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IMPACT OF GREY MULLET (*MUGILL CEPHALUS*) DIFFERENT DENSITY CULTURED WITH NILE TILAPIA (*OREOCHROMIS NILOTICUS*) IN EARTHEN PONDS ON THE WATER QUALITY AND FISH PRODUCTION

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Abstract

This experiment was conducted at a private fish farm from Sahl Eltena , North Sinia, Egypt, to evaluate the effect of stocking density of Grey mullet (*Mugil cephalus)* in polyculture with Nile tilapia (*Oreochromis niloticus)* on water quality and growth performance of the two fish species. The study was carried out in nine earthen ponds (5 faddan each with an average depth 1.25m) with three treatments each in three replicates. Each pond was stocked with 10,000 tilapia fingerlings (10.0±0.5g) per feddan. The ponds were divided to three treatments, first, second and third treatments which stocked by 2000, 4000 and 6000 fingerlings (30.0±1.5g) of mullet respectively. The irrigation canal is a branch of El-Salam canal. The results showed that the water quality parameters within the permissible limits for fish culture during the cultural season. Zooplankton and phytoplankton density decreased with increasing fish density. The results indicated that final body weight of Nile tilapia and mullet increased significantly with the decreasing of stocking density of grey mullet. While, the total production significantly increased with increasing density. It could be concluded that final body weight of *M. cephalus* increased significantly with the decreasing of stocking density. Net production (kg)/faddan were highly significant in the third treatment.

The results recommended culturing 10,000 fingerlings of Nile tilapia with a density of 6000 fingerlings of mullet to give high economic return.

Key words: Nile tilapia, Mullet, water quality, zooplankton, phytoplankton, density culture.

INTRODUCTION

Fish have been considered as a healthy dietary alternative to other meat sources because of the high protein and low in saturated fats levels (Domingo *et al.*, 2007). In addition to a high protein content, omega-3 polyunsaturated fatty acids present in fish and shellfish contribute to the health benefits of regular fish consumption (Sidhu, 2003). Tilapias are wildly recognized as one of the most important fish species for freshwater aquaculture with different intensification culture systems (Pullin, 1997).

Tilapia is one of the most widely cultured fish in the world. Currently, farmed tilapia represents more than 75% of world tilapia production (FAO, 2009), and this contribution has been exponentially growing in recent years. Several factors have contributed to the rapid global growth of tilapia. Tilapia is easily cultured and highly adaptable to a wide range of environmental conditions. Tilapia feed on a wide variety of dietary sources, including phytoplankton, periphyton, zooplanktons, larval fish, and detritus. Adult tilapia is principally herbivorous but readily adapts to complete commercial diets based on plant and animal protein sources (Green, 2006). In general, most tilapia is highly tolerant of saline waters, although salinity tolerance differs among species. Nile tilapia is thought to be the least adaptable to marked changes (direct transfer, 18 parts per thousand in salinity (El-Sayed, 2006).

In Egypt, mullet fish especially *Mugil cephalus* and *Liza ramada* are economically very important because they have market value and have been cultivated successfully by fish farmers. Mullet (Mugilidiae) are catadromous fishes widely distributed in the coastal, temperate and tropical waters throughout the world. These coastal species often enter estuarine and freshwater areas. Striped mullet (*Mugil cephalus*) is one of the best-known members of Mugilidae and has significant commercial value in many countries (Oren, 1981).

Approximately 20 species of mullet fish are cultured in many parts of the world (Lee, 1997), and especially its extensive culture is very common for a long time (Agiragac and Kalma, 1998). Adults Grey mullet eat all available food, microalge including epiphytic and benthic forms, and decaying plant detritus (Lupatsch *et al.*, 2003). Striped mullet are used (*M. cephalus*) to remove the organic matter deposited on the sea floor due to the deposition of solid waste from undigested feed, also, Grey mullet (*M. cephalus*) could efficiently use peryphyton that colonized the bamboo substrates in inland saline groundwater (Jana *et al*., 2004).

Tilapias and mullet response very good to pond poly-culture in earthen ponds, both tilapia and mullet responded in their growth performance when they stocked together in earthen pond fertilized with chicken manure, super phosphate and urea (Afifi *et al.*, 1996).

In the last few years, increased interests in aquaculture and polyculture has been witnessed due to spurred interests of many people in fish farming, and this will continue to play an important role in meeting the demand for fish (FAO, 2003)

This study aimed to evaluate the suitable density of grey mullet in poly-culture with Nile tilapia in earthen ponds and its reflection on the economic return of fish farm production.

MATERIALS AND METHODS

The present study was conducted in nine earthen ponds of 20,000 m^2 surface area/ each and 1.25m depth. The ponds were prepared by drying for two weeks before the beginning of the experiment. Ponds were located at Sahl Eltena, North Sinia, Egypt. Ponds were filled with water from El-Salam canal which it is a source of freshwater. The experiment includes three treatments being, 10,000 + 2000, 10,000+4000, and 10,000+ 6000 per faddan (fed) tilapia and mullet for the three treatments respectively. These treatments were assigned to ponds in a completely randomized design and each was in three replicates. The initial weight of tilapia and mullet were (10.0±0.5g) and (30.0±1.5g) respectively. The grow-out duration was 210 days.

Organic fertilizer was analyzed before application using standard methods (AOAC, 1990). It consisted of dry matter wet weight 91.12±3.3%; nitrogen 2.36±0.2%; phosphorus 1.87±0.3% and potassium 0.59±0.07 %. Commercial feed pellets (25% crude protein) was used throughout the experiment and was provided twice a day; five days a week at a rate of 3% of body weight for all fish species in each treatment. Experimental fish were stocked at the rate of 5 fish/m^2. A sample of 100 fish was taken biweekly using a seine net. At the end of the experiment, ponds were drained and all fish were harvested, counted and weighed.

The following measurements were calculated:

- Survival rate (%) = final number of fish/ initial number x 100

- Gross yield of fish/feddan=harvested fish weight (kg)/unit area (feddan)

- Net yield/fed. = (harvested fish weight - initial fish weight)/unit area

Water quality monitoring:

Temperature (°C) and dissolved oxygen (DO mg/l), were measured using oxygen meter (Aqua Lytic OX 24), pH by pH meter (Orion 543) and salinity (g/l) using a conductivity meter Orion. Secchi disk (SD) visibilities (cm), ammonia (mg/l), nitrate (mg/l) nitrite (mg/l), total alkalinity and total hardness (mg/l) as $CaCO_3$ (mg/l), phosphorus (mg/l) and chlorophyll a (µg/l) were measured monthly using standard methods (APHA, 2000) and illustrated in 7 figures and the average values in different months were tabulated in table 1

Zooplankton collection and counting

Plankton was monitored in all ponds. Zooplankton was enumerated biweekly by passing 40 L of pond water through a nylon plankton collecting net (40 µm). The pond water was collected from four positions around the pond using a 10 L bucket. The samples were then collected in bottles and fixed with two to four drops of 4% formalin solution. The organisms were concentrated in a 100 ml from which sub-samples of 1.0 ml were taken for counting on a Sedgewick-rafter counting chamber mounted on a microscope at x40 magnication (APHA 2000). Zooplankton was enumerated and the categories included copepods, cladocerans, rotifers and ostracoda according to Foissner and Perjer, 1996.

Phytoplankton collection and counting:

The phytoplankton samples were also collected biweekly from the same sites of zooplankton collection (APHA 2000).

Statistical analysis:

Results were expressed in tables as (mean ± standard division). Data were analyzed using the SPSS statistical package. One way ANOVA and Duncan's multiple comparison tests were used to compare the data among stations at ($p< 0.05$). All the statistical analyses were done using SPSS program version 15 (SPSS, Richmond, USA) as discussed by Dythem (1999).

RESULTS AND DISCUSSIONS

Polyculture system is commonly applied semi-intensively in ponds where the flow of nutrients through the food web depends largely on nutrient availability in the water column. Nutrients are predominantly supplied as fertilizer and/or feed; yet, in ponds that receive protein pellets, less than approximately 35% of the supplied nitrogen (N) and phosphorous (P) are retained`` in fish biomass (Rahman *et al*., 2008).

Table 1. Average all means of some water quality parameters in different treatments throughout the culture season.

	Treatment 1	Treatment 2	Treatment 3
Temperature °C	28.6 ^{a} ±1.5	28.6 ^{a} ±1.4	28.7 ^{a} ±1.2
pH	8.12 ^{a} ±0.5	8.17 ^{a} ±0.4	8.32 ^{a} ±0.4
S.D Cm	24 a ±1.2	19.5 b ±1.5	12 c ±2
D.O. mg/l	6.68 ^{a} ±0.2	6.02 ^{b} ±0.3	5.4 ^{c} ±0.3
NH_4 mg/l	0.84 ^{b} ±0.1	1.02 ^{a} ±0.1	1.12 ^{a} ±0.1
NO_2 mg/l	0.014 ^{c} ±0.01	0.03 ^{b} ±0.01	0.04 ^{a} 8±0.03
NO_3 mg/l	0.11 ^{c} ±0.01	0.18 ^{b} ±0.02	0.26 ^{a} ±0.03
Salinity g/l	5.17 ^{a} ±0.5	5.21 ^{a} ±0.5	5.32 ^{a} ±0.5
Total alkalinity mg/l	272 ^{a} ±12	273.1 ^{a} ±14	269.1 ^{a} ±12
Total hardness mg/l	338.5 ^{a} ±22	342.3 ^{a} ±24	342.8 ^{a} ±32
Chlorophyll a µg/l	68.72 ^{c} ±11.1	84.88 ^{b} ±14.2	112.2 8 ^{a} ±14.6

Values with different superscripts in the same raw are significantly different ($P< 0.05$).

Means monitored water quality are summarized in Table 1. There were no significant differences in water temperature among treatments during the experimental period. These averages of water temperatures were 28.6; 28.6 and 28.7°C in treatments (T1, T2 and T3) throughout the whole period respectively. Certainly the low water temperature affected the growth of striped mullet although it could not survive at temperature range of 8-24 ^{O}C (Abdel Tawwab *et al.,* 2005). The pH values were 8.12; 8.17 and 8.32 in T1; T2 and T3 respectively. These results indicated that the increasing density of mullet did not significantly affect the water pH values. The SD readings were higher in water ponds for the first treatment indicating that the low abundance of plankton in these ponds compared to the other treatment ponds. These results indicated that the organic compound and nutrient were significantly increased the density. Also, the density in all ponds was more suitable. These results are in agreement with those obtained by Shaker *et al.,* (2002). Dissolved oxygen concentration was higher in T1 than the other two treatments and in T2 than that in last treatment. The dissolved oxygen was never fell below 5.2 mg/l in any pond. Dissolved oxygen decreased with increasing the stocking density of fish, this may be due to oxygen consumption, fish growth and metabolism this in agreement with Ibarz *et al.,* 2007. The concentration of nitrogen compound showed a higher significance difference ($P<0.01$) in T3 than in the others. These results may be due to increase of stocking density. These results are in agreement with those obtained by Shaker and Abdel-Aal (2006) and Hamed and Hassan (2011) who reported that the nitrogen compound had a positive correlation with one stocking density. The pH; temperature and dissolved oxygen were the most influencing parameters in fish ponds. In the present study although the previous parameters fluctuated from time to time, they stayed within the acceptable and favorable levels required for growth, survival and values well-being of the tested tilapia and mullet fish ponds as recorded by (Mmochi *et al.,* 2002 and Tiwari and Chauhan, 2006).

The average values of nitrogen compound in water during the experiment were significantly ($P< 0.05$) increased with period this finding that the nitrogen compound were depending on pond management, the nitrogen compound (NH_4, NO_2 and NO_3) were the main products of the organic matter analysis. These results are in agreement with those obtained by Shaker *et al.* (2013) who reported that the nitrogen compound increase with increase the organic matter. The increase of NH_3 -N in T3 ponds with increasing stocking density could be explained by the decomposition of organic matter and via the direct excretion of ammonia by the large biomass of fish. The $NO_3$and NO_2 concentrations in water followed the same trend of ammonia-nitrogen. These results may be due to the consumption of nitrate (which is an essential nutrient) by phytoplankton communities. Also, the increase of nitrate in T3 may be related to the increase of phytoplankton standing corps. It is of particular interest to notice a positive correlation between nitrate content and total phytoplankton which may be attributed to high consumption rate of NO_3-N by the dense vegetation. These results are in harmony with those obtained by Shaker (2008). Total ammonia increased significantly with increasing stocking density of fish in ponds as results of increasing fish west and residual of feed.

There was no significant difference in total hardness and total alkalinity among treatments. In polyculture ponds, the principal surface area for nitrification is the sediment, where oxygen availability is the limiting factor. Water quality is improved through the higher rate of nitrification and ammonia uptake by algae (Thompson *et al.*, 2002). The uneaten food and dead algae cells remain attached with the phytoplankton, providing a rich source of organic nutrients for heterotrophs associated with dead phytoplankton layer. Processing of this organic matter yields inorganic nutrients that can be utilized by living algae again. The average concentrations of chlorophyll a were 68.72µg/l; 84.88µg/l and 112.28µg/l for treatments 1; 2 and 3 respectively. These results indicated that the nutrients in water were significantly ($P<0.05$) increased with increasing fish density in ponds under these limits. These results are in harmony with the S.D results in this experiment. The higher amounts of chlorophyll a which recorded in treatment 3, indicated a higher level of phytoplankton production. This is consistent with the work reported by Shaker and Abdel-Aal (2006) with higher inputs of artificial feed in semi-intensive earthen ponds at Manzala fish farm.

Table 1a. Monthly means of water temperature (°C), pH and dissolved oxygen (mg/l) in different treatments during the culture season.

	Treat	May	June	July	Aug.	Sept.	Oct.	Nov.
Temp. °C	T1	26.2 [a] ±0.3	28.1 [a] ±0.3	31.3 [a] ±0.2	31.5 [a] ±0.6	28.4 [a] ±0.2	27.6 [a] ±0.3	27.3 [a] ±0.2
	T2	26.3 [a] ±0.2	28.0 a ±0.2	31.5 [a] ±0.5	31.4 [a] ±0.4	28.5 [a] ±0.3	27.7 [a] ±0.2	27.1 [a] ±0.2
	T3	26.5 [a] ±0.4	28.3 [a] ±0.4	31.4[a] ±0.4	31.6 [a] ±0.3	28.6 [a] ±0.2	27.6 [a] ±0.3	27.2 [a] ±0.3
pH	T1	7.8 [a] ±0.2	7.9 [a] ±0.2	8.1 [a] ±0.2	8.4 [a] ±0.1	8.4 [a] ±0.2	8.1[a] ±0.3	8.2 [a] ±0.2
	T2	7.7 [a] ±0.1	7.9 [a] ±0.2	8.2 [a] ±0.3	8.5 [a] ±0.2	8.5 [a] ±0.3	8.1 [a] ±0.2	8.3 [a] ±0.3
	T3	7.9 [a] ±0.2	8.0 [a] ±0.1	8.2 [a] ±0.2	8.8 [a] ±0.2	8.7 [a] ±0.3	8.3 [a] ±0.1	8.4 [a] ±0.2
DO mg/l	T1	6.6 [a] ±0.3	6.9 [a] ±0.1	6.6 [a] ±0.1	6.3 [a] ±0.2	6.8 [a] ±0.2	6.9 [a] ±0.4	6. 7 [a] ±0.2
	T2	5.9 [b] ±0.2	6.4 [b] ±0.1	6.2 [b] ±0.2	5.8 [b] ±0.1	5.9 [b] ±0.3	6.2 [b] ±0.3	5.8 [b] ±0.2
	T3	5.2 [c] ±0.2	5.8 [c] ±0.2	5.7 [c] ±0.2	5.2 [c] ±0.1	5.3 [c] ±0.3	5.4[c] ±0.3	5.2 [c] ±0.2

Means having the same letter in the same column for the same parameter and month are not significantly different ($P > 0.05$).

Table 1b. Monthly means 0f total ammonia (mg/L), nitrite (mg/l) and nitrate (mg/l) in different treatments during the culture season.

	Treat	May	June	July	Aug.	Sept.	Oct.	Nov.
NH_4 mg/l	T1	0.6 [c] ±0.04	0.7 [c] ±0.06	0.9 [c] ±0.05	0.95 [c] ±0.06	0.9 [c] ±0.02	0.9 [c] ±0.05	0.96[c] ±0.05
	T2	0.7 [b] ±0.08	0.9 [b] ±0.05	1.0 [b] ±0.08	1.2 [b] ±0.07	1.2 [b] ±0.07	1.1 [b] ±0.06	1.1 [b] ±0.07
	T3	0.9 [a] ±0.07	1.0 [a] ±0.07	1.1 [a] ±0.09	1.2 [a] ±0.08	1.3 [a] ±0.07	1.1 [a] ±0.08	1. 2 [a] ±0.06
NO_2 mg/l	T1	0.009[c] ±0.001	0.012[c] ±0.002	0.017[c] ±0.002	0.016[c] ±0.001	0.015[c] ±0.001	0.018[c] ±0.001	0.016[c] ±0.003
	T2	0.023[b] ±0.002	0.032[b] ±0.002	0.041[b] ±0.002	0.031[b] ±0.001	0.041[b] ±0.001	0.032[b] ±0.001	0.04[b]2 ±0.002
	T3	0.034[a] ±0.002	0.038[a] ±0.003	0.054[a] ±0.003	0.053[a] ±0.001	0.054[a] ±0.001	0.055[a] ±0.001	0.054[a] ±0.003
NO_3 mg/l	T1	0.09 [c] ±0.002	0.11[c] ±0.001	0. 12[c] ±0.001	0.13[c] ±0.02	0.11[c] ±0.01	0.14[c] ±0.01	0.13[c] ±0.02
	T2	0.11[b] ±0.004	0.15[b] ±0.002	0.19[b] ±0.003	0.19[b] ±0.03	0.23[b] ±0.01	0.22[b] ±0.02	0.21[b] ±0.01
	T3	0.13[a] 0.003	0.17[a] ±0.001	0.34[a] 0.002	0.34[a] ±0.02	0.38[a] ±0.02	0.31[a] ±0.01	0.29[a] ±0.01

Means having different letter in the same column for the same parameter and month are not significantly different ($P < 0.05$).

Table 1c. Concentration of salinity (g/l), total alkalinity (mg/l) and total hardness (mg/l) in different treatments during the culture season

	Treat	May	June	July	Aug.	Sept.	Oct.	Nov.
Sal. g/l	T1	3.8 ^{a} ±0.1	4.2 ^{a} ±0.2	6.8 ^{a} ±0.2	6.2 ^{a} ±0.2	5.4 ^{a} ±0.1	5.2 ^{a} ±0.2	4.6 ^{a} ±0.1
	T2	3.9 ^{a} ±0.2	4.1 ^{a} ±0.1	6.9 ^{a} ±0.2	6.1 ^{a} ±0.2	5.5 ^{a} ±0.1	5.3 ^{a} ±0.1	4.7 ^{a} ±0.2
	T3	3.8 ^{a} ±0.1	4.3 ^{a} ±0.2	6.7 ^{a} ±0.2	6.4 ^{a} ±0.3	5.7 ^{a} ±0.2	5.5 ^{a} ±0.2	4.9 ^{a} ±0.3
T. alk. mg/l	T1	274 ^{a} ±13	284 ^{a} ±22	257 ^{a} ±17	262 ^{a} ±25	269 ^{a} ±19	274 ^{a} ±20	284 ^{a} ±21
	T2	279 ^{a} ±12	288 ^{a} ±21	265 ^{a} ±21	266 ^{a} ±21	265 ^{a} ±17	268 ^{a} ±27	281 ^{a} ±19
	T3	281 ^{a} ±14	279 ^{a} ±19	262 ^{a} ±23	259 ^{a} ±19	263 ^{a} ±23	265 ^{a} ±21	275 ^{a} ±24
T.H. mg/l	T1	310 ^{a} ±15	327 ^{a} ±26	359 ^{a} ±12	351 ^{a} ±21	335 ^{a} ±22	342 ^{a} ±19	346 ^{a} ±17
	T2	325 ^{a} ±17	321 ^{a} ±21	366 ^{a} ±17	356 ^{a} ±19	342 ^{a} ±19	345 ^{a} ±18	341 ^{a} ±18
	T3	317 ^{a} ±21	329 ^{a} ±19	362 ^{a} ±25	355 ^{a} ±23	339 ^{a} ±27	346 ^{a} ±19	352 ^{a} ±19

Means having different letter in the same column for the same parameter and month are not significantly different (P < 0.05).

Table 2. Average number of all means (org./10^5) of phytoplankton under different treatments during the experiment period.

Items Treat.	Chlorophyta	Bicillarophyta	Cyanophyta	Euglena	Total
T1	355.2 ^{c} ±48	312.4 ^{c} ±57	102.8 ^{c} ±12	165.4 ^{c} ±15	935.8 ^{c} ±74.1
T2	466.8 ^{b} ±68	347.7 ^{b} ±69	114.1 ^{b} ±12	176.2 ^{b} ±36	1104.8 ^{b} ±77.2
T3	642.2 ^{a} ±88	384.6 ^{a} ±78	116.3 ^{a} ±14	188.2 ^{a} ±22	1331.3 ^{a} ±82.4

Means in column followed by different letters are significantly different (P<0.05).

Total and classification of phytoplankton and zooplankton are illustrated in Tables (2 & 3) respectively. The identification of phytoplankton and zooplankton were classified to four groups. The main group of phytoplankton was Chlorophyta followed by Bicillarophyta. The total numbers of Chlorophyta were 355.2org/l; 466.8org/l and 642.2org/l for three treatments respectively. Bicillarophyta were 312.4org/l; 347.7 org/l and 384.6 org/l for the same treatments respectively. The average total numbers of phytoplankton were 935.8 orgx10^5/L; 1104.8 orgx10^5/L and 1331.3 orgx10^5/L for T1, T2 and T3 respectively which were significantly higher in third treatment than these in the other treatments. These results may be due to the uneaten feed in these treatments which led to increase the nutrients that increased the density of phytoplankton these results are hand in hand with Shaker and Abdel Aal (2006) who recorded that higher input of artificial feed lead to higher increase of phytoplankton.

Table 3. The average all means of (Rotifer, Cladocera and Copepod and Ostracoda individual/L) in different treatments throughout the culture season

	Treat.	May	June	July	Aug.	Sept.	Oct.	Nov.	Total	T.M.
Rotifer Ind./l	**T1**	35.2± 0.8a	72.2± 0.7a	97.2± 0.8a	130.2 ±0.7a	118.2 ±0.6a	80.2± 0.4a	63.1± 0.4a	596	85.2
	T2	32.3± 0.4a	71.1± 0.5b	84.3± 0.6b	78.1± 0.6b	78.3± 0.4b	67.3± 0.2b	52.2± 0.4b	463	66.1
	T3	33.2± 0.6a	44.3± 0.9c	70.1± 0.5c	70.3± 0.8c	67.1± 0.5c	35.2± 0.4c	21.2± 0.3c	271	38.7
Cladocera Ind./l	**T1**	29.5± 0.9a	37.2± 0.9a	35.2± 0.7a	30.3± 0.7a	39.3± 0.8a	38.2± 0.6a	27.4± 0.6a	391	48.6
	T2	24.2± 0.5b	31.1± 0.7b	33.1± 0.8b	28.2± 0.6b	30.2± 0.9b	24.3± 0.7b	23.6± 0.2b	195	27.9
	T3	22.2± 0.8c	28.3± 0.6c	31.2± 0.4c	30.1± 0.5a	28.4± 0.5c	15.4± 0.8c	14.5± 0.4c	170	24.3
Copepod Ind./l	**T1**	15.2± 0.3c	28.4± 0.5a	23.2± 0.1a	24.2± 0.3a	18.2± 0.8a	19.2± 0.2a	19.2± 0.2a	148	21.1
	T2	17.3± 0.4b	25.1± 0.6b	24.1± 0.3b	21.3± 0.6b	13.1± 0.3b	16.3± 0.4b	9.4± 0.4b	127	18.1
	T3	18.4± 0.3a	17.3± 0.7c	16.2± 0.6c	19.2± 0.3c	11.2± 0.9c	11.1± 0.7c	6.2± 0.5c	100	14.3
Ostracoda Ind./l	**T1**	5.5± 0.2a	6.1± 0.2a	4.1± 0.1a	6.1± 0.1a	7.1± 0.2a	5.2± 0.1a	6.1± 0.2a	40	5.7
	T2	2.1± 0.1c	4.1± 0.1b	3.1± 0.2b	4.2± 0.2b	5.2± 0.1b	3.1± 0.2b	4.2± 0.2b	26	3.7
	T3	3.3± 0.2b	3.2± 0.2c	1.2± 0.3c	3.2± 0.3c	4.4± 0.3c	2.1± 0.3c	2.2± 0.3c	19	2.7

Means having different letters in the same column for the same order and same month are significantly different ($P < 0.05$).

Zooplankton was collected from different ponds was identification and counted as four orders rotifer, cladocera, copepod and ostracoda Table (3). Rotifer count was gradually decreased in number with increasing mullet density, so rotifer count was highly significant in T1 (130.2±0.7 ind/l) in August whereas, it was significantly decreased in T3 (21.2±0.3 ind/l) at November during the culture season. Order cladocera likewise rotifer order where cladocera count was reduced with time in each treatment as following T1 was ranged from 39.3±0.8 ind./l to 27.4±0.6 ind./l, T2 was ranged from 33.1±0.8 ind./l to 23.6±0.2 ind./l and T3 was ranged from 31.2±0.4 ind./l to 14.5±0.4 ind./l during culture season. Order coppoda likewise cladocera order where copepoda count was reduced with time in each treatment as following T1 was ranged from 24.2±0.3 ind./l to 15.2±0.3 ind./l, T2 was ranged from 25.1±0.6 ind./l to 9.4±0.4 ind./l and T3 was ranged from 19.2±0.3 ind./l to 6.2±0.5 ind./l during culture season. But order ostracoda count was as following, T1 was ranged from 2.1±0.1 ind./l to 5.5±0.2 ind./l, T2 was ranged from 5.2±0.2 ind./l to 2.1±0.1 ind./l and T3 was ranged from 4.4±0.3 ind./l to 2.2±0.3 ind./l during culture season.

The average number of zooplankton and phytoplankton increase with the increasing of water temperature. The highest number were recorded in July, August and September these may due to the increase of water temperature and nutrients so the increase in productivity plankton these in agree with Hamed and Hasssan (2011). The decrease of zooplankton in October and November may due to the increase of fish biomass and the habit of mullet feeding on zooplankton. In general zooplankton was gradual decreased with increasing fish body weight, these was agreement with Hamed and Hasssan (2011) who found that ontogenetic shift in the diet of *M. cephalus* from feeding primarily on copepods and other small zooplankton, to feeding on detritus and algae is coincident with metamorphic changes in the intestine, teeth and lips of the fish as it becomes a juvenile.

Table 4. The growth performance of Nile Tilapia mono sex (10,000/fadan) and mullet (2000, 4000 and 6000 finger legs/faddan) in treatment 1, 2 and 3.

Treat. Items	**T1**		**T2**		**T3**	
	Tilapia	**Mullet**	**Tilapia**	**Mullet**	**tilapia**	**mullet**
Initial weight g	$10^{b} \pm 1$	$30^{a} \pm 2$	$10^{b} \pm 1$	$30^{a} \pm 2$	$10^{b} \pm 1$	$30^{a} \pm 2$
Final weight g	$305^{a} \pm 20$	$280^{b} \pm 20$	$285^{b} \pm 25$	$270^{b} \pm 20$	$275^{b} \pm 20$	$250^{c} \pm 15$
Initial number	10000	2000	10000	4000	10000	6000
Fish stock /feddan	12000		14000		16000	
Survival rate %	$100^{a} \pm 0$	$95^{b} \pm 1$	$100^{a} \pm 0$	95 ± 1^{b}	100 ± 0^{a}	94 ± 2^{b}
Net gain	$295^{a} \pm 15$	$250^{b} \pm 10$	$275^{b} \pm 10$	$240^{b} \pm 10$	$265^{b} \pm 10$	$220^{c} \pm 10$
Daily gain	1.97	1.67	1.83	1.6	1.77	1.47
Total production kg	3050	532	2850	1026	2750	1410
Total prod. /feddan	3582		3876		4160	

Means in the raw followed by different letters for each fish are significantly different ($P<0.05$).

Growth performance of Tilapia and Mullet:

Fish production and growth performance parameters are illustrated in Table (4). The average final weight of Nile tilapia was 305g; 285g and 275 g, for T1; T2 and T3, respectively. The average final weights of mullet were 280; 270 and 250 g for the same treatments respectively. Significant ($P<0.05$) differences among the treatments continued to the end of the experiment. Generally, the final weight, net gain and daily gain increased significantly in all fish species. This accept with Lea (2013) who found mullet in polyculture had significantly better weight gain, specific growth rate, survival and production than those on monoculture, also, Shaker (2008) and Shaker *et al*. (2008) reported that the final weight depends on initial weight and pond management, while the live food (phytoplankton and zooplankton) is more suitable for different fish species. The increase of production with increasing density of fish may be due to the increase of west and residue of artificial feed led to increase of productivity of water phytoplankton and zooplankton according to tables 2 and 3. These results may be due to that zooplankton diets are more digested than artificial feed. Mullet showed significantly ($P<0.05$) lower survival rate of tilapia. The increasing of mullet density did not affected survival rate of tilapia or mullet. Wilcox *et al*. (2006) found that the production of marine fish species increased with increasing natural feeds such as rotifers (*Brachionus* sp.) or brine shrimps (*Artemia* sp.). Results indicated that the increase in the growth of tilapia and mullet due to increased phytoplankton and zooplankton growth, especially mullet depends a lot on nutrition on zooplankton.

CONCLUSION

From the previous results for the analysis of water quality is evident following:

1. The water quality is very appropriate for the fish farming of tilapia and mullet.
2. Good water source allows fish density an increase.
3. The study recommends increasing stocking density of up to 16,000 fingerlings per feddan.

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تأثير استزراع البورى الاصيل بكثافات مختلفة مع البلطى النيلى فى الأحواض الترابية على جودة المياه والأنتاج السمكى

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الملخص العربى

تمت الدراسة فى مزرعة خاصة فى منطقة سهل الطينة (محافظة شمال سيناء) لدراسة تأثير الكثافات المختلفة من أسماك البورى الاصيل المستزرع مع البلطى النيلى على جودة المياه واداء النمو للأسماك. أقيمت التجربة فى احواض تربية مساحة ٢٠ الف متر مربع/ لكل حوض كل حوض يحتوى على عشرة الاف سمكة بلطى لكل فدان / متوسط وزن ١٠جم ±٠.٥ وقسمت التجربة الى ثلاث معاملات الاولى ٢٠٠٠ (الفان سمكة بورى لكل فدان) والثانية ٤٠٠٠ (اربعة الاف سمكة بورى لكل فدان) والمعاملة الثالثة ٦٠٠٠ (ستة الالف سمكة بورى لكل فدان) وكان متوسط سمكة البورى ٣٠± ١.٥ جم وكل معاملة لها ثلاث تكرارات. وكان مصدر المياه ترعه فرعيه من ترعة السلام ماء عذب. واوضحت النتائج ان قياسات جودة المياه كانت داخل الحدود المسموح بها لتربية البلطى والبورى و أن كثافة الهائمات الحيوانية والنباتية تقل بزيادة كثافة أسماك البورى فى الأحواض و ان هناك زيادة معنوية باوزان الأسماك مع نقص الكثافة السمكية بالاحواض بينما وجد زيادة فى الانتاج مع زيادة كثافة اسماك البورى.