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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, T_1; 7700 fish (10 tilapia : 1 mullet)/ feddan, T_2; 8000 fish (3 tilapia : 1 mullet)/ feddan, T_3; and 11000 fish (10 tilapia : 1 mullet)/ feddan, T_4. Eight ponds (2 ponds/treatment) each of 1 feddan area (4200 m^2), 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 T_2 followed by T_3, T_1 and T_4, 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 T_4 than that of $T_{2,}$ T_3 and $T_{1,}$ respectively. And these measures for mullet were higher with T_3 than that of T_2, T_1 and T_4, respectively. While the total biomass and net production per pond were higher with T_4 than those of T_3, T_2 and T_1 respectively. The economical efficiency was in favor of T_3 more than T_4 (regarding net returns/total costs %).

Key words: Nile tilapia, grey mullet, polycuture, 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 m^2) 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. (T_1); 7700 fish (10 tilapia : 1 mullet)/fed. (T_2); 8000 fish (3 tilapia : 1 mullet)/fed. (T_3) and 11000 fish (10 tilapia : 1 mullet)/fed. (T_4), 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

* T_1, T_2, T_3 and T_4 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 T_2 followed by T_3,

T_1 and T_4, respectively. While final weight, total gain, daily gain of grey mullet were affected significantly, the highest value was obtained with T_2 followed by T_3, T_1 and T_4, 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 2^{nd} stocking rate (7700 fish, 10 tilapia : 1 mullet)/fed. was the best followed by the 3^{rd} stocking rate (8000 fish, 3 tilapia : 1 mullet)/fed., the 1^{st} stocking rate (6000 fish, 5 tilapia: 1 mullet)/fed. and the 4^{th} 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.

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	
Nile tilapia:					
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	----
Grey mullet:					
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	----

* T_1, T_2, T_3 and T_4 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, $\{(\ln W_2 - \ln W_1) \times 100/\text{days}\}$

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, T_1 and T_4 were the best followed by T_2, T_3, respectively for tilapia. While with grey mullet T_2 was the best followed by T_3, T_1 and T_4, respectively. Regarding the FCR for both species in the pond T_1 and T_4 were the best followed by T_2 and T_3, 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	
Nile tilapia:					
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
Grey mullet:					
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
Nile tilapia and grey mullet					
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

* T_1, T_2, T_3 and T_4 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.

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 T_4 followed by T_2, T_3 and T_1, respectively. Also, body mass of grey mullet at harvesting and the net production per feddan were higher for T_4 followed by T_3, T_2 and T_1. 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.

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	
Nile tilapia					
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
Grey mullet					
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
Total biomass, kg/feddan					
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

* T_1, T_2, T_3 and T_4 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

The economic analysis (Table 6) shows that the income from T_4, T_3 and T_2 were higher than that of T_1 about 61, 56 and 23%, respectively. On the other hand the total cost of treatments as a percent of T_1 were 123, 138 and 159 for T_2, T_3 and T_4, respectively. However, the net returns/pond as a percent of T_1 were 124, 190 and 164% for T_2, T_3 and T_4, respectively. Even though, the net returned/total costs (%) cleared that T_3 was the best followed by T_4, T_2 and T_1, respectively. This result is reflection to the net production and price of tilapia and mullet per each treatment.

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	---
Total variable costs	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

* T_1, T_2, T_3 and T_4 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.

In conclusion, under the experimental condition the results show that the T_4 was more efficient than T_3, T_2 and T_1, respectively. However, the economical efficiency was in favor of T_3 more than T_4 (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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تأثير معدلات تخزين أسماك البلطى النيلى والبورى على أدائها فى الزراعة المختلطة فى الأحواض الأرضية

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2) مديرية الزراعة بالفيوم – وزارة الزراعة.

أجريت تجربة نمو لمدة 150 يوم بدأت فى 2003/6/20 وذلك لتقييم اثر أربع معدلات تخزين لأسماك البلطى النيلى والبورى المرباة معا فى أحواض أرضية بإطسا- الفيوم- مصر على مظاهر النمو والكفاءة الإنتاجية والاقتصادية، وكانت معدلات التخزين المختبرة هى: 6000 سمكة (5 بلطى : 1 بورى)/فدان (المعاملة الأولى)، 7700 سمكة (10 بلطى : 1 بورى)/فدان (المعاملة الثانية)، 8000 سمكة (3 بلطى : 1 بورى)/فدان (المعاملة الثالثة)، 11000 سمكة (10 بلطى : 1 بورى)/فدان (المعاملة الرابعة)، وقد تم استخدام ثمان أحواض (2 حوض/معاملة)، مساحة الحوض 1 فدان وارتفاع عمود الماء به 1.2 م، و كانت تمد بالماء العذب، وغذيت الأسماك على عليقة تجارية (25% بروتين، 4.45 كيلوكالورى/جم طاقة كلية) بمعدل 3% من وزنها وذلك على مرتين يوميا وقد أظهرت النتائج أن:-

مقاييس نوعية الماء لم تتأثر معنويا بالمعاملات وكانت فى الحدود المناسبة لأسماك البلطى والبورى، وبالنسبة لمظاهر النمو فقد تأثرت بالمعاملات حيث كانت أعلى قيم مع المعاملة الثانية تلاها المعاملة الثالثة ثم الأولى وأخيرا الرابعة على الترتيب، وقد تراوحت معدلات الحيوية لأسماك البلطى بين 92 إلى 98% ولأسماك البورى بين 92 إلى 96% وكان وزن الأسماك عند الحصاد والإنتاج الصافى للمعاملة الرابعة أعلى منه للثالثة والثانية والأولى على الترتيب.

ونستخلص من ذلك أن معدل التخزين فى المعاملة الرابعة أكثر كفاءة منه للمعاملات الأخرى وذلك بالنسبة لكفاءة إنتاج السمك من الحوض، أما بالنسبة للكفاءة الاقتصادية فقد تفوقت المعاملة الثالثة وذلك عند النظر للعائد الصافى كنسبة مئوية من التكاليف الكلية.

الكلمات الدالة: البلطى- البورى- معدل التخزين – الزراعة المختلطة- مظاهر النمو- الكفاءة الإنتاجية والاقتصادية