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Performance of Grey Mullet (*Mugil cephalus* L.) Reared in Monoculture in the New Desert Areas

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ABSTRACT

This study aimed to investigate the prevailing water quality parameters, plankton communities , total production and economic returns of grey mullet (*Mugil cephalus*)fingerlings ,reared at three different stocking densities in monoculture system under Egyptian condition. Fish were stocked at three denities of 1 fish/m^3 (SD_1), 2 fish/m^3 (SD_2) and 3 fish/m^3 (SD_3). Average initial weight of mullet fingerlings was 10±0.20 g. The present study was conducted at 6 earthen ponds each 5000m^2. The duration of the experiment lasted 8 month. Results showed that there was significant differences ($P< 0.05$) between (SD_1 and SD_2) and (SD_3) on growth performance, which decreased as stocking densities increased . The highest final mean weight of fish resulted from (SD_1) followed by (SD_2) and (SD_3), however the total fish yield increased with increase of the stocking density but with no increases in profitability compared to the lowest stocking rate 1fish/m^3. Based on the obtained results and economical evaluation it could be recommended that, the best stoking rate of grey mullet (*M.cephalus*) fingerlings during rearing period. was 2 fish /m^3 (SD_2) under the experimental condition in the new desert areas.

Key words: Monoculture, Mullet, Stocking densities, Plankton communities, Growth performance, Yield and Economic returns

INTRODUCTION

The most common species of fish produced in Egypt are tilapia (40% of production from all sources) and grey mullet (*Mugil cephalus*) (14%) These two groups account for more than half of all fish production (MSSP, 2001). Fertilization and supplementary feeding led to best growth rate of *M.cephalus* compared to supplementary feeding only.(Abd -El Tawab *and Yones* 2001)

Flathead grey mullet enhanced phytoplankton development due to the removal of large cladoceranss and not as a consequence of nutrient release. Further more, the flathead grey mullet strongly

modified the benthic community , probably due to direct predation (Torras *et al.*, 2000).The survival of mullet exceeded 97% and it did not appear to be affected by the quantity or quality of food presented and it also had the ability to digest and utilize the artificial diet (Abd El-Ghany *et al.*, 1996) .Mullet have a world wide distribution because they feed at the lowest trophic levels on plant detritus and algae .They are extremely abundant in estuaries , and are easily caught and transported . They are especially suited for farming in fish ponds (Oren,1981).

The aim of the present study was to investigate the water quality criteria, plankton communities, growth parameters, survival rate, body composition, total fish production and economic efficiency of grey mullet (*M.cephalus*) reared at different densities in the new desert areas under monoculture conditions.

MATERIALS AND METHODS

The present study was carried out in private fish farm at Wady-El Natron, Behira Governorate , Egypt .Six brackish water earthen ponds of 5000 m^2 each and water depth 1.00 m. in average were used during the experimental period. Ponds were stocked with grey mullet (*Mugil cephalus* L.) fingerlings in monoculture system at stocking density of 1 fish/m^3 (SD_1), 2 fish/m^3 (SD_2) and 3 fish/m^3 (SD_3). Three treatments in two replicates each were used. Fish were adapted for two weeks period in concrete pond before the start of the experiment fed diet formulated from locally available ingredients. Then active fish averaging 10 ±0.20g. in weight were allotted randomly to six earthen ponds. Diet was formulated to contain nearly 20% crude protein and 3420 k. cal gross energy per kg. The protein, carbohydrate and lipids sources were fishmeal, yellow corn, wheat bran, wheat flour and corn oil respectively (Table, 1). Feed was distributed in the pelleted form of 2.0 mm. Feed was given to the fish at 3% of the total biomass per day (5 days per week). The daily ration was offered into two portions at 9.00, a.m. and 2.00 p.m.. A sample of 100 fish from each pond were weight at fortnight intervals and the amount of feed offered was readjusted. Individual weight and length were recorded (150 fish/pond) at the end of the present study.

Feed ingredients and sample were pulverized and homogenized. In this homogenate, dry weight, nitrogen, fat, fiber and nitrogen free extract (N.F.E.) were determined according to A.O.A.C. (1990). Whole body of fish samples were ground together after deep freezing and the following were determined, dry matter, ash, lipid and protein according to A. O.A.C.(1990) . The experiment, was started on 25 March and lasted for 32 weeks. Organic and chemical fertilizer were used in all experimental ponds, to accelerate phytoplankton and zooplankton, at a rate of 200 kg cattle manure, 20 kg. superphosphate and 10 kg ammonium sulfate biweekly.

Table (1) *Composition and proximate chemical analyses of the experimental diet (As % of dry matter basis).*

Ingredients	%
Fish meal	20
Yellow corn	33
Wheat bran	33
Wheat flour	7
Corn oil	2
Vitamin premix*	2.5
Mineral premix**	2.5
Total	100
Chemical analysis	
Dry matter	86.51
Crude protein	19.81
Ether extract	3. 38
Ash	19.02
Crude fiber	9.11
Nitrogen free extract+	48.68
Gross Energy (kcal/g diet) ++	3.42

***Vitamins mixture contained (as g/ kg premix) : Thiamine 2.5 ; Riboflavin 2.5 , acid pyridxine 2.0 Inositol 100.0 ;Biotin 0.3; Pantothenic acid 100.0 ; Folic acid 0.75; Para-aminobenzioic 2. 5 Choline 200.0 Nicotinic acid 10. Cyanocobalmine 0.005; Tocopherol acetate 20.1 ;Ascorbic acid 50.0 ; Menadione 2.0 . ; Retinol palmitate 100.000IU ; Cholecalciferol 500.000 IU.*

**** Minerals premix (as g/ kg of premix) CaHPO4.2H20 727.7775; MgSO4 ; H20 127.5 ; KCal 50.0; NaCl 60.; FeSO4. 7H20 25.; ZnSO4. 7H20 5.5; MnSO4. 4H20 2.53; CuSO4.5H200.785; CoSO4. 7 H20 0.4775; Calo3.6H2 0.295; CrC13.6H20 0.1275*

+ Calculated by difference

++ Gross energy were calculated , the energy value (Kcal/ g) for protein 5.65; for lipid 9.45 and for carbohydrate 4.1 (Jobling , 1983)

To process the data, total gain was calculated according to the equations.

Total gain g / fish = Average final fish weight (g) – Average Initial fish weight (g)

Absolute Growth Rate (g / day) =

$$\frac{\text{Final fish weight (g)} - \text{Initial fish weight (g)}}{\text{Time in day}}$$

Water Quality Measurements

Temperature, dissolved oxygen and pH were measured daily using temperature and dissolved oxygen meter (YSI model 57) and pH meter (model corning 345). Transparency and Turbidity were measured daily by Secchi disk. Determinations of phosphorous and ammonia were carried out every two weeks according to methods of Boyd (1990). Phytoplankton and zooplankton communities in pond water determined every two weeks according to the methods described by Boyd and Tucker (1992). Samples were collected from different sites of the experimental ponds randomly to represent the water of the whole pond.

Statistical Analysis

One way analysis of variance was tested after Steel and Torrie (1980). Duncan's Multiple Range test (Duncan, 1955) was applied to compare the significance means of the various parameters at 5% probability level.

RESULTS AND DISCUSSION

A) Water quality criteria

1- Physial characteristics

Average water quality criteria as affected by different stocking densities are presented in Table(2).Results revealed that there are no significant differences in water temperature, which was ranged between 22.4 and 29.3^{o}C in all treatments. Transparency (Secchi disk reading in cm) was significantly affected by different stocking densities. The maximum averages were obtained from treatment 1(SD_1) and treatment 2 (SD_2) [14.65 and 15.0 cm, respectively], where third treatment was the lowest(13.5cm). These mean that , at higher densities the water are more turbid which may be resulted from fish movement in the ponds. These values (water temperature ^{o}C and Secchi disk reading cm.) are beneficial to fish cultivation. In this connection, Oren (1981); Marai *et al*. (2003) and Lupatsch *et al*. (2003) reported that no significant deferences in temperature was observed in ponds with different stocking densities. In this respect, Abd-El Tawab *and Yones* (2001) found that temperature of El-Fayoum fish farms ranged between 25.6 to 30.6, which are near to our findings. Temperature and transparency values are in the range recommended for the fish species cultured in the three treatments (Boyd , 1990).

2- Chemical Characteristics

Average of pH values for treatments (SD_1); (SD_2) and (SD_3) were 8.25; 8.8 and 8.4, respectively. And differences were insignificant ($P \leq 0.05$). Average of dissolved oxygen (DO) values were ranged between 3.82 to 8.95 mg/L. These values may be beneficial to fish cultivation and indicate also that dissolved oxygen concentrations were decreased at early moring in all experimental ponds. This values were agreed with the findings of Boyd and Tucker(1998).

Unionized (free) ammonia values (NH_3) in Table (2) were low to be toxic to fish , and it was < 0.5 mg/L and lay in the normal range. These values are beneficial to fish cultivation and agreed with the findings of Wurts (2003) and Samra (2006) who concluded that the toxic levels for unionized ammonia for short time exposure usually lie between 0.6 to 2.0 mg/L for pond fish. Averages of salinity and total hardness were no significantly affected by treatments (Table, 2). These values showed no variations and they lay in the disirable range for mullet, cultured in the three treatments Oren,(1981).Averages of phosphorus had ranged between 1.8 and 2.5mg/L, which were insignificantly differences (Table, 2) and showed no nutrient limitations (Boyd, 1990).

3-Hydro-Biological Features (Plankton communities)

3-1-Phytoplankton

Results presented in Table (3) illustrated the effect of stocking densities of grey mullet on phytoplankton communities. The total phytoplankton productivity for treatments (SD_1); (SD_2) and (SD_3) were found to be 1860; 1254 and 840 thousand organism/L, respectively.The results in Table (3) indicate also that the highest phytoplankton values were obtained by the lowest density(SD_1) also followed in a decreasing order with higher density, (SD_2) and (SD_3) treatments, respectively. The present study indicated also that green algae are the dominant group followed by euglena; blue green algae and diatoms in the all treatment mullet groups. This means that, *M.cephalus* fingerlings preferred diatoms and blue green algae in their feeding habits and this recommended by Essa and Salama (1990). This community composition of phytoplankton reported in this study is in agreement with observations of Abdel – Hakim *et al*. (2000). On the other hand Abd-El Tawab (1994) gave different community compositions of phytoplankton, which may be due to the differences in the ecological conditions of the ecosystems studied.

Table (2) *: Physical and chemical characteristics of experimental ponds water during the present study.*

Parameters	Treatment		
	(SD_1) 1fish/m^3	**(SD_2) 2 fish/m^3**	**(SD_3) 3 fish/m^3**
Temperature (^oC)	25.65 a	25.85 a	25.20 a
	(22.4 – 28.9)	(22.4 – 29.3)	(22.4-28.0)
Seccki disk (cm)	14.65 b	15.0 a	13.5 b
	(12.5 – 16.98)	(11.8 – 18.2)	(10.3 – 16.8)
Dissolved oxygen	6.42 a	6.11a	5.36 b
(mg/L)	(3.90 – 8.95)	(4.11 – 8.12)	(3.82 – 6.90)
pH	8.25 a	8.8 a	8.4 a
	(7.5 – 9.0)	(7.8 – 9.8)	(7.9 – 9.01)
NH_3 mg/L	0.18 a	0.23 b	0.24 b
	(0.05 – 0.31)	(0.05 – 0.41)	(0.06 – 0.42)
Salinity g/L	12.15 a	12.20a	12.25 a
	(10.3 – 14.0)	(10.2 – 14.2)	10.3 – 14.2)
Total hardaness	270 a	271 a	275 a
mg/L	(210- 330)	(211 – 331)	(210-340)
Available	2.5 a	2.34 a	1.81 b
Phosphorus	(1.8 – 2.2)	(1.8-2.88)	(1.5 – 2. 13)

Means with the same letter in the same row are not significantly difference at the 5% level.

3.2- Zooplankton

Results presented in Table (3) illustrated the effect of stocking densities on zooplankton communities in mullet ponds .The total zooplankton productivity for treatments (SD_1) ; (SD_2) and (SD_3) were found to be 4342; 3101 and 2526 organism /L , respectively on the average. Results revealed that the lowest total zooplankton counts were obtained by the treatment (SD_3) followed in an increasing order by (SD_2) and (SD_3) treatments, respectively. Results in Table (3) revealed also that the highest counts of Rotifer for treatment (SD_1) , while the lowest treatment in (SD_3) , which it was considered as (100%) .The counts of copepoda for treatments (SD_1) ; (SD_2) and (SD_3) were only 86; 51 and 26 organism/L respectively .The present study indicates that Rotifera is the dominant group in the water ponds followed by Crustacea in all treatment ponds. This means that *M cephalus* fingerlings

Table (3): *Average numbers of phytoplankton and zooplankton in the ponds water of mullet, reared at different densities.*

Org anisms	(SD_1) 1fish/m^3	(SD_2) 2fish/m^3	(SD_3) 3fish/m^3
Phytoplankton (thousands organism / L)			
Blue green algae	420	400	309
Green algae	680	558	410
Diatoms	230	188	120
Euglena	600	508	310
(Biomass)Thou. org./L	1860	1254	840
% of the smallest value	179.76%	149.28%	100%
Zooplankton (organism / L)			
Rotifera	2551	2120	1840
Copepoda	86	51	26
Cladocera	95	80	46
Crustacea	1610	850	620
(Biomass) org./L	4342	3101	2526
% of the smallest value	171.89%	122.76%	100%

preferred crustacean organisms in their feeding habits and the results of Essa and Salama (1990) recommended this finding. These results may be due to the feeding habits of mullet species. The results indicted that the community composition of phytoplankton and zooplankton in all treatment ponds fluctuated greatly with stocking densities and feeding habits of mullet whether phytoplanktonphagic or zooplanktonphagic

B) Survival Rate

Averages survival rate as affected by different stocking densities are presentes in Table (4). The results revealed that there are no significant differences in survival rate , which has ranged between 85.3 % and 85.7 % in all treatments. Generally , the survival rate of grey mullet exceeded 85% in all treatments and it did not appear to be affected by the stocking densities. These results are in agreement with Oren, (1981) and Lupatsch *et al.* (2003).

Table (4): *Effect of stocking density on growth performance of grey mullet (Mugil cephalus).*

Treatments	Avg. Initial body weight g/fish	Avg. final Body weight g/ fish	Avg. weight gain g/fish	Growth rate g/ day	% of the smallest value	%survival rate
(SD_1)	10.0 a	210 a	200 a	0.89 a	% 141.26a	85.3 a
(SD_2)	9.8 a	205.8 ab	196 ab	0.87 ab	%138.09ab	85.7 a
(SD_3)	10.2 a	150.5 b	140.3 b	0.63 b	% 100b	85.4 a

Means with common superscripts in each column were not significantly difference at the 5% level.

C) Growth performance

As shown in Table (4) the average final body weight of grey mullet were 210 , 205.8 and 150.5 g. for (SD_1) ; (SD_2) and (SD_3), respectively. Daily gains were between 0.63 and 0.89 g/day. These values are in agreement with that report by Ojaveer *et al.* (1996) , Abe- El Tawab and Yones (2001) and Abdel Hakim *et al.* (2006) who found that the growth of grey mullet was influenced by the different stocking densities, fertilization and supplementary feeding which led to best growth of *M. cephalues.* The obtained results reported that the stocking rate of 2 fish/m^3 led to assign the largest growth of grey mullet.

D) Chemical composition of whole body

The chemical compositions of the whole body of grey mullet at the end of the study showed in Table (5). The difference stocking rates (1,2,3 fish/m^3) markedly affected the chemical composition of *M.cephalus* body, The lipid content was higher in highest density (SD_3), while protein content was lowest compared to other treatments .Moisture and ash contents of fish were some what similar and showed no trends related to stocking rates .

These values are in a partly agreement with that reported by Hepher (1988) who reported that stocking rate had affected the consuming natural food, organisms contain low energy , while protein is in excess, therefore it is expected that low stocking density fish consuming natural food have minimal fat and maximal protein accumulation in their body.

E) Total fish production (kg/Feddan)

Total fish yield (kg / Feddan) of the grey mullet in relation to stocking rates are presented in Table (6). Results revealed that total fish yields at harvesting for (SD_1); (SD_2) and (SD_3) were found to be 895.65; 1763.70 and 1927.90 kg

Table (5): *Proximate chemical composition of whole body of grey mullet reared in ponds stocked with different densities .*

Treatments	Moisture %	Crude protein %	Fat%	Ash%
Initial	80.22 a ± 0.12	58.80 c ± 0.22	11.20c ± 0.12	29.9 a ± 0.18
Final Stocking rate **(SD_1)**	76.19 b ± 0.53	61.32 a ± 1.40	12.98 b ± 0.12	25.71 a ± 1.56
Final Stocking rate **(SD_2)**	76.94 b ± 0.24	61.68 a ± 0.67	12.85 b ± 0.08	25.37 a ± 0.54
Final Stocking rate **(SD_3)**	73.36 c ± 0.53	60.51 b ± 0.65	13.84 a ± 0.15	25.65 a ± 0.85

Means with common superscripts in each column were not significantly difference at the 5% level.

Table (6): Economical Efficiency of grey mullet (kg/feddan) in L.E.

Item	(SD_1)	(SD_2)	(SD_3)
Production kg./feddan	895.65	1763.70	1927.90
% of the smallest value	100%	196.9%	215.25%
(A) Operating costs			
Fish fingerlings	3750	7500	11250
Food	3642.29	622569	8916.53
Chicken manure	200	200	200
(B)Fixed cost			
Taxes	100	100	100
Labor	300	300	300
Depreciation	100	100	100
Total fixed cost	500	500	500
(C) Total costs (kg./feddan)	**8092.29**	**14425.69**	**20866.53**
(D) Return			
Total Return /feddan	11195.62	22046.25	21206.9
Net Return /feddan	3103.33	7620.56	340.37
(E) % Net returns to total costs	**27.71%**	**34.56%**	**1.60%**

The economical evaluation of results carried out according market price in 2005 in L.E.

Fish / Feddan respectively. These results indicate that increasing the stocking rates from 1 to 2 fish/m^3 resulted in an increase in fish total yield by 96.9 % and a further increase in the stocking rate 3 fish /m^3 resulted in increase in the total yield by 115.25% but with no increases in profitability compared to the lowest stocking rate 1 fish/m^3. These results may indicate that in monoculture system of grey mullet stocking rate 2 fish/m^3 is required for better yield. These results are agreement with Abd-El Tawab (1994) and Abd-El Tawab and Yones (2001). Regarding to the more effective stocking ratio 2 fish/m^3 for marketable size, it was obvious that the stocked 2 fish/m^3 in ponds were valuable (Table, 6), since produced about 60% of the total fish production as an marketable size, followed by 1 fish /m^3. These results led also to conclude that the stocking rate of 2 fish/m^3 led to assign economic value.

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محمد نجيب بكير

المعمل المركزى لبحوث الثروة السمكية بالعباسة

مركز البحوث الزراعية –الجيزة – مصر

أجريت هذا الدراسة بهدف التعرف على تأثير معدل التخزين السمكى على جودة المياه والمجموعات البلانكتونية والإنتاج الكلى والكفاءة الاقتصادية لأسماك البورى الحر (*Mugil Cephalus* L.) وقد تم استزراع اصبعيات البورى فى ثلاث كثافات مختلفة ١ ، ٢ ، ٣ اصبعية للمتر المكعب) بمتوسط وزن ١٠ ± ٠.٢٠ جرام للسمكة الواحدة وقد تم استخدام ٦ أحواض ترابية مساحة الحوض ٥٠٠٠ متر مربع واستمرت التجربة ٨ شهور. وقد أشارت النتائج إلى أن هناك اختلافات معنوية بين المعاملات الثلاثة فى أداء النمو وكان أفضل معدل نمو للأسماك تم الحصول عليه فى معدل الكثافات الأقل مقارنة بمعدل الكثافة الأكبر على درجة معنوية ٥% وكان أكبر متوسط وزن للأسماك ناتج من المعاملة الأولى ١سمكة/م٣ (٢١٠ جرام) يليها فى الترتيب المعاملة الثانية ٢ سمكة/م^{٣}(٢٠٥ جرام) ثم المعاملة الثالثة ٣ سمكة /م^{٣} (١٥٠جرام) وعلى العكس فأن الإنتاج الكلى للأسماك كان أعلى فى الكثافة الأكبر (٣سمكة/م^{٣}) عنه فى الكثافة الأقل ولكن دون تحقيق جدوى اقتصادية مناسبة .

وبناء على النتائج التى تم التحصل عليها وكذلك التقييم الاقتصادى يمكن أن نوصى باستزراع اصبعيات البورى الحر (*Mugil Cephalus* L.) بمتوسط وزن ١٠ جرام بمعدل كثافة 2 سمكة للمتر المكعب تحت نفس ظروف التجربة فى المناطق الصحراوية الجديدة وذلك للحصول على أفضل إنتاج وعائد اقتصادى ممكن.