

EFFECT OF STOCKING RATES OF NILE TILAPIA (*Oreochromis niloticus* L.) AND GREY MULLET (*Mugil cephalus* L.) ON THEIR PERFORMANCE IN POLYCULTURE EARTHEN PONDS

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ABSTRACT:

A growing experiment was conducted, for 150 days started on 20/6/2003 to evaluate the effect of four stocking rates of Nile tilapia and grey mullet fish in polyculture earthen ponds, rearing systems, on their growth performance, production and economical efficiencies. Stocked rates were; 6000 fish (5 tilapia : 1 mullet)/feddan, T₁; 7700 fish (10 tilapia : 1 mullet)/ feddan, T₂; 8000 fish (3 tilapia : 1 mullet)/ feddan, T₃; and 11000 fish (10 tilapia : 1 mullet)/ feddan, T₄. Eight ponds (2 ponds/treatment) each of 1 feddan area (4200 m²), 1.2 m depth were supplied with fresh water. Fish were fed twice daily on a supplementary diet (25% CP, 4.45 kcal/g, GE) at a rate of 3% from their biomass.

The results revealed that; water quality parameters didn't show significant differences among treatments and they were within the acceptable limits. Harvesting body weight, total gain, daily gain and specific growth rate of fish were affected by stocking rates. The highest values for tilapia and mullet were obtained with T₂ followed by T₃, T₁ and T₄, respectively. Survival rates of tilapia ranged between 92 to 98% and ranged between 92 to 96% for mullet. Body mass of tilapia at harvesting and the net production per feddan were higher with T₄ than that of T₂, T₃ and T₁, respectively. And these measures for mullet were higher with T₃ than that of T₂, T₁ and T₄, respectively. While the total biomass and net production per pond were higher with T₄ than those of T₃, T₂ and T₁ respectively. The economical efficiency was in favor of T₃

more than T_4 (regarding net returns/total costs %).

Key words: Nile tilapia, grey mullet, polyculture, stocking rate, growth performance, production and economical efficiencies.

INTRODUCTION:

Polyculture is the practice of culturing more than one specie of aquatic organism in the same pond. The motivating principles is that fish production in ponds may be maximized by raising a combination of species having different food habits in productions that effectively utilize available food in a pond and improves its water quality (Hepher and Pruginin, 1981; Naylor *et al.*, 2000; McVey *et al.*, 2002 and Davenport *et al.*, 2003). Also, Milstein and Svirsky (1996) reported that an appropriate combination of fish species at adequate densities will utilize the available resources efficiently, maximize the synergistic fish-fish and fish environment relationships and minimize the antagonistic ones. So in recent years it has begun to regain attention as a possible mean to increase efficiency in aquaculture production systems, and to reduce environment impacts (Greglutz, 2003).

Nile tilapia are reared in polyculture systems with number of fish species include; carps, grey mullets, catfish and freshwater shrimp (Pillay, 1990, Cardona *et al.*, 1996 and Yossef, 2000). Wohlfarth *et al.* (1985) reported that growth performance and survival of tilapia were influenced by their stocking rate, the species of fish co-stocked with them, fish stocking rates and feeding regimes. Also, Milstein (1995) reported that the highest total yield and best tilapia performances were obtained in polyculture ponds, where tilapia was the main species.

Therefore the present study aimed to evaluate some stocking rates of Nile tilapia and grey mullets in polyculture earthen ponds which are applied in various commercial fish farms at El-Fayoum Governorate.

MATERIALS AND METHODS:

This study was conducted for a period of 150 days started on 20/6/2003 in rectangle-shaped earthen ponds each of 1 feddan (fed.) area (4200 m²) with a water level of 1.2 m depth. The ponds were located in commercial farm at Etsa, El-Fayoum Governorate, ARE. They were supplied with fresh water from Nile river at canal endings, water turnover rate was 1/3 from water volume/week/pond.

Monosex Nile tilapia fingerlings of 11.7 ± 0.67 g and grey mullet fingerlings of 50 ± 0.80 g live body weight were assigned randomly to ponds at a rate of 6000 fish (5 tilapia : 1 mullet)/fed. (T₁); 7700 fish (10 tilapia : 1 mullet)/fed. (T₂); 8000 fish (3 tilapia : 1 mullet)/fed. (T₃) and 11000 fish (10 tilapia : 1 mullet)/fed. (T₄), where 2 ponds represented one of the evaluated four stocking rates. These stocking rates were applied in commercial farms. Also, selection of species ratio generally depends on seed availability, market demand, price of fish, nutrient status of a pond...etc. Fish were fed on commercial supplementary diet at a rate of 3% from their body weight, twice daily at 9 h and 15 h in addition to the available natural food in the ponds. The chemical analysis of used diet is shown in Table (1).

Table (1). Chemical analysis of used diet, on DM basis.

Items	%
Crude protein, CP	25.34
Ether extract, EE	6.28
Ash	8.64
Crude fiber, CF	7.69
Nitrogen free extract. NFE ¹	52.05
GE, kcal/g*	4.450

1, Calculated by differences

* Calculated according to Omar, 1984.

Cultured fish were sampled and their body weight was determined at start and at two week intervals and the feeding rate was adjusted accordingly. At harvesting fish were weighed and counted

gravimetrically to determine survival rate, growth rates and efficiency of feed utilization, then the fish were classified into grades.

Chemical analysis of used diet was conducted according to methods of AOAC (1984). Regarding water quality parameters during the experimental period; water temperature, pH, dissolved oxygen and total ammonia-N were obtained through centigrade thermometer, Orion digital pH meter model 201, Col Parmer oxygen meter model 5946 and Hanna instruments ammonia test kit (HI 4829), respectively. Gross energy of used diet was calculated according to Omar (1984).

Analysis of variance and LSD range test were used to compare treatment means. Data were analyzed using Statgraphic Package Software (SPSS, 1997).

RESULTS AND DISCUSSIONS:

Water quality parameters as affected by stocking rates of Nile tilapia and grey mullet are presented in Table (2).

Table (2). Water quality parameters as affected by stocking rates of Nile tilapia and grey mullet.

Item	Treatments*				SED
	T ₁	T ₂	T ₃	T ₄	
Water temperature, C°	27.1	27.2	27.2	27.3	0.473
pH	7.4	7.6	8.0	7.8	0.130
NH ₃ - N, mg/l	0.10	0.10	0.10	0.11	0.003
Dissolved oxygen, mg/l	6.5	6.5	6.6	6.4	1.474

* T₁, T₂, T₃ and T₄ were 6000 fish (5 tilapia : 1 mullet)/fed; 7700 fish (10 tilapia : 1 mullet)/fed; 8000 fish (3 tilapia : 1 mullet)/fed. and 11000 fish (10 tilapia : 1 mullet)/fed.

SED, standard error of differences

Since in a pond of any kind there exists a dynamic system of material/energy cycle, broadly between all living organisms and the non living environment which are in nature, inseparably interrelated and interact upon each other, parameters showed insignificant differences

among treatments. Martin and Michael (2003) reported that in applied farms the basic principles of complete graze pressure on both planktonic and benthic communities by implementing polyculture methods by using species, which are able to use both the planktonic and benthic food resources and the water quality parameters improved. Eventhough the values during the experimental period were within the acceptable limits for tilapia and grey mullet as indicated by Miranda-Filho *et al.* (1995); Milstein and Svirsky (1996); El-Sayed *et al.* (1996) and Abd El-Maksoud *et al.* (1999 a,b).

Fish growth performance parameters as affected by stocking rate are shown in Table (3). Final weight, total gain, daily gain and specific growth rate of Nile tilapia were affected insignificantly, the highest means were obtained with T₂ followed by T₃, T₁ and T₄, respectively. While final weight, total gain, daily gain of grey mullet were affected significantly, the highest value was obtained with T₂ followed by T₃, T₁ and T₄, respectively. The results of daily gain ranged between 1.17 to 1.23 g and 1.25 to 1.95 g for tilapia and mullet respectively. These results are higher than that obtained by Hassouna *et al.*, (1998), Nagdi (1998), Milstein *et al.*, (1995) and Abd El-Maksoud *et al.*, (1999 a,b) for tilapia. The differences between their results and that obtained in the present study may be due to the differences of culture system, feeding regime, fish density and initial weight of cultured fish. While the results of grey mullet were nearly similar to that obtained with Abd El-Maksoud *et al.*, (1999 a,b) in polyculture system where they used fish with the same initial weight and produce the same final weight.

Based on results obtained in this study, it could be concluded that growth rate of fish is affected by total density, stocking rate per each specie and weight of stocking fish. The 2nd stocking rate (7700 fish, 10 tilapia : 1 mullet)/fed. was the best followed by the 3rd stocking rate (8000

Table (3). Growth performance of Nile tilapia and grey mullet as affected by stocking rates in polyculture earthen ponds.

Item	Treatments*				SED
	T ₁	T ₂	T ₃	T ₄	
<i>Nile tilapia:</i>					
Initial weight/fish, g.	13.50	10.00	11.50	11.75	2.151
Final weight/fish, g.	190.18	194.10	192.92	187.77	9.943
Weight gain ¹ /fish, g.	176.68	184.10	181.42	176.02	9.481
Daily gain ² /fish, g.	1.18	1.23	1.21	1.17	0.200
SGR ³ , %.	1.76	1.98	1.88	1.85	0.121
Relative % in SGR.	100	112	106	105	----
<i>Grey mullet:</i>					
Initial weight/fish, g.	50.00	48.00	50.33	51.00	2.789
Final weight/fish, g.	250.00 ^B	340.00 ^A	295.00 ^{AB}	238.33 ^B	26.667
Weight gain/fish, g.	200.00 ^B	292.00 ^A	244.67 ^{AB}	187.33 ^B	27.849
Daily gain/fish, g.	1.33 ^B	1.95 ^A	1.63 ^{AB}	1.25 ^B	0.186
SGR, %.	1.07 ^B	1.31 ^A	1.18 ^{AB}	1.03 ^B	0.085
Relative % in SGR.	100	122	110	96	----

* T₁, T₂, T₃ and T₄ were 6000 fish (5 tilapia : 1 mullet)/fed; 7700 fish (10 tilapia : 1 mullet)/fed; 8000 fish (3 tilapia : 1 mullet)/fed. and 11000 fish (10 tilapia : 1 mullet)/fed.

- Averages in the same row having different superscripts are significantly different ($P \leq 0.01$).

- SED, standard error of differences.

1, Final weight – initial weight

2, weight gain/period, day

3, $\{(\ln W_2 - \ln W_1) \times 100/\text{days}\}$

fish, 3 tilapia : 1 mullet)/fed., the 1st stocking rate (6000 fish, 5 tilapia: 1 mullet)/fed. and the 4th stocking rate (11000 fish, 10 tilapia : 1 mullet)/fed., respectively. In this connection Milstein and Svirsky (1996) reported that at an appropriate combination of fish species at adequate densities will utilize the available resources efficiently, maximize the

synergistic fish-fish and fish environment relationships and minimize the antagonistic ones.

The effect of stocking rate on feed conversion ratio (FCR) of fish is presented in Table (4). Data showed that there are insignificant differences between treatments. However, T₁ and T₄ were the best followed by T₂, T₃, respectively for tilapia. While with grey mullet T₂ was the best followed by T₃, T₁ and T₄, respectively. Regarding the FCR for both species in the pond T₁ and T₄ were the best followed by T₂ and T₃, respectively.

Table (4). Effect of stocking rate on feed conversion ratio (FCR) of Nile tilapia and grey mullet in polyculture earthen ponds.

Item	Treatments*				SED
	T ₁	T ₂	T ₃	T ₄	
<i>Nile tilapia:</i>					
Feed intake, kg/pond	1775 ^d	2513 ^b	2184 ^c	3440 ^a	12.45
FCR	2.06	2.13	2.14	2.07	0.047
<i>Grey mullet:</i>					
Feed intake, kg/pond	400 ^b	412 ^b	991 ^a	385 ^b	11.00
FCR	2.22 ^{ab}	2.11 ^b	2.21 ^{ab}	2.29 ^a	0.061
<i>Nile tilapia and grey mullet</i>					
Initial weight, kg/pond	117.5	103.6	169.66	168.5	---
Final weight, kg/pond	1160 ^d	1478.48 ^c	1638.7 ^b	2002 ^a	18.93
Feed intake, kg/pond	2175 ^d	2925 ^c	3175 ^b	3825 ^a	18.28
FCR	2.09	2.13	2.16	2.09	0.029

* T₁, T₂, T₃ and T₄ were 6000 fish (5 tilapia : 1 mullet)/fed; 7700 fish (10 tilapia : 1 mullet)/fed; 8000 fish (3 tilapia : 1 mullet)/fed. and 11000 fish (10 tilapia : 1 mullet)/fed.

Averages in the same row having different superscripts are significantly different (P ≤ 0.01). SED, standard error of differences.

Table (5) represents the production efficiency of fish as affected by stocking rate. Survival rates of Nile tilapia ranged between 92 and 97.8%. These rates are in the normal ranges as indicated by Teichert-Coddington and Green (1993), Knud-Hansen and Batterson (1994), Hassouna *et al.*, (1998) and Abd El-Maksoud *et al.*, (1999 a,b), who reported values ranged between 87 and 95%. The survival rates of grey mullet were ranged between 92 and 96%. In this connection, Abd El-Maksoud *et al.*, (1999 a,b) found that the survival rate of grey mullet ranged between 93 and 94%, when they stocked 8000 fish/feddan (3 tilapia : 1 mullet). The mortality in the 4 present treatments could be explained as a result of injuries during sampling.

Body mass of Nile tilapia at harvesting and the net production per feddan were higher with T₄ followed by T₂, T₃ and T₁, respectively. Also, body mass of grey mullet at harvesting and the net production per feddan were higher for T₄ followed by T₃, T₂ and T₁. These results reflect the effect of stocking rates and their effects on daily gain/fish. In this connection Scorvo-Filho *et al.*, (1995) found that there were significant difference ($P \leq 0.01$) in total biomass among stocking rates of striped mullet (*Mugil platanus*) reared in mono and polyculture systems with common carp (*Carpinus carpio*). Also, Milstein (1995) reported that the highest total yields and best tilapia performance were obtained in polyculture ponds, where the tilapia was the main species.

The economical analysis (Table 6) shows that the income from T₄, T₃ and T₂ were higher than that of T₁ about 61, 56 and 23%, respectively. On the other hand the total cost of treatments as a percent of T₁ were 123, 138 and 159 for T₂, T₃ and T₄, respectively. However, the net returns/pond as a percent of T₁ were 124, 190 and 164% for T₂, T₃ and T₄, respectively. Even though, the net returned/total costs (%) cleared that T₃ was the best

Table (5). Production efficiency of Nile tilapia and grey mullet fish as affected by stocking rate.

Item	Treatment*				CV%
	T ₁	T ₂	T ₃	T ₄	
<i>Nile tilapia</i>					
Fish No/feddan					
At start	5000	7000	6000	10000	---
At harvesting	4890	6440	5650	9495	4.08
Survival rate ¹ %	97.80	92.00	94.17	94.95	1.25
Fish biomass, kg/feddan					
At start	67.5	70	69	117.5	---
At harvesting;	929.98	1,250.00	1,090.00	1,782.88	5.29
1 st grade ²	580	840	720	1123	5.42
2 nd grade ³	310	340	310	530	14.60
3 rd grade ⁴	40	70	60	130	28.38
Net production ⁵	862.48	1,180.00	1,021.00	1,665.38	5.74
Relative % of net production	100	136.81	118.38	193.09	5.23
<i>Grey mullet</i>					
Fish No/feddan					
At start	1000	700	2000	1000	---
At harvesting	920	672	1860	920	4.32
Survival rate ¹ %	92.00	96.00	93.00	92.00	1.12
Fish biomass, kg/feddan					
At start	50	33.6	100.66	51	---
At harvesting;	230.00	228.48	548.70	219.24	9.65
Net production	180.00	194.88	448.04	168.24	8.64
Relative % of net production	100	108.27	248.91	93.47	16.58
<i>Total biomass, kg/feddan</i>					
At start	117.5	103.6	169.66	168.5	---
At harvesting;	1,159.98	1,478.48	1,638.70	2,002.11	4.63
Net production ²	1,042.48	1,374.88	1,469.04	1,833.61	5.09
Relative % of net production	100	131.89	140.92	175.89	4.56

* T₁, T₂, T₃ and T₄ were 6000 fish (5 tilapia : 1 mullet)/fed; 7700 fish (10 tilapia : 1 mullet)/fed; 8000 fish (3 tilapia : 1 mullet)/fed. and 11000 fish (10 tilapia : 1 mullet)/fed.

- CV%, coefficient of variability

1, Survival rate = (fish No at harvesting/fish No at start) 100

2, 3-4 fish/kg

3, 5-6 fish/kg

4, 7-10 fish/kg

5, body mass of fish at harvesting, kg – body mass of fish at start, kg

Table (6). Effect of stocking rates on economical efficiency of fish.

Item	Treatments*				CV%
	T ₁	T ₂	T ₃	T ₄	
Income, L.E/fed					
Nile tilapia	5730	7790	6770	10901	9.97
Grey mullet	2760	2736	6588	2628	5.31
Total	8490	10526	13358	13529	6.65
Relative % of total income	100	123.98	157.34	159.35	7.13
Variable costs, L.E/fed.					
Fingerlings including transport					
Nile tilapia	850	1190	1020	1700	---
Grey mullet	450	315	900	450	---
Total	1300	1505	1920	2150	---
Labors	262.5	262.5	262.5	262.5	---
Irrigation	350	350	350	350	---
Feeds	3045	4095	4445	5355	0.60
Others	125	125	125	125	---
<i>Total variable costs</i>	5082.5	6337.5	7102.5	8242.5	0.38
Fixed costs, L.E/fed.					
Opportunity, land charge	400	400	400	400	---
Deprecation (pond& equipment)	62.5	62.5	62.5	62.5	---
Total costs	5545	6800	7565	8705	0.35
Relative % of total costs	100	122.63	136.43	156.99	0.22
Net returns, L.E/fed.	2945	3726	5793	4824	17.29
Relative % of net returns	100	126.52	196.71	163.80	19.90
Net returns/total costs, %	53.11	54.79	76.58	55.42	15.93

* T₁, T₂, T₃ and T₄ were 6000 fish (5 tilapia : 1 mullet)/fed; 7700 fish (10 tilapia : 1 mullet)/fed; 8000 fish (3 tilapia : 1 mullet)/fed. and 11000 fish (10 tilapia : 1 mullet)/fed.

- The average of price of 1 kg fish × the fish yield, kg/ fed.

- CV%, coefficient of variability

- Selling price of one kg of tilapia was 7, 5 and 3 L.E. for 1st grade, 2nd grade and 3rd grade, respectively and for mullet was 12 L.E.

followed by T₄, T₂ and T₁, respectively. This result is reflection to the net production and price of tilapia and mullet per each treatment.

In conclusion, under the experimental condition the results show that the T₄ was more efficient than T₃, T₂ and T₁, respectively. However, the economical efficiency was in favor of T₃ more than T₄ (regarding net returns/total costs, %).

Therefore, it could be recommend the rearing of Nile tilapia and grey mullet together in polyculture earthen ponds at a density of 8000 fish/fed (3 tilapia: 1 mullet) for the better net income.

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