Efficiency of African Catfish *Clarias gariepinus* in controlling unwanted reproduction of Nile Tilapia *Oreochromis niloticus* in low input production system

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ABSTRACT

The present experiment was conducted in twelve earthen ponds 2100-m^2 at WorldFish Center research facility at Abbassa, Egypt, to assess the efficiency of African catfish (*Clarias gariepinus*) in controlling unwanted Nile tilapia (*Oreochrmis niloticus*) reproduction in grow out and to evaluate the performance of tilapia in polyculture system with catfish under low-input production system. Mixed sex tilapia fry (averaging 0.15 g total body weight) stocked at the rate of 2 fish/m^2 and African catfish fingerlings (223 g) were introduced two month later at stocking rates of 7 and 13% of tilapia into T2 and T3 respectively in addition to T1 which had no African catfish introduced to it. Ponds were fertilized weekly using chicken letter at the rate of 500 kg/ha. Water quality parameters were monitored weekly for measuring DO concentration, temperature, Secchi disk, pH and NH4. Also monthly water samples were taken for measuring pH, alkalinity, TAN, NO3, NO2 available phosphorus, chlorophyll *a*, and total hardness. Statistical analysis of the obtained fish production data at the end of the thirty-week experimental period, showed that catfish significantly ($P \leq .05$) reduced the biomass of recovered tilapia reproduction to 14.9 and 8 % fry as percentage of the total fish yield in T2 and T3, respectively as compared to 26.6% obtained in T1. Tilapia production in polyculture with catfish was significantly lower than tilapia monoculture while, on the other hand, total fish production was significantly ($P \leq .05$) higher in the case of both of the two polyculture treatments compared to the tilapia only treatment.

The overall conclusion of the present experiment showed that under such stocking rate and production system, introduction of catfish at the rate of 13% of total Tilapia stocked has not only eliminated 70% of total Tilapia recruitment but also enhanced total pond production of marketable size fish in both of the polyculture treatments.

INTRODUCTION

Tilapia is the main cultured fish species in Egyptian farms, in year 2004 tilapias contributed to 43 % of farmed fish production and 23% of total fisheries Production (GAFRD, 2005). The main problem facing tilapia producers is the early sexual maturity and fry production before fish reach marketable size, which lead to overpopulation in production ponds and produce smaller fish at harvest (Guerrero, 1980).

The use of 17a-Methyltesosterone (MT) for the production of all male population tilapia was widely used in Egypt to overcome this problem. But the Egyptian Government banned the use of MT hormone for mono-sex tilapia production. Therefore, there is a need for focusing on alternative methods for controlling tilapia reproduction in production ponds.

Introduction of predator's fish for recruitment control in tilapia was reported by Guerrero, 1980; De Graaf (1996) El-Gamal *et al.* (1998) and Fagbenro (2004). Among predators which could be used for biological control of tilapia reproduction is the African catfish (*Clarias gariepinus*). Lin (1996) mentioned that African catfish have been investigated as a potential aquaculture species. This species known for its high growth rate, resistance to low level of dissolved oxygen (DO), poor water quality, handling stress and excellent meat quality (El-Naggar *et al.*, 2006). Of the major limitation for the use of predator as population control methods, is the difficulty in obtaining stock of desirable size. On other hand, the new development of catfish spawning methodology which make attaining catfish fingerlings more practical to be stocked in poly-culture system with tilapia.

This experiment was designed to determine the best stocking ration of African catfish (*Clarias gariepinus*) as a predator to control unwanted tilapia offspring in a polyculture system and to assess the effects of that on fish growth, water quality, and total fish production under low input production system in earthen pond.

MATERIALS AND METHODS

The experiment was conducted at the WorldFish Center, Abbassa, Egypt, in twelve earthen ponds of similar size (2100-m^2) each, from 14th of April to the 26th of November 2005.

Experimental design

Ponds were assigned into three treatments four replicates each, using a stratified random block design as follows:

Treatment 1 (T1): Pond stocked with Tilapia only (T. Only)
Treatment 2 (T2): Pond stocked with Tilapia and 7 % catfish (T. + 7% CF)
Treatment 3 (T3): Pond stocked with Tilapia and 13 % catfish (T. + 13% CF)

Pre-stocking preparation and management of the experimental ponds:

All ponds were dried for a week to eliminate wild fish before starting of preparation for the experiment. Fine mesh screens were fixed over water inlet and outlet pipes. Ten days before stocking, all ponds were treated with chlorine at the rate of 15L/1000 m^2 to eradicate their cysts and discourage the growth of harmful cyanobacteria. Ponds left for chlorine evaporation for two days and fertilized by chicken manure at rate of 400 kg/hectare. Partial filling of the ponds to 50% of target level started on the following day after applying the initial fertilization. Two days prior to stocking tilapia fry, water was added to the ponds through pipes covered with narrow mesh screen to reach the maximum target level in ponds of 1meter. Each pond was covered completely with bird netting supported by wood sticks, to prevent entry of natural enemy of the fish such as birds, in order to avoid fish mortalities due to bird picking of the fish. Water depth in all ponds was maintained at the same level throughout the experiment by adding water weekly to replace evaporation and seepage losses.

Experimental fish:

Nile tilapia (*Oreochrmis niloticus*) fry were obtained from the Arabian Fisheries Company Hatchery and kept in holding concrete tanks for two days before stocking for recovery from any transportation stress or mortalities, while catfish fingerlings (*Clarias gariepinus*) were obtained from previous year spawning done at the WorldFish Center facilities.

Mixed-sex Nile tilapia fry (0.15 g size) were stocked at rate 2 fish m^{-2} in all treatments. After two months of initial tilapia stocking catfish fingerlings (223 g size) were introduced into ponds at stocking, rate 315 and 650 fish per ponds representing 7%, and 13% of tilapia number in T2 and T3, respectively. All ponds were fertilized with similar amount of chicken litter at a rate of 500 kg/hectare per week for 30 weeks.

Fish Sampling and data collection and final analysis

During the experiment fish samples were taken monthly where individual weight and length of 30 tilapia fish from each pond recorded. Because of difficulty in getting catfish in monthly fish sample, no attempt was done to make growth curve. Initial integrated water samples were taken two days before stocking and monthly basis afterwards. Water samples were analysed for pH, alkalinity, total ammonium nitrogen (TAN), nitrite-nitrogen, nitrate-nitrogen, available phosphorus, chlorophyll *a*, and Hardness according to APHA, (1998). In addition, weekly measurement of DO, Temperature, Secchi disk, pH and NH_4 were done.

All fish were harvested between 17th and 26th of November 2005 after 215 days of growing period. At harvest fish weight and number for each size group were recorded. Fish yield (kg $pond^{-1}$), extrapolated yield (kg ha^{-1}), survival, and daily weight gain (g $fish^{-1}$ d^{-1}), were calculated for each pond.

Data were analyzed statistically by analysis of variance using SPSS (version 8.0) statistical software package (SPSS, Inc., Chicago, Illinois, USA). Differences were considered significant at an alpha level of 0.05.

RESULTS

Fish Growth

The obtained result of this experiment (Table 1) showed that there were significant differences in all growth yield, tilapia production, tilapia fry biomass, tilapia fry biomass as percentage of fish yield, market size tilapia yield, market size catfish quantity and mean weight of catfish marketable size among treatments ($P<0.05$). The introduction of Catfish into tilapia ponds resulted in reduced survival rate, growth rate (g/d) and mean weight of market size of tilapia but there was no significant difference among treatments ($P<0.05$).

Net fish yield was higher in T1 followed by T2 and T3 respectively, while on the other hand, market size fish yield was lowest in T1 then T2 and was highest ($P< 0.05$) for T3. The obtained tilapia fry biomass (kg/ha) and its share as a percentage of the total fish yield significantly decreased ($P<0.05$) among the three treatments being highest fir T1 followed by T2 then T3 respectively.

Table 1: Fish yield, survival, growth, mean weight of tilapia marketable size, tilapia fry biomass for different treatments

Parameters	T. Only(T1)	T. + 7% CF (T2)	T. + 13% CF (T3)
Gross yield (kg/ha)	2540.1 ± 72.54 a	2855.6 ± 31.99 b	3048.6 ± 86.3 b
Net yield (kg/ha)	2527 ± 73.62 a	2521.8 ± 31.8 a	2373.9 ± 85.68 a
Survival (%)	90.2 ± 5.51 a	87.8 ± 4.56 a	89 ± 2.28 a
Tilapia Growth (g/day)	0.99 ± 0.054 a	0.91 ± 0.045 a	0.89 ± 0.019 a
Tilapia Production (Kg/ha)	2528.8 ± 70.99 a	2099.67 ± 43.86 b	1970.27 ± 49.96 b
Market Size Fish (kg/ha)	1887.47 ± 75.7 a	2427.3 ± 58.36 b	2804.2 ± 88.73 c
Market Size Tilapia (kg/ha)	1865.0 ± 70.99 a	1671.3 ± 27.05 b	1725.9 ± 55.45 ab
Tilapia fry Biomass (kg/ha)	664.1 ± 12.74 c	428.4 ± 70.45 b	244.4 ± 13.76 a
Tilapia fry Biomass as a % of total fish yield	26.6 ± 1.2 c	14.97 ± 2.37 b	8 ± 0.54 a
Mean weight of marketable size tilapia (gm)	208.8 ± 11.26 a	191.3 ± 9.49 a	187.3 ± 3.97 a
Market Size Catfish Yield (kg/ha)	8.5 ± 4.9 a	755.93 ± 33.92 b	1078.36 ± 39.6 c
Mean weight of Marketable Catfish (g)	599 ± 299.5 a	468 ± 47.8 a	353 ± 15.3 b

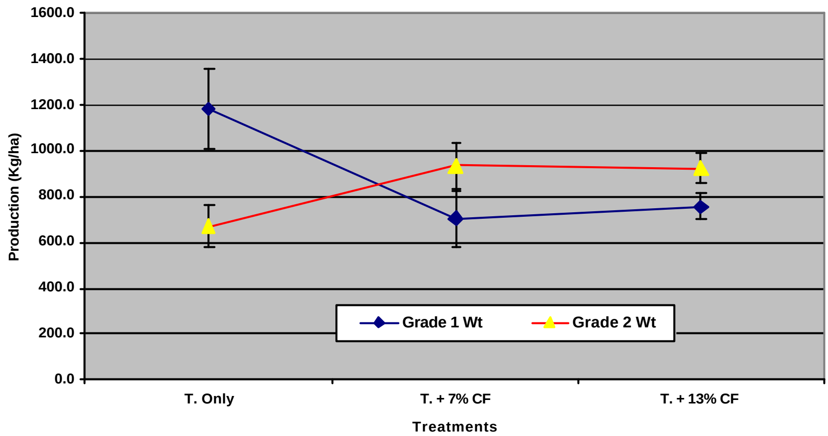
* Values with the same letter in the row are not significantly different. All values are mean ± SE.

The current results also showed that total production of marketable size tilapia was higher for T1 than for T2 but not significantly different from T3

($P<0.05$). Mean weight of marketable tilapia inversely correlated with increasing stocking rate of catfish, but the difference was not significant ($P >0.05$).

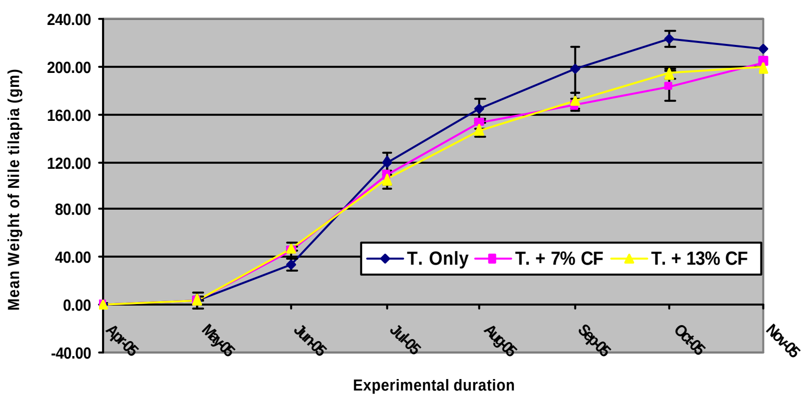
Figure 1 illustrates the comparison of tilapia grades production showed that first grade tilapia (> 200 g) was significantly higher in T1 compared to T2 and T3 ($P< 0.05$), While it was the reverse for second grade (100-200 g) tilapia production which was significantly lower in T1 treatment compared to T2 and T3 ($P< 0.05$).

Figure1. Tilapia production (average ± SE) as classified to size grades (grade 1 and grade 2) from various treatments.



Tilapia growth curves during the experiment based on monthly fish samples from each pond are presented in Figure 2. It was noticed that growth of tilapia in T1 started to show an increase over that for T2 and T3 starting from the third sample, which is one month after catfish stocking into the ponds. This divergence continued all through the experimental period to the end of trial. The average weight of tilapia at harvest for the three treatments was similar to that obtained in fish sample throughout the trial.

Figure 2. Average weight of Nile tilapia from fish as sampled during the pond rearing trial.



Water Quality Parameters:

Among water quality parameters only pH was significantly (P<0.05) and available phosphorus differed significantly (P<0.05) between treatments. While the rest of water quality parameters measured such as water temperature, dissolved oxygen (DO), alkalinity, NH_3, nitrite-N, chlorophyll *a* and Secchi disk visibility were not significantly different (P<0.05) among treatments, (Table 2).

Table 2. Recorded water quality parameters (mean ± SE) throughout the experiment.

Parameters	*N**	T1 (T. Only)	T2 (T. + 7% CF)	T3 (T. + 13% CF
Temperature range °C	35	17.7 – 28.4	17.9 – 28.6	17.6 – 28.7
pH	26	8.76 ± 0.08 b	8.52 ± 0.04 a	8.47 ± 0.05a
DO	35	0.91 ± 0.10 a	0.92 ± 0.09 a	0.93 ± 0.03 a
Alkalinity (mg/L as $CaCO_3$)	6	348.3 ± 18.36 a	371.9 ± 39.21a	397.1 ± 28 a
NH3	26	0.15 ± 0.01 a	0.10 ± 0.02 a	0.10 ± 0.01 a
Nitrate-N (mg/L)	6	0.33 ± 0.09 a	0.27 ± 0.04 a	0.26 ± 0.08 a
Chlorophyll *a* (µg/L)	6	65.36 ± 11.47 a	70.38 ± 13.78 a	72.14 ± 7.16a
Available phosphorus (mg/l)	6	0.75 ± 0.09 a	1.04 ± 0.07 b	0.98 ± 0.06ab
Secchi Disk Visibility	26	23.5 ± 0.59 a	24.8 ± 0.38 a	23.3 ± 0.93 a

* Number of samples

Monthly variation in mean values (± SE) for pH and available phosphorus throughout the experimental period is presented in Figures 3 and 4 respectively.

Fig. 3. Fluctuation in mean value for the pH (± SE) during the culture period.

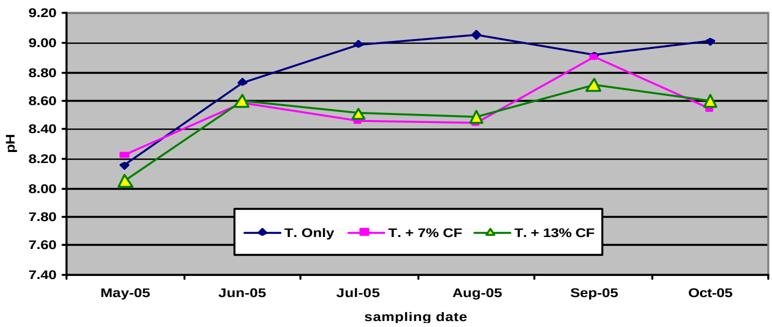
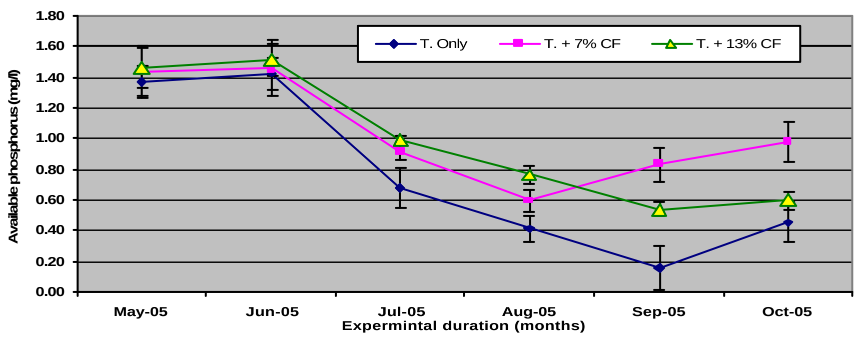


Figure 4. Mean value for the available phosphorus (± SE) during the culture period



DISCUSSION

The present study showed that poly-culture of catfish with mixed sex tilapia in earthen ponds under low input system (fertilization only), would impact tilapia reproduction and significantly reduce tilapia fry biomass. Tilapia fry production decreased significantly with increasing stocking rate of catfish (T. only, T. + 7% CF, and T. +13% CF) where biomass of tilapia reproduction at harvest was 8, 14.9 and 26.6% of fish yield respectively (P<0.05). De Graaf (1996) reported that catfish at ratio of 1 : 2.7 and snakehead at ratio 1:30 were able to control tilapia reproduction to less than 0.15 % of total harvest biomass against 25% fingerlings found in mixed sex tilapia culture.

The efficiency of catfish and Nile perch in controlling tilapia reproduction was investigated by El-Gamal *et al.* (1998) who reported that in earthen ponds when artificial feed was offered to fish, catfish were observed consuming artificial feed and attributed the less predator performance of catfish in such environment to availability of feed. They also reported that stomach analysis of catfish and Nile perch showed that predator activity started at an average weight 13.0 g and 5.5 g, respectively.

Gross fish yields were increased with increasing stocking density of catfish, but net fish yield slightly decreased with catfish being introduced into tilapia ponds, but no significantly different among treatments (P<0.05). Tilapia production was significantly affected by introduction of catfish into tilapia ponds either at 7 or 13%, (T2 or T3 respectively) (P<0.05) with no significant difference between treatment T2 and T3. Lin 1996 reported similar result and concluded that polyculture of tilapia with African catfish would reduce tilapia yield than in monoculture of tilapia. The result of this experiment disagrees with that obtained by Ngugi *et al.* (2006), who found that final weight and yield of market size tilapia was higher in ponds stocked with tilapia: catfish at 2:1 than those ponds stocked at 6:1 and 19:1.

Mean weight of marketable tilapia decreased with increasing stocking density of catfish, but the difference was not significant at (P<0.05). First grade tilapia was significantly higher in T1 compared to the two other treatments (P<0.05), while second grade tilapia was significantly lower (P<0.05) in T1 compared to T2 and T3. Tilapia survival was not affected with introduction of catfish into grow out ponds and ranged from 87.8 to 90.2%. Also daily weight gain of tilapia was not significantly different (P<0.05) and ranged between 0.89 to 0.97 g/day/fish. Under high input production system higher daily weight gain of tilapia, was reported by Long and Yi (2004) to be 1.25 to 2.5 g/fish/day when artificial feed 30% protein were offered to fish.

Water quality parameters measured during the trial indicated that addition of catfish into tilapia ponds did improve ponds water quality. It was noted that pH value decreased significantly in T2 and T3 treatments (tilapia and catfish) (P<0.05) compared to T1 ponds (tilapia only), and that were opposite to available phosphorus which increased significantly (P<0.05) in presence of catfish in tilapia ponds. Inverse relationship between pH and available phosphorus was explained by Boyd (1990), who stated that available phosphorus increases when pH values decline. It was noted during the trial that catfish reduced algal bloom, but did not result in significant difference in Secchi disk visibility among the treatments. Other water quality parameters such as dissolved oxygen, alkalinity, NH_3, nitrate and chlorophyll-a were not significantly different among treatments (P<0.05).

In conclusion, this study has clearly demonstrated that introduction of catfish at the rate of 13% of total Tilapia stocked has not only eliminated 70% of total Tilapia recruitment but also enhanced total pond production of marketable size fish in both of the polyculture treatments.

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