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# EFFECT OF CATFISH (*Clarias gariepinus*) STOCKING DENSITIES AS PREDATOR ON POND PRODUCTIVITY OF NILE TILAPIA (*Oreochromis niloticus*) REARED IN EARTHERN POND

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### *Abstract*

The present study was conducted to evaluate the effect of African catfish density on growth performance of Nile tilapia reared on earthen ponds Total fish yield and net of returns under Egyptian commercial farming system. The study was conducted in eight earthen ponds (one feddan each). All ponds were stocked with Nile tilapia (*Oreochromis niloticus*) at a rate of 18,000 fish with initial weight of 50g and African catfish (*Clarias gariepinus)* as predators at densities of 300 (T1); 600 (T2); 900 (t3) and 0 (T4) to represent four treatments at average initial weight of 90g each. Fish were fed on a commercial diet 27% protein at a daily rate of 3% of pond fish biomass. The experiment lasted for 20 weeks. Results were summarized as following:

1- Treatment 2, the final body weigh (FBW) of tilapia increased significantly compared to fish in treatment 3 and insignificant differences among other groups.

2- Averages of total weight gain (TWG) of the treatments T1, T2 and T4 were significantly higher than that of T3.

3- Feed conversion ratio (FCR) ranged between 1.79 (T3) and 2.03 (T1) kg.

4- The highest net returns (LE.10, 924.3) were recorded by T2 followed by T3 T1, and T4 (control group), respectively.

The optimum stocking density of catfish was 600 fish/feddan in terns of growth performance and net return.

**Key words:** Catfish, *Clarias gariepinus*, Nile tilapia, *Oreochromis niloticus*, Predator, Earthen ponds.

## INTRODUCTION

Tilapia is the most cultured fish in Egypt. The total production of tilapia from aquaculture activities accounted 386186 metric tons in and represents about 55.6% of the total fish culture production (GAFRD 2008). The aquaculturists are still trying to increase their tilapia pond productivity through applying modern technologies such as using better feeds quality, management of water quality and to control reproduction to produce fish of good marketable size. Overcrowding in pond culture caused by the prolific reproduction of tilapia results in competition for food and consequent yields composed mainly of small fish of low marketable value. One of the management strategies used to control pond overpopulation is tilapia-snake head (Channa striates) in polyculture (Kaewpaitoon, 1992). The carnivorous snake head not only functions as a biological control, but also increases the economic gain due to its high marketable value. African catfish (*Clarias gariepinus*), which often contaminate tilapia ponds in Egypt, have been recently investigated as a potential aquaculture species. Considerable effort has been made to investigate its reproductive biology and feeding habits (De Groot 1987). It is omnivorous, feeding mainly on detritus, invertebrates and small fish; however the extent of its predatory ability is unknown (Pillay, 1990). The aquaculture of species at lower trophic levels, such as tilapia, presents the greatest potential for production efficiency (Welcomme 1996). However, reproduction of tilapia in confined ponds causes stunted growth due to the shortage of natural food, particularly in semi-intensive culture. Various methods of reproduction control have been applied, such as cage culture, culture with predators, intermittent harvesting, hybridization, induction of sterility fish and production of super-male fish (Mair and Little 1991). However, reproduction control of tilapias culture by predators has bee practiced world wide. Various predatory fish species have been used with varying success in combination with different tilapia species depending on their availability. However, the difficulty in breeding or obtaining predator of the correct size often resulted in limited application of this reproduction control method (Balarin and Hatton, 1979; Penman and McAndrew, 2000).

The proper use of predatory fish is considered as a safe biological method for control tilapia reproduction in ponds without affecting the big size prey. In this respect, Fortes (1980) used Tarpon (*Megalops cyprinoids*) as a predator to control the reproduction of Java tilapia (*Tilapia mossambica*) fingerlings in brackish water ponds. Similarly, McGinty (1983) used peacock bass (*Cichla ocellaris*) as a predator for controlling *Tilapia nilotica* in fertilized ponds. Fischer and Grant (1994) used Tucunare (*Cichla monoculus*) as a native predator for controlling the reproduction of *Oreochromis niloticus*. El Gamal (1992) and El Gamal *et al.* (1998) used Nile perch (*Lates niloticus*) and African catfish (*Clarias gariepinus*) for controlling Nile tilapia reproduction. Yi *et al.* (2004) used snakehead (*Channa striata*) as a predator in polyculture with Nile tilapia to control its reproduction. Wysujack and Mehner (2005) reported that European catfish (*Silurus glanis*) was stocked in a lake for manipulation purpose to reduce unwanted roach and bream population.

Swingle (1960) recommended the use of local predatory species for this purpose. Nile catfish, *Clarias gariepinus* (*C. lazera*) is one of the most abundant and widely distributed fish in the River Nile, its tributaries and lakes (Boulenger, 1907). Otherwise, African catfish is the principal clarid catfish in Africa (Teugels, 1984), where it is widely distributed throughout Africa and has long been considered as one of the most suitable species for culture in Africa (El Bolok and Koura, 1960; DeKimpe and Micha, 1974). It is considered as an excellent pond culture fish in many countries and as the third important commercial fish in Egypt after tilapia and bagrids (Khallaf and Gaber, 1991).

Tawwab (2005) studied the factors affecting predation efficiency of African catfish (*Clarias gariepinus*) for controlling the reproduction of Nile tilapia in four indoor experiments. He reported that the predation rate of Nile catfish at different predator sizes increased at the stocking ratio 1 catfish: 15 tilapia than at the ratio 1:10 (catfish: tilapia). He added that predation rate of large African catfish was greater than small ones. The present investigation aimed to study the effect of stocking density of African catfish as predator in Nile tilapia ponds on pond productivity, thus even in mono-sex Nile tilapia ponds some females are not converted to male and other tilapia species (*Tilapia zillii*) which enter randomly into ponds can cause over population.

## MATERIAL AND METHODS

The present study was carried out in earthen ponds at a private fish farm in Wady El-Rayan area, Fayoum Governorate, Egypt. The farm located 150km South-West of Cairo. The study was conducted during the period from 15.4.2009 to 2.9.2009 which lasted for 20 weeks to represent a complete fish culture season under the Egyptian conditions. The study aimed to evaluate the effect of stocking African catfish (*Clarias gariepinus*) at different densities in reproduction, growth performance, feed utilization, pond productivity and economical efficiency.

**Experimental ponds**

Eight experimental earthen ponds one feddan each (one feddan is 4200m$^2$) with a water depth of 125cm were allotted randomly into four treatments. All treatments were stocked with equal number of tilapia fingerlings; 18 thousand per feddan (Average size 50g.). The catfish were stocked with initial weight of 90g. at all treatments. The first treatment was stocked with 300 fingerlings of catfish (T1), the second treatment (T2) was stocked with 600 fingerlings of catfish, the third treatment received (T3) 900 fingerlings of catfish and fourth treatment has served as control with no stocked of catfish. Water level of the experimental ponds was maintained at 125 cm through the whole experimental period and water losses due to evaporation and seepage were compensated with new water. The ponds water source was from Wady El-Rayyan lake number one. Ponds water was exchanged with new water at a rate of 3 to 5% daily to keep the water quality of the experimental ponds in good condition required for the cultured fish species.

Pond fertilization

Before fish stocked into experimental ponds, the dried ponds were filled to level of 50cm with water then 50kg. of supper phosphate were spread in a liquid form into each pond. The ponds were left without fish for two weeks, thereafter the pond water column was increased to 75cm level and ponds were stocked with the experimental fish. After stocked the fish; the ponds were fertilized for one month with chicken manure at a rate of one cubic meter divided in equal daily portions. Also after two weeks of fish stocked; the ponds were provided with additional 50kg. of super phosphate then fertilizers applications were stopped completely till the end of the experimental period ( 20 weeks) .

Artificial feeds

Fish were fed on a commercial diet containing 27% crude protein at all the growing period. The artificial diet was fed at a rate of 3% of the pond fish biomass daily divided into four equal portions at 8$^{am}$, 11 $^{am}$, 1$^{pm}$ and 3$^{pm}$., respectively.

Experimental fish

The experimental tilapias were purchased from a privet tilapia mono sex hatchery at Fayoum Governorate as fry and over wintered on the experimental farm to have an average initial weight of 50g, while catfish fingerlings were purchased from privet farm at Dakahliya governorate with an initial body weight of 90g. All fish were free of parasites and bacterial diseases.

Water quality parameters

Water quality parameters including water temperature (°C) were determined daily at 11:00am. Water pH (units) was determined also daily at noon using digital pH meter model 68 engineered systems and Designs. Dissolved oxygen was measured daily at 6am using on oxygen meter model WPA 20 Scientific Instruments. Secchi Disk reading (cm) was measured daily using the Seccki disk and water salinity mg/L was determined monthly according to the methods described by APHA (1992).

Records maintained

1- Live body weight

Live body weight (LBW) of individual fish of each treatment (50 fish) were recorded every 2 weeks (14 days). The amount of feed required for the next 14 days was adjusted according to the body weights recorded in the previous fish sample.

2- Weight gain

Weight gain (WG) = final weight – initial weight

3- Total pond fish yield

The total yield/pond was determined at harvesting and fish are graded into four categories i.e. super (1 to 3 fish/kg); grad 1 (4 to 5 fish/kg); grade 2 (up to 7 fish/kg) and grade 3 (10 fish/kg).

**Statistical analysis**

The statistical evaluation of results was performed according to the methods described by Snedecor and Cochran (1976) and Duncan's multiple range test (Duncan 1955) was carried out to detect the significant differences among treatment means.

## RESULTS AND DISCUSSION

### Growth performance

As presented in table (1) averages of initial weight of Nile tilapia was found to be 50g with insignificant differences among the experimental groups indicating the random distribution of tilapias into experimental ponds. The same trend was observed with African catfish where the initial weight was 90g/fish with insignificant differences among the experimental groups.

Table1. Effect of Nile catfish stocking density on fish weights, biomass and total biomass

| Parameter | Unit | T1 | T2 | T3 | Control |
|---|---|---|---|---|---|
| Pond surface area | Fed | 4200 | 4200 | 4200 | 4200 |
| No. of fish stocked | Fish /pond | | | | |
| Tilapia | | 18000 | 18000 | 18000 | 18000 |
| Catfish | | 300 | 600 | 900 | 0 |
| Average initial body weight | G/fish | | | | |
| Tilapia | | 50a±1.91 | 50a±1.91 | 50a±1.91 | 50a±1.91 |
| Catfish | | 90a±3.59 | 90a±3.59 | 90a±3.59 | 0 |
| Initial biomass | Kg/pond | | | | |
| Tilapia | | 900 | 900 | 900 | 900 |
| Catfish | | 27 | 54 | 81 | 0 |
| Total initial biomass | Kg/pond | 927 | 954 | 981 | 900 |

As presented in table (2), averages of final body weights of tilapia for T1; T2; T3 and T4 were 213.2; 226.2; 202.4 and 223.8g respectively. The analysis of variance for tilapia final weights indicate that T2 (tilapia with 600 catfish) and T4 (tilapia without catfish) recorded significantly ($p<0.05$) the highest final weight followed in a significant ($p<0.05$) decreasing order by T1 and T3, respectively. These results may indicate that stocking the tilapia with 600 catfish fingerlings as predator improved final weights of tilapia compared to lower (300) or higher (900) catfish per pond. As presented in the same table averages of final weight of Nile catfish stocked with tilapia at 300 (T1); 600 (T2) and 900 (T3) fish per pond were 950; 940 and 860g respectively. These results indicate that stocking of African catfish with tilapia at densities 300 or 600 fish/feddan improved significantly the final weight of catfish compared to the higher stocking density (900 fish/feddan).

Averages of total gain in weight fish (g) for tilapia recorded higher values for T1; T2 and T4 ($p<0.05$) compared to T3 where 900 catfish were stocked with tilapia per pond. On the other hand total gain per fish for catfish recorded its highest value in T1 (300 fish/pond) followed in a decreasing order by T2 and T3, respectively which indicate that total gain in catfish decreased with increasing its stocking density with tilapia.

Results of table (2) show that the highest daily gain (g.) records were obtained by the control and T2 followed in a significant decreasing order by T1 and T3 ($p<0.05$), respectively. Also the total gain in biomass (tilapia+catfish) kg/pond for T1; T2; T3 and T4 were 3196; 3669; 3435.8 and 3129 kg, respectively. These results indicate that stocking of 600 of catfish/pond with tilapia improved significantly the final biomass followed in a significant ($p<0.05$) decreasing order by T3, T1 and T4 respectively. As percentage of the lowest total gain in biomass (T4), Treatment T1; T2 and T3 recorded 102.1; 117.3 and 109.8 percent compared to T4. These results were in accordance with the findings of Benedict *et al.*, (2009). Who reported that stocking large *H. longifilis* with tilapia; small *H. longifilis* with tilapia at a ratio of 1:4 (catfish: tilapia) and mixed sex tilapia (1:3 male : female sex ratio) breeders stocked in monoculture improved final mean weight, specific growth rate, average net and gross yields of Nile tilapia than those stocked in monoculture. The same authors added that marketable size tilapia constituted highest percentage in ponds stocked with large *H. longifilis* while tilapia in monoculture had the highest percentage of sub-marketable fish.

Concerning fish grades of Nile tilapia at harvesting, results of table (2) show clearly that T2 (600 catfish + tilapia) had the greatest percentage of super grade (1-3 fish kg.) followed by the T4, T1 and T3, respectively. Furthermore the T2 group had lower percentages of fish grade 1; 2; 3 fish compared to the other groups. Percentages of trash fish recorded its highest value (21.5%) in the control group followed descending by T1; T3 and T2, respectively. These results may indicate that stocking of 300 catfish in Nile tilapia ponds seemed to be insufficient to improve final weight of tilapia, thus percentages of super grade of T1 and the control group seemed to be similar. Also results of the same table indicate that stocking of 900 catfish with tilapia decrease the percentage of tilapia super grade which indicate that catfish at higher stocking density than 600fish/pond may results in competition of both species on diet and space which resulted in lower grade of super tilapia and higher percentage of catfish. Results of the same table indicate that the best feed conversion ratio was recorded by T3 followed by T2; T4 and T1, respectively. In general results of table (2) may lead us to recommend the stocking of 600catfish (90 g initial weight) with 18,000 Nile tilapia (50 g initial weight) for controlling and checking tilapias reproduction in ponds without affecting the big size of pray.

Table 2. Effect of catfish stocking density on growth performance, feed conversion, total yield and fish grads

| Items | | T1 | T2 | T3 | T4 |
|---|---|---|---|---|---|
| Average final body weight | G/fish | | | | |
| Tilapia | | 213.2b ±6.3 | 226.2a ±8.1 | 202.4c ±6.3 | 223.8a ±7.8 |
| Catfish | | 950a±10.8 | 940a±9.1 | 860b±9.4 | 0 |
| Total final body weight | Kg/ species | | | | |
| Tilapia | | 3838 | 4072 | 3642.8 | 4029 |
| Catfish | | 285 | 564 | 774 | 0 |
| Total final body weight | Kg/pond | 4123 | 4623 | 4416.8 | 4029 |
| Total gain in weight | G/fish | | | | |
| Tilapia | | 163.2 | 176.2 | 152.4 | 173.8 |
| Catfish | | 860 | 850 | 770 | 0 |
| Average of daily weight gain | | | | | |
| Tilapia | | 1.17 | 1.26 | 1.09 | 1.24 |
| Catfish | | 6.14 | 6.07 | 5.5 | 0 |
| Total gain in biomass | Kg/pond | 3196 | 3669 | 3435.8 | 3129 |
| % of the lowest value | % | 102.1 | 117.3 | 109.8 | 100 |
| Fish grade/ Tilapia | % | | | | |
| Grade super (1 to 3fish/kg) | | 55.1 | 61.2 | 44.6 | 55.2 |
| Grade 1(4 to 5 fish/kg) | | 8.9 | 9.0 | 10.9 | 9.5 |
| Grade 2 (to 7 fish/kg) | | 6.6 | 5.3 | 7.1 | 5.5 |
| Grade 3 (10 fish/kg) | | 8.8 | 4.6 | 7.3 | 8.3 |
| Trash fish | | 13.6 | 7.8 | 12.5 | 21.5 |
| Catfish | | 6.9 | 12.2 | 17.5 | 0.0 |
| Total of costumed food | Kg/fish | 6487.5 | 6737.5 | 6166 | 6073 |
| Food conversion ratio | FCR | 2.03 | 1.84 | 1.79 | 1.94 |

**Costs and returns**

Averages of variable costs including prices of tilapia and catfish fingerlings, feeds, fertilization and labor costs are presented in table (3). Results indicate that fertilizer and labor costs were almost the same in all treatments, while fingerlings and feed costs differed according to the number of catfish stocked in the treatment groups and the amount of feed consumed connected with fish growth in each treatment. As presented in the same table averages of fixed costs (depreciations and taxes) were similar in all treatment groups. Results of table (3) show that total operation costs (variable + fixed) recorded the highest figure (31312.5 LE) for T2 group due to its higher feed costs while the lowest figure was recorded by the control group due to absence of catfish fingerlings costs and lower feed costs.

Results of table (3) show that total returns/feddan for T1; T2; T3 and T4 were LE.36415.2; 42236.8; 38331.2 and 34993.0, respectively, indicating that the T2 group recorded the highest total returns followed in a decreasing order by T3; T1 and T4, respectively. The higher total returns/feddan obtained by the T2 (600 catfish) was due to the higher percentage of super fish grade of tilapia and the higher yield of catfish at harvesting which represented the main items of total returns. Results of table (3) reveal also that the highest net returns were obtained by T2 followed in a decreasing order by T3; T1 and the control groups respectively. The same trend was also observed with the percent of returns relative to costs, thus the highest percentage was achieved by T2 (600 catfish/feddan) and the lowest values were recorded by T1 and the control groups indicating that stocking of 600 catfish/feddan in Nile tilapia ponds is required to achieve the highest profitability from tilapia aquaculture under Egyptian condition.

In conclusion, the optimum stocking density of catfish was 600 fish/feddan in terms of good growth and net return.

Table 3. Effect of catfish as predator in Nile tilapia ponds on economical efficiency.

| Items | T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| **1- Variable costs LE per pond** | | | | |
| a- fingerlings/pond | | | | |
| Tilapia | 7200 | 7200 | 7200 | 7200 |
| Catfish | 1200 | 2400 | 3600 | 0 |
| b- Artificial food | 19462.5 | 20212.5 | 18498 | 18219 |
| c-Fertilizers: | | | | |
| chicken manure | 200 | 200 | 200 | 200 |
| superphosphate | 200 | 200 | 200 | 200 |
| Labor | 1000 | 1000 | 1000 | 1000 |
| Total variable costs, LE | 29262.5 | 30012.5 | 28298 | 28019 |
| 2-Fixed costs, LE | | | | |
| a-Depreciation (materials and others) | 1200 | 1200 | 1200 | 1200 |
| b- Taxes | 100 | 100 | 100 | 100 |
| **2-Total fixed costs, LE** | 1300 | 1300 | 1300 | 1300 |
| **Total operating costs (variable and fixed)** | 30562.5 | 31312.5 | 29598 | 29319 |
| Fish Sale/ **Tilapia** | | | | |
| Grade super | 22728 | 28360.0 | 19704.0 | 22250.0 |
| Grade 1 | 3319.2 | 3736.8 | 4341.6 | 3429.0 |
| Grade 2 | 2188.8 | 1952.0 | 2521.6 | 1760.0 |
| Grade 3 | 2536.8 | 1506.4 | 2262.4 | 2352.0 |
| Trash fish | 3362.4 | 2169.6 | 3309.6 | 5202.0 |
| **Catfish** | 2280.0 | 4512.0 | 6192.0 | 0.0 |
| **b-Total return/feddan, LE** | 36415.2 | 42236.8 | 38331.2 | 34993.0 |
| **Net Returns (total returns – costs)** | 5852.7 | 10924.3 | 8733.2 | 5674 |
| **% Returns relative to costs** | 19.1 | 34.9 | 29.5 | 19.4 |

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# تأثير الكثافات المختلفة لاسماك القراميط فى الافتراس على انتاجية أسماك البلطى النيلي في الأحواض الترابية

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أجريت هذة التجربة لدراسة تاثير الكثافات المختلفة لاسماك القراميط النيلية المرباة مع اسماك البلطى فى احواض ترابية على أداء النمو فى اسماك البلطى النيلى، انتاجية الحوض وتكلفة وصافى العائد من استزراع البلطى النيلى تحت ظروف الاستزراع المصرية. إجريت التجربة فى ٨ أحواض ترابية، مساحة كل منها واحد فدان. وخزن كل حوض بعدد ١٨ الف أصبعية بلطى( متوسط الوزن الإبتدائي ٥٠ جم).تم تخزين اسماك **القراميط** مع البلطى لإستخدامها كمفترسات فى أربع معاملات بمعدل ٣٠٠ ، ٦٠٠ ، ٩٠٠ و بدون قراميط فى الفدان. كل معاملة من المعاملات الاربعة تمت فى حوضين (مكررين) ولمدة ٢٠ اسبوعا.

وتتلخص النتائج المتحصل عليها كالاتى:

١- معدل الكثافة ٦٠٠ قرموط فى الفدان فى احواض البلطى زاد الوزن النهائى لاسماك البلطى مقارنة بكثافة ٩٠٠ قرموط فى الفدان.

٢- متوسط الزيادة فى الوزن للمعاملة الاولى ، الثانية والرابعة كان اعلى من المعاملة الثالثة.

٣- معامل التحويل الغذائى تراوح بين ١,٧٩ للمجموعة الثالثة ، ٢,٠٣ للمجموعة الاولى.

٤- اعلى عائد تم تحقيقة كان ١٠٩٢٤,٣ جنيها للمعاملة الثانية ، تبعها للمعاملة الثالثة ثم الاولى ثم الكنترول على التوالى.

يستنتج من هذة الدراسة ان افضل كثافة لاسماك القراميط ٦٠٠ سمكة/فدان تبعا لنمو البلطى واعلى عائد للفدان.