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# EFFECT OF STOCKING DENSITY IN INTENSIVE FISH CULTURE SYSTEM ON GROWTH PERFORMANCE, FEED UTILIZATION AND ECONOMIC PRODUCTIVITY OF NILE TILAPIA (*Oreochromis niloticus* L.) REARED IN HAPAS

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## *ABSTRACT:*

This study was carried out to evaluate the effect of varying stocking densities in intensive Nile tilapia culture system on the growth performance, feed utilization, and economic productivity of Nile tilapia (*Oreochromis niloticus* Linnaeus 1757) reared in Brackish water ponds (average depth, 1.7 m) of Rayyan region, Fayoum Governorate, Egypt, for a period of 6 months. Tilapia fingerlings with a mean initial weight of 20 ± 2.4 g were randomly stocked at 100, 200, 300 and 400 fingerling/$m^3$ and fed on a commercial diet (27% Crude Protein). Each treatment was carried out in 3 hapas representing 4 treatment.

Results revealed that there were significant differences ($P > 0.05$) in final weight, weight gain, daily gain, specific growth rate, feed conversion ratio (FCR) among all treatments studied. However there were insignificant differences ($P < 0.05$) in survival rate. Results show also that as stocking density increased, the growth performance values decreased indicating an inverse relationship between stocking density and growth parameters. The stocking density of 200 fingerling /$m^3$ with a final weight of 315 g per fish, feed conversion ratio of 1.74, survival of 92.90% and fish production of 58.49 kg/$m^3$ was considered best on the basis of the profit index of 1.35 compared with the range of 1.26 to 1.32 for the other three treatments.

Under the experimental conditions Nile tilapia reared at 200 fish/$m^3$ was the best regarding to profit index and relatively high growth parameters

**Key words:** Nile tilapia, stocking density, growth performance, feed utilization and economic evaluation

## INTRODUCTION:

Tilapia has become popular for farmers as it is easy to culture and there is a good demand for this fish in the market. Moreover, tilapias (*Oreochromis spp.*) adapt well to the local environment and local feed, and have high productivity (Sorphea *et al.*, 2010). For many years, tilapia has drawn attention of the farmers for their better growth performance. It rank high in global aquaculture production after carps (FAO, 2012). Tilapias are a hardy species produced by several culture methods under a wide range of environmental conditions in tropical and subtropical regions in developing countries and can be cultured in mesh cages that maintain free circulation of water. It ensures flexibility in management practices with easy and low cost of harvesting.

Egypt fish production from aquaculture activities contributed by 70.48% of the total fish production which amounted 1.305 million metric tons, where tilapia acts as 52.68 % of them (GAFRD 2011).

Fish farmers were interested in recent years to increase production per water unit by stocking density of fish as a one of the solutions to increase production.

Stocking density is one of the most important variables in aquaculture because it directly influences survival, growth, behavior, health, water quality, feeding and production. The full utilization of space for maximum fish production through intensive culture can improve the profitability of the fish farm. Fish intensification by increasing stocking density is also found suitable to overcome the problem of land shortage (Khattab *et al.*, 2004).

Growth, survival and yield effects of stocking density on aquaculture are well known for a diversity of species (Garr *et al.*, 2011; Khatune-Jannat *et al.*, 2012; Zhu *et al.*, 2011) and seem to impact production differently. Both growth performance and survival rate which tended to be higher at lower stocking densities in the African catfish, *C.*

*gariepinus* (Hecht *et al.*, 1996), in Thai climbing perch, *Anabas testudineus* (Khatune-Jannat *et al.*, 2012), in Amur sturgeon *Acipenser schrenckii* (Zhu *et al.*, 2011), in silver catfish *Rhamdia quelen* (Pouey *et al.*, 2011) and in Oreochromis spp. (Sorphea *et al.*, 2010), but only survival is higher under same conditions in Oreochromis spp. (Ridha, 2005). In some cases advantage of lower stocking densities is either non-existent, as in channel catfish (Southworth *et al.*, 2009), in Oreochromis niloticus (Osofero *et al.*, 2009) or existent temporary and wanes after sometime so that generally no differences occur across different stocking densities, as in apple snail, *Pomacea paludosa* aquaculture (Garr *et al.*, 2011). Although they may promote competition for food and negatively influence reproductive success via reduced fecundity and egg quality (Tave, 1986), high stocking densities may sometimes have no effect on mortality rates and may actually enhance total fish yield (Khatune-Jannat *et al.*, 2012; Pouey *et al.*, 2011; Sorphea *et al.*, 2010) and lead to higher gross and net return at a lower cost of production (Abou *et al.*, 2007). Where land costs, fresh water, manpower and other facilities are limiting it may be more profitable to adopt higher stocking densities in fish culture (Ridha, 2005).

Generally high density is considered as a potential source of stress, with a negative effect on fish growth rate (Lefrançois *et al*., 2001) and survival and feeding rates (Rowland *et al*., 2006).

The object of the present study was to investigate the influence of different stocking densities of Nile tilapia reared in hapas on growth performance and total yield.

## MATERIALS AND METHODS:

This study was carried out to investigate the effect of stocking density on growth performance and feed utilization of Nile tilapia reared in hapas under natural water condition. The study started on beginning April 2012 till 6/10/2012 for a proximally 189 days in Rayyan region Fayoum Governorate.

Nile tilapia fingerlings were obtained from a private farm from on July 2011. A total of 12000 Nile tilapia fingerlings with an average initial body weight of 20 ± 2.4 g were distributed in 12 hapa 2 × 2×1 m suspended in a big natural pond of agricultural drainage water supplied continually from neighboring and the area of this pond exceed 30 feddan.

The experimental fish were divided into four stocking densities (100, 200, 300 and 400 fish/$m^3$ ) and each density was performed in three hapas replicates. Fish were fed on an artificial diet containing 27% CP at a feeding rate of 3% of body weight twice a day. The proximate analysis of the diet including DM; CP; EE; ash; CF; NFE and gross energy is given in Table 1.

Table (1). Proximate analysis of diet used.

| Items | % |
|---|---|
| DM | 11.15 |
| Crude protein, CP | 27.31 |
| Ether extract, EE | 7.24 |
| Ash | 7.69 |
| Crude fiber, CF | 6.26 |
| Nitrogen free extract. NFE[1] | 51.50 |
| GE, kcal/g* | 4.598 |

1, Calculated by differences * Calculated according to NRC, 1993.

Some fish were weighed every two week in order to adjust the feed amount in the hapa according to the new weight obtained.

Statistical analyses were performed using SPSS (1997), one way analysis of variance were used and significantly between treatments was evaluated at the 5 % probability level.

## RESULTS AND DISCUSSION:

Water quality recorded during the experimental period was 7 – 9 % for salinity, the temperature was stable around 27-28C° oxygen concentration was suitable (6.2-7.0) and pH water was around 7.8 (Table 2), all water quality were within the acceptable levels for best growth of Nile tilapia (Khalfalla *et al*. 2008)

**Table (2). Water quality parameters**

| Month | Temperature | pH | Dissolved oxygen | $NH_4$ |
|---|---|---|---|---|
| May | 27 | 7.8 | 6.3 | 0.019 |
| June | 28 | 7.7 | 6.2 | 0.020 |
| July | 29 | 7.6 | 5.8 | 0.020 |
| August | 30 | 7.6 | 5..2 | 0.019 |
| September | 29 | 7.8 | 6.8 | 0.018 |

### Growth performance:

The effect of stocking density on growth performance parameters is illustrated in Table 3. Significant differences (P<0.05) on final fish weight, weight gain, daily gain and specific growth rate were observed between groups. Final mean weight showed a decreasing tendency with increasing stocking density. The differences between the lowest and highest density were 25% in final weight. Fish reared at the highest densities (400 fish/$m^3$) had the lowest mean growth performance parameters while those of the lowest densities (100 fish/$m^3$) showed the highest means while the densities of 200 and 300 fish/$m^3$ were in between. These results may be due to the presence and abundance of oxygen and large areas for fish movement in low densities and increased competation of food and/or space can negatively affect fish growth. These results are agreement with results obtained by Chakraborty *et al.* (2010) and Yi and Lin (2001) who stated that increased fish biomass of Nile tilapia in cages had a significant negative effect on the final mean body weight. Diana *et al*. (2004) reported that sex reversed Nile tilapia stocked in ponds at a low density showed better growth than at a higher density. The lower growth performance of tilapia at higher stocking density may due to voluntary appetite suppression, more expenditure of energy because of intense antagonistic behavioural interaction, competition for food and living space effects (Diana *et al*., 2004) and increased stress (Ouattara *et al*., 2003). For there more Dambo and Rana (1992) reported that increasing stocking density of Nile tilapia fry might have lead to diminishing social dominance, resulting in lower individual growth rates.

**Table (3). Effect of stocking density on growth performance parameters of Nile tilapia reared in hapas.**

| Parameters | Stocking density/ $m^3$ | | | | SED |
|---|---|---|---|---|---|
| | 100 | 200 | 300 | 400 | |
| Initial mean body weight, g | 18.67 | 20.67 | 18.67 | 22.00 | 0.900 |
| Final mean body weight, g | 361.67[a] | 315.00[b] | 271.67[c] | 268.33[c] | 11.73 |
| Total gain, g (1) | 343.00[a] | 294.33[b] | 253.00[c] | 246.33[c] | 0.062 |
| Daily gain, g (2) | 1.81[a] | 1.56[b] | 1.34[c] | 1.30[c] | 0.031 |
| SGR, % (3) | 1.57[a] | 1.44[b] | 1.42[b] | 1.32[c] | 0.073 |

* Average in the same row having different superscripts differ significantly P≤0.05.
* SED is the standard error of difference
Experimental period = 189 days
(1) = Final weight - Initial weight
(2) = Total gain, g /period in days.
(3) = 100 (ln Final weight-ln Initial weight)/period in days), where ln is the natural log.

## Feed utilization:

Results of the effect of stocking density on feed utilization are presented in Table (3). Significant differences in feed conversion ratio (FCR) was observed between groups. Results of this Table indicated that The FCR improved at stocking density (100 fish/$m^3$) (1.55) than high socking density (400 fish/$m^3$) (2.02) and the difference among both groups was 23% but other densities were in between. These results was near to that obtained by Alhassan *et al.* (2012). Explanation for this can be drawn from Aksungur et al. (2007) who indicated that social interactions through competition for food and/or space can negatively affect fish growth. Moreover, Aksungur et al. (2007) explained that, higher stocking densities leads to increased stress and that resulting increase in energy requirements causing a reduction in growth rates and food utilization.

Results of Table (4) show that the survival rate was insignificantly (P≤0.05) affected with stocking density. It was between 95 – 89.25% independently of the density and the period. Part of the mortalities observed was due to fish crowding and other part after sampling**.** These results agreement with El-Sayed, (2002).

**Table (4). Effect of stocking density on feed utilization of Nile tilapia reared in hapas.**

| Parameters | Stocking density/ $m^3$ | | | | SED |
|---|---|---|---|---|---|
| | 100 | 200 | 300 | 400 | |
| **Feed intake, g/fish** | 531.67 | 511.67 | 486.67 | 498.33 | 20.55 |
| **FCR** | $1.55^c$ | $1.74^b$ | $1.92^a$ | $2.02^a$ | 0.228 |
| **Survival rate%** | 95.00 | 92.90 | 90.39 | 89.25 | 4.99 |
| **Feed intake, kg/hapa** | 201.93 | 380.43 | 528.1 | 711.46 | |

* Average in the same row having different superscripts differ significantly P≤0.05.
* SED is the standard error of difference

## Economic evaluation:

The effect of stocking density on economic evaluation was shown in Table (5). Although increasing final body weight of the lowest density, the net returns of hapa improved with increasing density and the best net returns were observed with the density 400 fish/$m^3$ followed by densities 300, 200 and 100 fish/$m^3$ respectively.

In conclusion regarding to returns and costs (profit index) the best density was 200 fish/$m^3$ than the lowest density (100 fish/$m^3$) and the highest density (400 fish/$m^3$).

**Table (5). Effect of stocking density on economic efficiency of Nile tilapia reared in hapas.**

| Parameters | Stocking density/ $m^3$ | | | |
|---|---|---|---|---|
| | 100 | 200 | 300 | 400 |
| **Costs, L.E. /hapa** | | | | |
| **Feed** | 707 | 1,331 | 1,848 | 2,490 |
| **Fish** | 140 | 280 | 420 | 560 |
| **Other costs** | 300 | 300 | 300 | 300 |
| **Total costs, L.E.** | 1147 | 1911 | 2568 | 3350 |
| **Hapa biomass, kg** | 137.47 | 233.96 | 294.78 | 383.19 |
| **Selling, L.E/ hapa** | 1512.17 | 2573.56 | 3242.58 | 4215.09 |
| **Net returns** | 365.17 | 662.56 | 674.58 | 865.09 |
| **Profit index** | 1.32 | 1.35 | 1.26 | 1.26 |

Price of one kg selling fish = 11 Price of kg feed = 3.5 L.E

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# تأثير كثافة التخزين فى نظام استزراع الاسماك المكثف على مظاهر النمو والاستفادة من الغذاء والانتاجية الاقتصادية للبلطى النيلى المربى فى هابات

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## الملخص العربى

أجريت هذه الدراسة لتقييم تأثير كثافة التخزين المختلفة فى النظام المكثف على مظاهر النمو والاستفادة من الغذاء والإنتاجية الاقتصادية للبلطى النيلى فى حوض مياة شروب (متوسط العمق 1.7 م) بمنطقة الريان- محافظة الفيوم لمدة 6 اشهر. وزعت اصبعيات البلطى بمتوسط وزن 20 ± 2.4 جم عشوائيا بمعدل 100، 200، 300 و 400 اصبعية/م$^3$ وغذيت بعليقة تجارية 27% بروتين. تم تمثيل كل معاملة فى اربع مكررات.

وجدت اختلافات معنوية فى الوزن النهائى والزيادة فى الوزن والزيادة اليومية ومعدل النمو النوعى ومعدل الاستفادة من الغذاء فى جميع المعاملات اما معدل الاعاشة لم يتأثر معنويا. بزيادة كثافة التخزين انخفضت قيم مظاهر النمو مشيرة الى علاقة عكسية. كثافة التخزين 200 سمكة/م$^3$ بمعدل وزن نهائى 315 جم ومعدل تحويل غذائى 1.74 واعاشة 92.9 وانتاج 58.49 كجم/م$^3$ تعتبر احسن الكثافات على اساس مؤشر الربح 1.35 بالمقارنة 1.26-1.32 لباقى المعاملات.

تحت ظروف التجربة يعتبر تربية البلطى النيلى بمعدل كثافة 200 سمكة/م$^3$ افضل نظرا لمؤشرات الربح العالية ومعدلات النمو العالية نسبيا.