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Effect of Stockig Density on Growth Performance and Economic Retern in Semi-Intensive and Extensive Fish Culture Methods in Earthen Ponds

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ABSTRACT

Effect of stocking density on fish performance has been investigated in earthen ponds over five months of growing period in a polyculture system including Nile tilapia (*Oreochromis niloticus)*,common carp *(Cyprinus carpio)*, silver carp *(Hypophthalmichtys molitrix)*, mullet (*Mugel cephalus)* and African catfish *(Clarias gariepinus)*. Experimental ponds have been allocated to various stocking rates of 1, 1.50, 2.00, 2.50, 10 and 15 fish/m^3. The treatments of 10 and 15 fish/m^3 represented the semi-intensive system, while the lower densities represented the extensive culture system. Fish in all treatments fed on 25% crude protein pelleted fish feed at a rate of 3% of body weight that was adjusted throughout the growing period. Feed was offered twice/day for five days/week. Water quality has been monitored monthly. The physico - chemical characters showed two distinct sets of values for the extensive and the semi-intensive stocking densities concurred with for the main water quality parameters, whereas the values of pH, E.C., salinity, alkalinity, hardness, total phosphorus and orthophosphate were significantly higher in extensive system than in semi-intensive system, while the values of D.O, SD, NH3, NO2, N03 were higher in the semi-intensive system compared to the in extensive system. Plankton communities expressed as Chlorophyll *"a"* was significantly higher in the extensive ponds. The results showed also that average fish production was significantly higher in semi-intensive ponds compared to that in extensive ponds. However, for the main fish species (Nile tilapia), the average final weight as well as the average daily weight gain did not vary among treatments, while there were some differences with regard to average final weight for other species. There was no difference concerning the condition factor in all treatments for any of the tested species. The economical analysis revealed increases in variable costs as well as higher net returns when the stocking density increased. However, the rate of return_ to capital percentage has decreased with the increase of the stocking density. The overall analysis suggested that the semi-intensive systems are the most profitable system.

Keywords: Polyculture, Intensive, Extensive,Water quality, Plankton, Growth performance, Economic evaluation,Tilapia, Mullet, Carp, Catfish.

INTRODUCTION

The fish polyculture system as practiced in aquaculture via stocking of fish species of different food habits proved to be an important management tool in utilizing efficiently the natural food resources in fish pond. Synergistic interactions among fish species are manifested by higher growth and yield in polyculture than in monoculture (Karplus *et al.* 1996). The bases for these interactions are the increase of available food resources and the improvement of environmental conditions (Milstein, 1992).

Fish polyculture system was first practiced in China since more than a thousand years ago. It was extremely extensive, requiring little management, stocking several species at low density, often without application of feeds, and producing relatively low yield at low production costs (Lin, 1982). In semi-intensive farming systems, usually natural food is stimulated through the application of organic manures or chemical fertilizers, while feeds are supplied to supplement the available natural food. Aeration devices and automatic feeders have been incorporated into such system whenever possible. By definition, fish are stoked in the semi-intensive system at higher densities compared to that in the extensive ones, and thus, production costs as well as yields are expected to be much higher. In these systems, the supplemented organic wastes and feeds are utilized directly by the fish and also act as fertilizers for the heterotrophic and autotrophic food web. Under manuring and supplemental feeding, natural food still represents an important component of the overall food utilized by fish. The autotrophic path constitutes not only the food source of plankton filter feeding fish, like silver carp, but also provides 60-80% and 50% of tilapia and carp requirements, respectively. The fish growth can even be attributed to natural food developed on the pond bottom (karplus, 1996).

Semi-intensive ployculture and monoculture systems are widely used in fish culture in Egypt, practiced in shallow earthen ponds and in deep dual-purpose irrigation reservoirs. The main species cultured in commercial ponds are Nile tilapia, *Oreochromis niloticus*,common carp *Cyprinus carpio*, silver carp, *Hypophthalmichtys molitrix*, stripped mullet, *Mugil cephalus* and grey mullet, *Liza ramada*. These species are stocked in variety of combinations. The outcomes of such system as fish biomass vary widely.

Recently, along with the intensification trend in Egyptian aquaculture, the requirement for high quality feed has increased. Such higher production costs as well as the high investments have called for better management practices. The contribution of feed costs in fish production increases along with the level of intensification, reaching the highest component in farm operation (Islam, 2002). From economic point of view, such practices may not suite the small-scale farmers with little resources whether in the tropics and to some extent in some parts of Egypt. This is due to finance of constraints which limit the ability of those farmers from accessing the commercially produced pelleted feeds. Thus, in order for those farms to utilize easy and find feed at low cost, alternative management strategies are required.

Fish stocking density is a key factor in determining the management of fish pond and so, the production. It affects the amounts of natural food available per fish, the level of supplemented feeding required (Hepher, 1988), and thus, the intensity of inter- and intra-specific food competition. With increasing stocking density, competition for food among fish increases. The optimal combined stocking densities of several species of fish cultured together should be carefully analyzed in order to optimize both fish performance (growth and yield) and economic profitability of the combined system. Therefore, the objectives of the present study are to evaluate fish production and growth performance as well as the grow-out environments under pond farm at different stocking densities. Economical evaluation for farming systems were also,as tested the main element in the study. Finally, the study tackled the issue of the use of drainage water in Egyptian fish farming.

MATERIALS AND METHODS

The present study was conducted in eighteen earthen ponds with,one feedan area each, and with an average water depth of 1.25m Ponds were localed at Barsseek farm belongs to the General Authority for Fish Resources Development were used in this study. Aeration devices were used in the six ponds (2 Impeller Paddle wheel Aerator-AR-A232-2 h), while, no aeration was practiced in the twelve ponds. Fish were stocked in 15 May and harvested in 20 October 2008, after about 155 day of growth period. Each treatment was conduced in three replicates.

The present study consisted of two parts, which were conducted in completely randomized design. The first group was used to evaluate the fish stocking density under the semi-intensive culture system at a rate of 10 and 15fish/m^3. The second part of the study was targeted to evaluate the lower stocking density ,extensive culture system, at the rate of 1, 1.5, 2.00 and 2.50fish/m^3 have been used as shown in Table 1. The two systems had been stocked with the same fish species, namely, Nile tilapia, *{Oreochromis niloticus);* common carp, *(Cyprinus carpio),* silver carp, *(Hypophthalmichtys molitrix),* mullet, *(Mugil cephalus)* and catfish, *(Clarias gariepinus).* Commercial feed pellets (25% crude protein) was used

Table (1): ***Stocking fish number and initial weights for different fish polyculture species in experimental earthen ponds.***

Species Treatments	Nile Tilapia			Mullet			Common Carp		
	No	I.w g	T.w kg	No	I.w g	T.w kg	No	I.w g	T.w kg
1	38220	50 ± 5.0	1911	2100	50 ± 3.0	105 ± 5.5	840	50 ± 3.0	42.0 ± 1.2
2	57330	50 ± 5.0	2866.5	3150	50 ± 3.0	157.5 ± 6.5	1260	50 ± 3.0	63.0 ± 1.3
3	3822	15 ± 2.0	57.33	210	30 ± 1..5	6.3 ± 0.4	84	30 ± 3.0	2. 52 ± 0.2
4	5733	15 ± 2.0	85.99	315	30 ± 1..5	9.45 ± 0.75	126	30 ± 3.0	3.7 8 ± 0.5
5	7644	15 ± 2.0	114.66	420	30 ± 1..5	12.6 ± 1.1	168	30 ± 3.0	5.04 ± 0.5
6	9555	15 ± 2.0	143.32	525	30 ± 1..5	15.75 ± 1.2	210	30 ± 3.0	6.3 ± 0.75

throughout the present study and was provided twice a day; five days a week at a rate of 3% of body weight and automatically and manually distributed for the semi-intensive and extensive fish ponds, respectively. All experimental ponds were fertilized using poultry liter (150 kg/Fadden). Thereafter, ponds were filled with water for no longer than two weeks before fish stocking. Fish sampling for all species was carried out monthly and the amount of feed was adjusted accordingly.

The chemical composition of the diet used was 90% dry matter, 89.5% organic matter,25% crude protein, 6% ether extract,7% crud fiber, 50.93% nitrogen free extract and 11.07 % ash,calculated gross (GE= 416)energy while that of poultry manure was 92.37 % dry matter, 67.5 % organic matter,

Table (1): *Continued*

Species Treatments	Silver Carp			Catfish			Total		No of fish per-m^3
	No	I.w g	T.w kg	No	I.w g	T.w kg	NO per feddan	T.w Kg	
1	420	50 ± 5.0	21.0 ± 0.6	420	50 ± 5.0	21.0 ± 0.6	42000	2100 ± 31.5	10.0
2	630	50 ± 5.0	31.5 ± 0.7	630	50 ± 5.0	31.5 ± 0.7	63000	3150 ± 35.5	15.0
3	42	50 ± 5.0	2.1 ± 0.2	42	50 ± 5.0	2.1 ± 0.2	4200	70.35 ± 3.2	1.0
4	63	50 ± 5.0	3.15 ± 0.3	63	50 ± 5.0	3.15 ± 0.3	6300	105.5 ± 3.4	1.5
5	84	50 ± 5.0	4.2 ± 0.4	84	50 ± 5.0	4.2 ± 0.4	8400	140.7 ± 3.44	2.0
6	105	50 ± 5.0	5.25 ± 0.5	105	50 ± 5.0	5.25 ± 0.5	10500	175.9 ± 5.5	2.5

18.19% crud protein, 1.92% ether extract, 12.57% crud fiber, 34.82% nitrogen free extract and 32.5% ash.

Water sampling was carried out for several parameters of concern to aquaculture. Physico-chemical water quality parameters were monitored monthly. Temperature and dissolved oxygen were determined directly by a portable digital oxygen meter (YSI model 58, USA). pH was measured using a digital pH meter (Accumet 340) and transparency by a secchi disc. Water electrical conductivity and salinity were determined by conductivity meter (Orion 630), Nitrate, nitrite and free ammonia were determined using a HACH water analysis kits (DR 2000), while total phosphorus, orthophosphate, total alkalinity, total hardness, chlorophyll *"a"* were determined according to standard methods (APHA, 2000) 100ml water sample was filtered through 0.45 M Millipore filter and chlorophyll *a* was extracted in 5 ml of 90% acetone and grinded by tissue grinder, kept for 24h at 5°C.The sample was then centrifuged and measured the absorbance of acetone, chlorophyll *a* concentration was calculated using the equation:

Chlorophyll a in ug= 11.9(A665-A750) V/LxlOOO/s

Where:

A665= the absorbance at 665A, A750 the absorbance at 750,

V = the acetone extract in ml,

L = the length path in the spectrophotometer in cm,

S = the volume in ml of sample filtered.

Qualitative and quantitative estimates of phytoplankton and zooplankton were also estimated monthly according to APHA(2000). The analyses of heavy metals in water and different fish species were determined using atomic absorption (Thermo 6500,) with graphite furnace according to APHA (2000).

At the end of the experiment, fish were harvested, counted,graded to four weight classes[first class=1-5, second class=6-12, third class13-24, and fourth class25-40 fish/kg] to calculate the total harvest (kg).The growth parameters were calculated as follows:

Daily weigth gain (DG) = (Wt_2 - Wti)/ T; Specific growth rate (SGR) = (Ln Wt_2 - Wti) x 100/ T;
where Wti is the initial weight in grams, Wt_2 is the second weight in grams, and T is the period in days; Condition factor (K) = Body weight / Total length^3 x 100.

Economic analysis was done at the end of the study .The total return (value of fish harvest), total variable costs (value of fingerlings, feed pellets, q1 8poultry manure, labor, irrigation water, and interest on variable capital), total fixed costs (depredation of pond equipment and interest on investment) and net return [total return- (total variable costs + total fixed costs)]were calculated according to Shaker and Abdel –Aal (2006).

Statistical analysis was performed using the analysis of variance (ANOVA). Duncan's Multiple Range Test Duncan (1955) was used to determine the significant differences between means at P≤0.05Standard errors of treatment means were also estimated. All statistical evaluations were carried out using Statistical Analysis Systems (SAS) program (SAS, 2000) according to Steel and Torrie (1960).

RESULTS AND DISCUSSION

1.Water quality

The results of physico-chemical parameters and the selected heavy metals in pond water under different experimental conditions are shown in Tables (2&3). The pH values in pond water of the treatments ranged from 8.35 to 9.5. The pH values in extensive ponds were not significantly different. Also the increase of fish density from 1.0 to 2.50 fish/m^3 did not affect pH values (P>0.05). This result is in agreement with Shaker *et al.* (2002) and Shaker and Abdel-Aal (2006).However, the increase in fish density from 2.50 to 15 fish/m^3 has significantly affected the pH values a here indicating that they improved significantly with the increase in stocking density. Dissolved oxygen (DO mg/1) concentrations ranged from 4.2 to 6.8 mg/1 in all treatments. DO concentrations in extensive ponds did not vary significantly, also there were sishtly difference the difference was significant between semi - intensive culture ponds and the others. The use of paddle wheel in semi-intensive ponds enhanced significantly (p<0.05) the DO concentrations in ponds furnished by those aerators compared to the rest of the ponds.

Results of Table (2) revealed that differences among the applied treatments in averages of water temperature were insignificant and ranged between 27.0 and 27.4°C. Temperature, the pH and dissolved oxygen values in all ponds, although fluctuated from time to time but within the acceptable and favorable levels required for growth, survival and well being of the tested fish species Essa *et al* (1989).

Table(2): Means ± standard errors of some physicochemical of water samples of experimental ponds.

Items / Treat.	Density Fish/ m^3	Temp. $^{0-}$C	pH	D. O mg/1	Satura. %	SD Cm	NH_3 mg/1	$N0_2$ mg/1	NO_3 mg/1
1	10	27.4 ± 1.1 a	8..5 ± 0.9 b	6.6 ± 1.0 a	81.5 ± 5..5 a	24.5 ± 2..5 a	2.4 ± 0.4 a	0..36 ± 0.12 b	0..35 ± 0.1 b
2	15	27.3 ± 0.7 a	8..3 5 ± 1.0 b	6.8 ± 1 0 a	85.1 ± 5.1 a	26.5 ± 3..5 a	2.6 ± 0.6 a	0.46 ± 0.11	0.41 ± 0.12a
3	1	27.0 ± 0.6 a	9.4 ± 1.1 a	4..2 ± 0.5 b	64.7 ± 3.5 b	9.5 ± 1.0 b	1..2 ± 0.4 b	0.11 ± 0.03 c	0.15 ± 0.05c
4	1.5	27.1 ± 0.8 a .	9..5 ± 0.9 a	4.4 ± 0.5 b	65.4 ± 6..5 b	11.0 ± 1.0 b	1..3 ± 0..5 b	0.13 ± 0.04 c	0.15 ± 0.05c
5	2	27.1 ± 1.0 a	9.45 ± 0.5 a	4..3 ± 0.5 b	63.5 ± 4..5 b	11.5 ±' 1..5 b	1.4 ± 0..5 b	0.15 ± 0.04	0.18 ± 0.06c
6	2.5	27.1 ± 0.6 a	9.45 ± 0.5 a	4..3 ± 0.4 b	64.1 ± 6.1 b	13.0 ± 1..5 b	1.5 ± 0..3 b	0.21 ± 0.05 c	0.24 ± 0.06c

Mean in the same column followed by different letters are significantly different (Duncan multiple Test P< 0.05) Temp = Temperature $^{0-}$C, D .O = Dissolved Oxygen, Satura. = Saturation% , T.alk. = Total alkalinity, T.H = total hardness T.P = total phosphorus,O.P = ortho phosphate

The secchi disc SD readings were higher in the semi-intensive ponds indicating the low standing crop and abundance of plankton in these ponds compared to the extensive cultured ponds. These results are in agreement with those obtained by Essa *et al* (1989) and Shaker (2002).

The average levels of ammonia-nitrogen were 2.4; 2.6; 1.2; 1.3; 1.4 and 1.5 mg/l for semi-intensive treatments (1-2) and extensive treatments (3-6), respectively. The concentrations of the un-ionized ammonia (toxic form) NH3-N in the present study was lower than those recorded in fertilized fish ponds at Lake Burullus (Mosua, 2004). The increase of NH3-N in the semi-intensive ponds compared to other treatments could be explained by the decomposition of organic matter and via the direct excretion of ammonia by the large biomass of fish.

The NO2 and NO3 concentrations in water followed the same trend of ammonia-nitrogen. The concentrations of NO2 and NO3 were also higher in semi-intensive treatments. These results may be due to the consumption of nitrate (which is an

Table (2): ***Continued.***

Items / Treat.	Density Fish/ m^3	T. N mg/1	E. C mmhos/Cm	Salinity g/l	T. alk mg/1	T.H mg/I	T. P mg/1	O. P mg/1	Chlorophyll"a" μg/l
1	10	5.4 ± 1.6a	2.4 ± 0..3b	1..99 ± 0.1 b	289 ± 50 b	409 ± 72 b	0..91 ± 0.06b	0..31 ± 0.06b	23.5 ± 4.6 b
2	15	5.8 ± 1.8 a	2.4 ± 0..2 b	1.8 ± 0.1 b	294 ± 42 b	434 ± 70 b	0..95 ± 0.14b	0..33 ± 0.07b	26.5 ± 3.1 b
3	1	3..2 ± 1.1 b	3..2 ± 0..3 a	2..5 ± 0.1 a	374 ± 64 a	484 ± 56 a	1..55 ± 0..24a	0.75 ± 0.11a	113.6 ± 12.6 a
4	1.5	3. 15 ± 0.9 b	3..1 ± 0..3 a	2..5 ± 0.1 a	379 ± 60 a	485 ± 66 a	1.71 ± 0.17a	0.76 ± 0.14a	95.5 ± 14.1 a
5	2	3..26 ± 1.1 b	3..30 ± 0..3 a	2..5 ± 0.1 a	379 ± 56 a	504 ± 54 a	1.73 ± 0.19a	0.75 ± 0.13a	95.5 ± 10.1 a
6	2.5	3.3 ± 1.16b	2..99 ± 0..3 a	2.6 ± 0.1 a	384 ± 52 a	494 ± 74 a	1.75 ± 0..21a	0.74 ± 0.19a	98.5 ± 6..9 a

Table (3): ***Phytoplankton and zooplankton in the experimental ponds****.*

Items / Treat.	Phytoplankton (org x 10/)					Zooplankton (org/L)				
	lue-Green	Green	Bacill-aroph	Cyano-ph	Total	Copep.	Clado-cera	Rotifera	Ostra-coda	Total
1	060	82	540	113	2595	55	34	21	12	122
2	76	75	358	80	1989	46	27	13	10	96
3	570	253	1112	819	9754	201	193	96	52	542
4	980	119	920	717	6736	140	120	90	55	405
5	582	753	800	697	5832	128	95	71	42	336
6	100	453	680	577	4810	109	84	59	37	289

Bacillaroph. = Bacillarobhyta, Cyanoph = Cyanophyta

essential, the increase of nitrate in semi-intensive treatments may be related to the decrease of phytoplankton standing corps. It is of particular interest to notice a negative correlation between nitrate content and total phytoplankton which may be attributed to high consumption rate of NO3-N by the dense vegetation. These results are in harmony with those obtained by Shaker *et al*. (2002); Shaker and Abdel-Aal (2006); Islam (2002) ; Mousa (2004) and Hassan (2010).

The average concentrations of total alkalinity (T. alk.) and total hardness (T.H) were suitable for fish growth, survival and well being. These results are in agreement with those obtained by Mousa (2004). The average concentrations of total phosphorus (T.P) and orthophosphate (O.P) were lesser in semi-intensive than in the other treatments. These results may be due to the water exchange in semi-intensive pond that led to the decrease of organic matter in these ponds. The average concentration of chlorophyll *"a"* increased with decreasing fish density per m^3.There results are in agreement with those obtained by Essa *et al* (1988).

The average numbers of phytoplankton and zooplankton (Table 3) decreased with the increase of fish stocking density. The average number of phytoplankton and zooplankton in semi-intensive were 2292,109; but in was 6783 and 393org. /I in extensive ponds, respectively. These results clearly demonstrate that the total amount of phytoplankton and zooplankton decreased in semi-intensive ponds compared to extensive ponds.Also, these results are in agreement with those obtained by Essa *et al* .(1988); Shaker (2002);Shaker and Abdel-Aal (2006) and Hassan and Agouz (2010).Fish semi-intensive farming is usually based on artificial feed, while in extensive system depends mainly on natural food supplemented by supplementary or artificial feed which in turn decreases the production cost per kg of fish in the extensive system. Generally, there were positive correlation among total phosphors (T.P); ortho phosphate (O.P); chlorophyll *"a"* and plankton community and inverse correlation with secchi disk reading in fish ponds. Chlorophyll *"a"* contents in water ponds were related to the occurrence of phytoplankton in ponds water.

2-Fish peiformance

Fish production and growth performance parameters are illustrated in Tables (4&5). The average final weights of Nile tilapia were 232.5 and 240g for semi-intensive and extensive ponds. Respectively. It is clear that the average weights of Nile tilapia and

Table(4): ***Fish production and net production of experimental ponds***

Fish sp. / Treat.	Nile Tilapia		Mullet		Common Carp		Silver Carp		Catfish		Total Production Kg / feddan	Net production kg/ feddan
	A.Wtg	T.Wt kg	A.Wtg	T.Wt kg	A.Wtg	T.Wt kg	A.Wtg	T.Wt kg	A.Wtg	T.Wt kg		
1	235 ± 26a	8982 ± 356b	250 ± 26a	525 ± 22b	900 ± 101b	756 ± 26b	550 ± 30c	231 ± 10c	1750 ± 156a	735 ± 42a	11229 ± 356b	9129 ± 304b
2	230 ± 26a	12613 ± 456a	250 ± 36a	787 ± 26a	875 ± 110b	1102 ± 36a	500 ± 30c	315 ± 10c	1750 ± 166a	1102 ± 32a	15919 ± 356a	12769 ± 324a
3	245 ± 29a	936 ± 99c	360 ± 22a	76 ± 16e	1700 ± 130a	143 ± 18c	1400 ± 76a	59 ± 14a	1600 ± 165a	67 ± 22a	1281 ± 372c	1210.7 ± 316c
4	245 ± 36a	1405 ± 91c	280 ± 38a	88 ± 19d	1050 ± 109b	132 ± 20b	1150 ± 75b	72 ± 12b	1350 ± 172ab	85 ± 20b	1782 ± 136c	1676.5 ± 136c
5	235 ± 30a	1796 ± 79c	260 ± 29a	109 ± 28d	980 ± 92b	165 ± 14b	1050 ± 64b	88 ± 12b	1300 ± 148ab	109 ± 30b	2267 ± 118c	2126.3 ± 112c
6	235 ± 20a	2245 ± 109c	260 ± 16a	136 ± 29c	590 ± 75c	124 ± 16b	810 ± 44bc	85 ± 16c	1100 ± 120b	115 ± 18b	2705 ± 98c	2529.1 ± 88c

Table (5): ***Growth performance of different fish species under different aquaculture systems on the experimental ponds.***

Items / Treat.	Daily Gain					Specific Growth Rate					Condition factor				
	N. Tilapia	Mullet	C. Carp	S. Carp	Cat-fish	N. Tilapia	Mullet	C. Carp	S. Carp	Cat-fish	N. Tilapia	Mullet	C. Cnrp	S. Carp	Cat-fish
1	1.19 ± 0.14a	1.29 ± 0.11b	5.48 ± 0.24b	3.22 ± 0.36c	10.9 7 ± 1.92a	1.00 ± 0.1b	1.04 ± 0.1c	1.86 ± 0.12 b	1.55 ± 0.12b	4.82 ± 0.2a	1.45 ± 0.2a	1.2 ± 0.11a	2.5 ± 0.15a	2.51 ± 0.14a	2.57 ± 0.22a
2	1.16 ± 0.1a	1.29 ± 0.11b	5..32 ± 0.46b	2.90 ± 0.26b	10.9 7 ± 1.56a	0.98 ± 0.1b	1.04 ± 0.1c	1.85 ± 0.16 b	1.48 ± 0.12b	2.29 ± 0.22a	1.63 ± 0.17a	1.22 ± 0.11a	2.67 ± 0.15a	2.54 ± 0.12a	2.67 ± 0.24a
3	1.48 ± 0.13a	2.13 ± 0.12a	10.77 ± 1.1a	8.71 ± 1.16a	10.00 ± 1.11a	2.19 ± 0.12a	1.60 ± 0.1a	2.60 ± 0.17a	2.15 ± 0.12a	2.23 ± 0.17a	1.48 ± 0.14a	1.33 ± 0.12a	2.64. ± 0.12a	2.76 ± 0.11a	2.69 ± 0.21a
4	1.48 ± 0.15a	1.61 ± 0.12b	6.58 ± 0.46b	7.10 ± 0.46b	8.39 ± 1.1b	1.80 ± 0.12a	1.44 ± 0.1b	2.29 ± 0.17a	2.02 ± 0.4a	2.12 ± 0.21a	1.62 ± 0.12a	1.24 ± 0.1a	2.57 ± 0.14a	2.52 ± 0.32a	2.46 ± 0.17a
5	1.42 ± 0.14a	1.48 ± 0.12b	6.13 ± 0.76b	6.45 ± 0.96b	8.06 ± 0.96b	1.77 ± 0.14a	1.39 ± 0.1b	2.25 ± 0.17a	1.96 ± 0.17a	2.10 ± 0.17a	1.59 ± 0.13a	1.27 ± 0.1a	2.62 ± 0.12a	2.54 ± 0.24a	2.57 ± 0.24a
6	1.42 ± 0.14a	1.48 ± 0.12b	3.61 ± 0.39b	4.90 ± 0.79b	6.77 ± 0.79b	1.77 ± 0.15a	1.39 ± 0.1b	1.92 ± 0.17 b	1.80 ± 0.17b	1.99 ± 0.15a	1.59 ± 0.12a	1.22 ± 0.1a	3.12 ± 0.11a	2.59 ± 0.26a	2.57 ± 0.14a

mullets were higher in semi-intensive system than in extensive conditions. This may be due to the use of artificial feed in addition to natural food the semi-intensive culture system and both species were able to utilize it efficiently. In the natural food condition that supplemented by artificial feed in extensive system, silver carp, common carp and catfish were able to utilize natural communities better and so attaining higher growth rates in extensive condition than in semi-intensive ones.

The average total fish production for all treatments were 11.229;15.919;

1.281;1.782; 2.267 and 2.705 kg/feddan for 10;15; 1.0; 1.50; 2.00 and 2.50 fish/m^3 density treatments, respectively. These results clearly demonstrate the positive correlation between fish production and stocking density. These findings agree with those obtained by Essa *et al* .(1988) Shaker *et al.* (2002), Sumagaysay and Lourdes (2003);Yang Yi *et al.* (2003) and Shaker and Abdel-Aal (2006) who found that phytoplankton based food chain was relatively unimportant in pond culture that relies on artificial feed to promote fish growth.

From the data presented in Table (5), it is clear also that the daily gain of catfish was higher than other fish species as silver carp, common carp, mullet and Nile tilapia. Also, the daily gain of different fish species was higher in extensive ponds than semi-intensive ponds. These results indicated that the daily gain for each species was negatively correlated with stocking density. Moreover, the same trend was observed in the specific growth rate (SGR). These results are in agreement with those obtained by Karplus *et al.* (1996) and Yang Yi *et al.* (2003). The condition factor did not vary among all species in all treatments ($P < 0.05$),which indicated the suitability of environment to fish growth and survival (Eass *et al*.,1988).

3- Economical analysis

The economical analysis for the present study is presented in Table (7&8), while the comparison between semi-intensive and extensive treatments is presented in Table (6).

Table (6): ***Effect of culture systems on some economical parameters.***

treatments / Items	Semi-intensive	Extensive
Stocking denisity/m^3	**12.5**	**1.75**
Fish production	**13574**	**2008.75**
Net production	**10949**	**1885.65**
Total phytoplankton org/1	**2292**	**6783**
Total zooplankton	**109**	**393**
Daily gain	**21.89**	**24.99**
Specific growth rate S.G.R.	**8.95**	**9.69**
Condition factors	**10.48**	**10.75**
Total costs	**74795.91**	**8382.01**
Net return	**14167.09**	**5041.49**
Average cost/kg	**5.45**	**4.18**
Return kg above T.V.C. LE	**1.15**	**2.83**
Rate of return to capital %	**20.81**	**60.15**
Economical efficiency %	**120.81**	**160.15**

Table (7): ***The economi-cal values per feddan of fish production in L.E.***

Item	Unit	Price	Treatment 1		Treatment 2		Treatment 3	
			Quan	Value L.E	Quan	Value LE	Quan	Value L.E
Tilapia 1st class	K.g	8.00	4807	38456	6518	52144	527	4216
Tilapia 2nd class	K.g	6.00	3098	18588	4248	25488	323	1938
Tilapia 3rd class	K.g	3.50	970	3395	1403	4910	73	255
Tilapia 4th class	K.g	2.00	107	214	444	888	13	26
Tilapia 1st class	K.g	12.00	448	5376	630	7560	76	912
Tilapia 2nd class	K.g	9.00	77	693	157	1413	-	-
Common Carp	K.g	4.00	756	3024	1102	4408	143	572
Silver Carp	K.g	4.00	231	924	315	1260	59	236
Cat Fish	K.g	5.00	735	3675	1102	5510	67	335
Total return	-	-	**11229**	**74345**	**15919**	**103581**	**1281**	**8590**
Variable costs	-	-	-	-	-	-	-	-
Fingerlings	-	-	-	-	-	-	-	-
T.50 g	1000	250	38.220	9555	57.330	14332.5	-	-
T.15 g	1000	100	-	-	-	-	38822	382.2
M..50g	1000	350	2100	735	3150	1102.5	-	-
M. 30g	1000	250	-	-	-	-	210	52.5
C.C.50g	1000	120	840	100.8	1260	151.2	-	-
C.C.30g	1000	100	-	-	-	-	84	8.4
S.C.50g	1000	120	420	50.4	630	75.6	42	5.00
C.F.50g	1000	350	420	147	-	220.5	42	14.7
Total costs of fish	-	-	-	**10588.2**	36.04	**15882.3**	-	**463.8**
Feed	Ton	2000	22.01	44020	-	72080	1.98	3960
Poultry manure	M 3	50	-	-	10	-	1.2	60
Irrigation water	hr.	2.50	10	25	1	25	10	25
Aerator	Unit	520	1	520	-	520	1	-
Labor	-	-	-	250	-	250	-	50
Interest ion operating (7%)	-	-	-	1617.77	-	2591.71	-	133.09
Total variable costs T.V.C	-	-	-	57020.97	-	91349.01	-	4690.89
Income above T.V.C.	-	-	-	17324.03	-	12231.99	-	3899.11
Fixed costs	-	-	-	-	-	-	-	-
Deprecation pond equipment D.P.E.	-	-	-	200	-	200	-	200
Interest ion investment (13%)	-	-	-	410.92	-	410.92	-	410.92
Total fixed costs	-	-	-	610.92	-	610.92	-	610.92
Total costs	-	-	-	57631.89	-	91959.93	-	5301.81
Net return	-	-	-	**16713.11**	**-**	**11621.07**	**-**	**3288.19**

Table (7): ***Continued.***

Item	Unit	Price	Treatment 4		Treatment 5		Treatment 6	
			Quan	Value L.E	Quan	Value LE	Quan	Value L.E
Tilapia 1st class	K.g	8.00	824	6592	984	7872	1216	9728
Tilapia 2nd class	K.g	6.00	462	2772	591	3546	747	4482
Tilapia 3rd class	K.g	3.50	99	346	197	689	247	864
Tilapia 4th class	K.g	2.00	20	40	24	48	35	70
Tilapia 1st class	K.g	12.00	78	936	99	1188	106	1272
Tilapia 2nd class	K.g	9.00	10	90	10	90	30	270
Common Carp	K.g	4.00	132	528	165	665	124	496
Silver Carp	K.g	4.00	72	288	88	352	85	340
Cat Fish	K.g	5.00	85	425	109	545	115	575
Total return	-	-	**1782**	**12017**	**2267**	**14990**	**2705**	**18097**
Variable costs	-	-	-	-	-	-	-	-
Fingerlings	-	-	-	-	-	-	-	-
T.50 g	1000	250	-	-	-	-	-	-
T.15 g	1000	100	5733	573.30	7644	764.4	9555	955.5
M..50g	1000	350	-	-	-	-	-	-
M. 30g	1000	250	315	78.75	420	105	525	
C.C.50g	1000	120	-	-	-	-	-	-
C.C.30g	1000	100	126	12.6	168	16.8	210	21
S.C.50g	1000	120	63	7.56	84	10.08	105	12.6
C.F.50g	1000	350	63	22.05	84	420	105	525
Total costs of fish	-	-	-	694.26	-	1316.28	-	1514.1
Feed	Ton	2000	2.95	5900	3.82	7640	4.14	8280
Poultry manure	M 3	50	1.2	60	1.2	60	1.2	60
Irrigation water	hr.	2.50	10	25	10	25	10	25
Aerator	Unit	520	-	-	-	-	-	-
Labor	-	-	-	50	-	50	-	50
Interest ion operating (7%)	-	-	-	196.49	-	262.40	-	289.93
Total variable costs T.V.C	-	-	-	6925.75	-	9353.68	-	10219.03
Income above T.V.C.	-	-	-	5091.25	-	5636.32	-	7877.97
Fixed costs	-	-	-	-	-	-	-	-
Deprecation pond equipment D.P.E.	-	-	-	200	-	200	-	200
Interest ion investment (13%)	-	-	-	410.92	-	410.92	-	410.92
Total fixed costs	-	-	-	610.92	-	610.92	-	610.92
Total costs	-	-	-	7536.67	-	9963.68	-	10829.95
Net return	-	-	-	**4480.33**	**-**	**5026.32**	**-**	**2767.05**

Table (8): ***Economic efficiency for different aquaculture systems.***

Item	Treatments					
	Semi-intensive		Extensive			
	T1	T2	T3	T4	T5	T6
Total return (L.E)	74345	103581	8590	12017	14990	18097
Net return (L.E)	16713.11	11621.07	3288.19	4480.33	5026.32	7267.05
Total production (K.g)	11229	15919	1281	1782	2267	2705
Average price (L.E)	6.62	6.51	6.70	6.74	6.61	6.69
Total variable costs T.V. C. (L.E)	57020.98	91349.01	4690.89	6925.75	9353.68	10219.03
Total fixed costs (L.E)	610.92	610.92	610.92	610.92	610.92	610.92
Total costs (L.E)	57631.89	91959.93	5301.81	7536.67	9963.68	10829.95
Income above T.V.C.	17324.03	12231.99	3899.11	5091.25	5636.32	7877.97
Average/ kg production (L.E)	5.08	5.74	3.66	3.89	4.13	3.78
Average/ kg cost(L.E)	5.13	5.78	4.14	4.23	4.39	4.00
Return / kg above T.V.C .(L.E)	1.54	0.77	3.04	2.86	2.49	2.91
Value of production /L.E T .V. C. (L.E)	130.38	113.39	183.12	173.51	160.26	177.09
Rate of return to capital %	28.99	12.64	62.02	59.45	50.45	67.10
Economical efficiency	128.99	112.64	162.02	159.45	150.45	167.10

The total return values per Fadden were 74.345; 103.581; 8.590; 12.017; 14.990 and 18.097 LE for Tl; T2; T3; T4; T5 and T6 respectively (Table7). These results indicated that the highest total return was obtained in semi-intensive treatments. as well as in treatment 2, these indicating a positive correlation between total return and stocking density. Also, the same trend was observed in total costs, where they increased with increasing stocking density and consequently feed costs.The finding of Shaker *et al.* (2003);Yang Yi *et al.* (2003) and Shaker and Abdel-Aal (2006) are in agreement with obtained are results. Moreover, the same trend was observed by the average cost/kg fish, while the opposite trend was observed in the rate of return to capital as percentage.

CONCLUSION

from the previous results it can be concluded that ,semi-intensive culture system are the most production and profitable system.

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تأثير الكثافة السمكية على أداء النمو والعائدالاقتصادى فى الاستزراع السمكى الشبه المكثف والعادى بالأحواض الترابية

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قسم الاستزراع السكمى بالمعمل المركزي لبحوث الثروه السمكيه بالعباسه-

أبو حماد- شرقية – مصر

فى دراسه لتأثير الكثافة العددية على أداء الأسماك بالأحواض الترابية لمدة خمسة شهور فى نظام الأستزراع المختلط (بلطى نيلى – البورى – المبروك العادى – المبروك الفضى والقراميط) ،على مياه الصرف الزراعى بمزرعة برسيق – محافظة البحيرة قسمت الأحوض التجريبية الى مجموعتين، الأولى : النظام الشبه مكثف بكثافات (١٠، ١٥) سمكة / متر. والثانية : النظام العادى بكثافات (١، ١,٥ ، ٢ ، ٢,٥) سمكة / متر.غذيت جميع الأحواض بعلف صناعى ٢٥% بروتين بمعدل ٣% من وزن الجسم على مرتين يوميا لمدة خمسة أيام اسبوعيا . تم تقدير خواص جودة المياه بصفة دورية مرة شهريا حيث لوحظ ارتفاع بعض خواص المياه فى النظام العادى عنه فى النظام الشبه مكثف وذلك فى ال EC- PH – القلوية – العسر – الفسفور الكلى T.P - الفسفور الذائب O.P – الكلورفيل. بينما لوحظ زيادة الأكسجين الذائب والأمونيا والنيتريت والنترات فى النظام شبه المكثف عن النظام العادى كما لوحظ زيادة الكلورفيل كمؤشر عن ازدهار البلانكتون فى النظام العادى

عنه فى النظام الشبه مكثف . أما بالنسبه للأنتاج السمكى فقد كان أعلى بفروق معنوية فى النظام الشبه مكثف عن النظام العادى بينما لوحظ فى البلطى عدم وجود فـــروق معنويه فى متوسط الوزن النهائى وكذلك النمو اليومى. كما أشارت النتائج الى أرتفاع التكاليف المتغيره و الثابتة نتيجه لزيادة معدلات الكثافة الســمكية وســعر العلــف و الاصبعيات وفائدة رأس المال الكلى وفائدة الأستثمار وكذلك ارتفاع العائد فى النظام شبه المكثف عنه فى النظام العادى أما بالنسبه لصافى العائد على وحدة التكاليف فقد كانت أعلى فى النظام العادى عن شبه المكثف.

تشير النتائج إلى :

- زيادة الإستفاده من وحدة المساحه المائيه فى شبه المكثف عن العادى.
- ارتفاع العائد المادى فى النظام الشبه مكثف عنه فى الظام العادى.
- معدل المخاطره فى الأستزراع العادى أقل منه فى شبه المكثف.

وعليه توصى هذه الدراسة بالتوسع فى المزارع بنظــام الشــبه مكثــف للجــدوى الاقتصادية العالية.