **114209** |

*Operation costs include workers, electricity, service…etc.

## Discussion

In the present study, the maximum growth performance averages for growth in length, length gain, daily length gain, growth in weight, total weight gains, daily gain and specific growth rate of *Oreochromis niloticus* were recorded in $T_3$ and $T_4$ (high stocking density) and the lowest averages were occurred in $T_1$ and $T_2$ (low stocking density).These results disagreed that obtained by Soltan (1998), El-Sayed (2004), Liti *et al.* (2005), Miguel *et al.* (2005), Hassan *et al.* (2006) and Abdel-Tawwab *et al.* (2014). They reported that the growth of *O. niloticus* decreased with increasing stocking rate, but the net yield was increased. Also, Yousif (1996) and Ayyat *et al.* (2011) mentioned that growth, final body weight, daily weight gain and production of fish are negatively correlated with increasing the stocking density. They concluded that these results may due to over population in fish ponds and the high competition on food available.

The decline in the growth rate with increasing of stocking density may be due to a social stress or chronic stress response, which may impair fish growth, due to the mobilization of dietary energy by the physiological alterations provoked by the stress response (Klanian & Adame, 2013). In the present study, this problem was not found, because the present of natural phytoplankton in ponds.

In fish farming practices, best growth rate and high production are usually attained at a particular stocking density, beyond which the growth rate is considerably reduced and below which the fish do not grow as well as or better than those at the optimal stocking rate. The optimal stocking density for cultured fish is dependent on the overall cultivation strategy and is thus influenced by the desired final market product, market size and type grow-out technique (Parsons and Dadswell, 1992).

On the other hand, El-Sayed (2002), El-Saidy & Gaber (2005) and Khattaby (2007) mentioned that the final weight, weight gain, daily gain and specific growth rate of the tested species increased significantly with increase in feeding levels. Kheir & Mohamed (2001) mentioned that the final body weight, growth rate, specific growth rate, normalized biomass index and feed conversion ratio of both *O. niloticus* and *S. galilaeus* fingerlings were increased with increases of feeding rates.

The present study was in disagreement with Ayyat *et al.* (2011), who mentioned that the food conversion ratio was higher at the higher stocking density. In the present study, the highest average feed intake was recorded in $T_2$ (low stocking density and high feeding rate), which contain the minimum average value in the abundance of phytoplankton species (Azab *et al*., 2018). The best feed conversion ratio, protein efficiency and feed efficiency ratio were recorded in $T_3$ (high stocking density and low feeding rate). This best food conversion ratio with higher in protein and feed efficiency, may be due to increase of natural food in this treatment. This result was agreement with Teichert-Coddington (1996) and El-Sayed (2002). They noticed that the feed conversion ratios decreased curvilinear as the rate of stocked *Tilapia* increased. Bakeer (2006) indicated that the feed conversion ratio (FCR) improved by decreasing the feeding levels.

In the present study, the maximum net income was recorded in high stocking density with low feeding rate ($T_3$). This result was matching with Teichert-Coddington (1996); who noticed that the total production increased as the rate of stocked *Tilapia* increased. Bakeer (2006) indicated that the low feeding level (2%) had decreased feed cost and increased the profit index than all other tested feeding levels.

On the other hand, Abdel-Hakim *et al.* (2006) mentioned that the total fish production increased in almost linear manner with each increase in feeding levels. Ayyat *et al.* (2011) mentioned that the highest income to the system was recorded from the group fed high protein, reared at low stocking density and fed diets supplemented with 10 mg vitamin B5.

**Conclusion**: The growth performance, the best food conversion ratio, protein efficiency ratio and feed efficiency ratio of *Oreochromis niloticus* reared in earthen ponds was positively correlated with high stocking density (8 fish/ $m^3$) and not correlated with feeding rates (2.5 or 3.5%). The net income of *O. niloticus* cultured in earthen ponds was positively correlated with high stocking density and low feeding rate (8 fish/ $m^3$ with feeding rate of 2.5%).

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## تأثير كثافة التسكين ومعدل التغذية علي أداء النمو والإنتاج الكلى لأسماك البلطى النيلى (أوريوكرومس نيلوتيكس) المرباه فى الأحواض الترابية

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**الملخص العربي**

يهدف هذا البحث إلى إجراء تجربة توضح تأثير كثافة التسكين ومعدل التغذية علي أداء النمو وإنتاج أسماك البلطى النيلى (أوريوكرومس نيلوتيكس) المرباه فى الأحواض الترابية.

تم إجراء التجربة بمزرعة برسيق بمنطقة ادكو، محافظة البحيرة، جمهورية مصر العربية والتجربة عبارة عن أحواض ترابية ( ١٢حوض) . مساحة الحوض ٢ فدان ومتوسط عمق الحوض ١م. تم تربية زريعة البلطي النيلي وحيد الجنس لمدة ٢١٤ يوم بكثافات تخزينية مختلفة ومعدلات تغذية مختلفة. إستمرت فترة التجربة ٧ شهور من مايو الي نوفمبر٢٠١٦م . المعاملة الاولي ($T_1$) كثافة تخزين ٦ سمكة / م$^3$ بمعدل تغذية ٢,٥% . المعاملة الثانية ($T_2$) كثافة تخزين ٦ سمكة / م$^3$ بمعدل تغذية ٣,٥% . المعاملة الثالثة ($T_3$) كثافة تخزين ٨ سمكة / م$^3$ بمعدل تغذية ٢,٥% . المعاملة الرابعة ($T_4$) كثافة تخزين ٨ سمكة / م$^3$ بمعدل تغذية ٣,٥% . وكان لكل معاملة ثلاث أحواض ترابية . تم تغذية الأسماك مرتين يومياً، ستة أيام في الاسبوع علي نظام غذائي يحتوي علي ١٨% بروتين بمعدل تغذية ١٠% ' ٧%' ٥% ' ٤% من الكتلة الحية خلال مايو ويونيو وأغسطس علي التوالي .تم تغيير معدلات التغذية فى الفترة من سبتمبر إلى نوفمبر وكان معدل التغذية ٢,٥ % من الكتلة الحية للأسماك في المعاملة الاولي ($T_1$)، المعاملة الثالثة ($T_3$) . وكان معدل التغذية ٣,٥% من الكتلة الحية في المعاملة الثانية ($T_2$) ' المعاملة الرابعة ($T_4$). وتم تغيير حجم نصف المياة لجميع الأحواض كل أسبوع.

أظهرت النتائج أن أعلي قيم أداء النمو (نمو في الطول والوزن ومجموع الوزن الكلي والزياده اليوميه في الوزن ومعدل النمو الخاص للبلطي النيلي سجلت فى المعاملة الثالثة $T_3$ (أعلى كثافة وأقل معدل تغذية). وعلى الجانب الاخر سجلت أقل قيم لهذه المعاملات فى المعاملة الاولى $T_1$(أقل كثافة وأقل معدل تغذية). وكذلك تم تسجيل أفضل معدل تحول غذائي وكفاءة البروتين في المعاملة الثالثة $T_3$ وأقل قيمة فى المعاملة الثانية $T_2$.

أوضحت النتائج أن أعلى تكلفة كلية سجلت فى المعاملة الرابعة $T_4$ وأقل تكلفة كانت فى المعاملة الأولى $T_1$. ولكن أعلى صافى ربح سجل في المعاملة الثالثة $T_3$ (أعلى كثافة وأقل معدل تغذية) وأقل صافى ربح سجل في المعاملة الأولى $T_1$ (أقل كثافة وأقل معدل تغذية).

**الخلاصة:**

يرتبط أداء النمو وأفضل نسبة تحويل غذائي ونسبة كفاءة البروتين ونسبة كفاءة التغذية لأسماك البلطي النيلي ارتباطا إيجابيا بكثافة التسكين العالية (٨ سمكة / م$^3$) وغير مرتبطه بمعدلات التغذية (٢,٥% أو ٣,٥%). صافي الربح مرتبط بشكل إيجابي بكثافة تسكين عالية ومعدل تغذية منخفض (٨ سمكة / م$^3$مع معدل تغذية ٢,٥%).