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Effect of Rearing Systems (Mono- and Poly-Culture) on the Performance of Freshwater Prawn (*M. rosenbergii*) Juveniles

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Abstract: This study was carried out to investigate the effect of mono and polyculture of freshwater prawn with Nile tilapia fry on growth performance and survival rate. Freshwater prawn-juveniles, (*M. rosenbergii*) averaging (0.30±0.02 g) in weight [Trial 1 (monoculture)] were cultured for 90 days, with different stocking densities (50, 100, 150 and 200 prawn m^{-2}) using 12 circular fiberglass tanks (0.36 m^2 and 0.6 m in water depth). Prawns were fed manufactured diet contained 35% protein. Water exchange occurred daily with 20% of water size. Growth measurements of prawn were recorded at 15 days intervals. The results showed that growth performance was significantly ($p\leq 0.05$) decreased with increasing the stocking density. Survival rate was inversely related to stocking density, since there were significant differences among the four densities, while the difference between stocking density of 50 and 100 prawn m^{-2} was not significant. The food conversion ratio FCR increased with increasing the stocking densities, since the fourth density (200 prawn m^{-2}) was significantly higher than that achieved in the first one (50 prawn m^{-2}). Prawn juveniles, of average weight 0.30±0.02 g [Trial 2 (Poly culture)]were stocked (as declared in Trial 1) in poly culture with Nile tilapia fry (average weight 0.3±0.03 g) at stocking density 12 fish per m^2 for each treatment, for 90 days. Growth measurements of prawns and fish were recorded at 15 days intervals. Results showed that growth performance for fish and prawn were significantly ($p\leq 0.05$) decreased with increasing of the stocking density of prawn. Survival rate was inversely related to stocking densities, since, there were significant differences among the four treatments. Also, the food conversion ratio FCR for fish and prawn increased with increasing stocking density, since, the differences were significant among the four stocking densities. Therefore, polyculture system is more suitable at stocking density of 100% prawn m^{-2} for optimum growth and survival rate than of monoculture.

Key words: Freshwater prawn, juveniles, stocking density, mono-culture, poly-culture, growth performance

INTRODUCTION

In Egypt, the culture of freshwater prawns (*M. rosenbergii*) has great economic interest for the following reasons: wide brackish surfaces are available, the climatic situation is very favorable and the market prices are high. Many farmers are devoted to monoculture, however, others practice polyculture (Personal contact). Polyculture of freshwater prawns, (*M. rosenbergii*) with various species of fish has received considerable attention in temperate climates (New, 2005). Prawns have been successfully cultured with tilapia (Rouse *et al*., 1980), channel catfish (Huner *et al*., 1981) and Chinese carp (Malech *et al*., 1981). All reported findings have shown an increase in total production

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over that obtained from prawn monoculture ponds. World production of freshwater prawn (*M. rosenbergii*) increased from <50.000 MT (metric tones) in 1995 to >280.000 MT in 2003 (FAO, 2005) and has become an important part of the rice-fish or small scale carp polyculture ecosystem in many developing countries (Giap *et al*., 2005). In certain polyculture systems, actual benefits to one or more of the species within the system may be realized. These improvements may be brought about by improvements in water quality or possibly the redistribution of food (Rouse *et al*., 1987). The aims of this study were to investigate the effect of mono and polyculture freshwater prawn (*M. rosenbergii*) with Nile tilapia fry (*Oreochromis niloticus*) in tanks on growth performance and survival rate.

MATERIALS AND METHODS

The present study was carried out at two trials at Fish Research Center (FRC), Suez Canal University, Ismailia, Egypt in season 2004.

Experimental Prawn

Fresh water prawn (*M. rosenbergii*) juveniles were obtained from the Maryut Fish Farming Company, Alexandria, in aerated tanks. Juveniles were graded, homogeneous size, were selected and kept in circular tanks. They were fed for fifteen day to adapt them for the experimental conditions.

Experimental Tanks

Twenty four fiberglass circular tanks (0.36 m^2 each, mean depth 0.6 m) were used for rearing prawn juveniles in both trials. Water in tanks was obtained from a well and aerated by a constant supply of air plower. PVC pipes have been used in tanks to provide shelters for prawns and reduce aggressive interaction (Lee and Wickins, 1992). Faeces were siphoned together with 20% of the water volume from each tank and replaced with fresh water daily, before morning feeding.

Experimental Diet and Feeding Regime

The diet used in feeding prawn juveniles was obtained from Sinai shrimps 21 company, Port Said, its comparison was according to (NRC, 1983). The diet was grounded to very small size of less than 15 mm mesh. Feeding rate assigned to a particular range of wet weights (Table 1) twice a day (9.00 a.m. and 5.00 p.m.) according to D'Abramo *et al*. (1989). The diet was offered by hand spreading.

Trial 1 (Monoculture)

Prawn juveniles were stocked in twelve circular tanks (0.36 m^2 and 0.6 m depth) for 90 days at four different stocking densities, i.e., 50, 100, 150, 200 prawns m^{-2} with three replicates for each density. At the stocking time, average weight of prawn juveniles were 0.3±0.02 g in weight (Tidwell *et al*., 2005).

Table 1: Weight dependent feeding rates used to determine biweekly feeding schedules for grow out tanks

Weight (g)	Percentage of body weight fed daily
0-1	20
1-2	15
2-5	12
5-10	9
10-15	8
15-20	7
20-25	6
25-30	5
~ 30	3

Trail 2 (Polyculture)

Prawn juveniles (average weight 0.3±0.02 g) were stocked in another twelve circular tanks (0.36 m^2 and 0.6 m depth) at four different stocking densities, i.e., 50, 100, 150, 200 prawn m^{-2} in polyculture with tilapia fry *Oreochromis niloticus* (average weight 0.35±0.03 g) at stocking densities of 12 fish per m^2 for each treatment (Karplus *et al*., 1986). Fish and prawns were stocked into the tanks with three replicates for each prawn density. During rearing period (90 days) of both trails, the growth performance and survival rate of prawns and fish were determined at 15 days intervals.

Parameters Tested

The following parameters were used to evaluate prawn growth performance in both trails:

Mean prawn weight	=	The average weight of prawn at t days
Weight Gain (WG)	=	$W_1 - W_0$
Average Daily Weight Gain (ADG)	=	$(W_1 - W_0)/t$
Percentage Weight Gain (%)	=	$(W_1 - W_0)\times 100/W_0$
Specific Growth Rate (% day) SGR	=	$(\mathrm{Ln}\, W_1 - \mathrm{Ln}\, W_0)\times 100/t$
Food Conversion Ratio (FCR)	=	$Df/(W_1 - W_0)$ (De Silva and Anderson, 1995)
Survival rate (%)	=	$N_i\times 100/N_0$ (Harrell *et al*., 1990)

Where:

W_1	=	Final wet weight (g)
W_0	=	Initial wet weight (g)
t	=	Time interval in days
N_i	=	No. of prawn at the end
N_0	=	No. of prawn initial stocked
Df	=	Dry feed intake (g)

Statistical Analysis

The data obtained in this study were analyzed by one-way ANOVA procedure of Statistical Analysis System (SAS, 1988). Means were compared by Duncan's new multiple range test (Zar, 1996).

RESULTS AND DISCUSSION

Trial 1 (Monoculture)

Mean Individual Weights

The *M. rosenbergii* juveniles were stocked at four different stocking densities, 50, 100, 150 and 200 prawn m^{-2}. It was observed from Table 2 that the initial average weight of juveniles was 0.30±0.02 g for all densities. The finial average body weights at the end of the trail period showed great differences among different stocking densities, since it was decreased with high stocking density. The stocking density 50 prawn m^{-2} showed the highest final body weight (3.47 g/juvenile) followed by the stocking 100 prawn m^{-2} (3.23 g/juvenile), then stocking density 150 prawn m^{-2} (2.64 g/juvenile), finaly stocking density 200 prawn m^{-2} (1.48 g/juvenile). It could be noticed that the average individual weight of prawn was found to be inversely related to stocking density. This is in agreement with the findings of Tidwell *et al.* (2004). They reported that the lowest stocking density gave relatively the highest growth. On the other hand, Wyban *et al.* (1987) found that individual body weights for marine shrimp *Penaeus vannamei* were 18.1, 17.1, 12.4 and 8.7 g for stocking densities 5, 10, 15 and 20 shrimp m^{-2}, respectively. The statistical analysis indicated that the differences among the mean

Table 2: Effect of different stocking densities on mean individual weight (g) of *M. rosenbergii*, juvenile

	Stocking rate (prawn m^{-2})			
Period (day)	50	100	150	200
At-stocking	0.30±0.02	0.30±0.02	0.30±0.02	0.30±0.02
15	0.56±0.012^a	0.55±0.017^a	0.50±0.014^b	0.42±0.013^c
30	0.97±0.011^a	0.92±0.012^a	0.79±0.023^b	0.57±0.025^c
45	1.52±0.023^a	1.42±0.021^a	1.17±0.017^b	0.74±0.012^c
60	2.10±0.013^a	1.96±0.170^b	1.61±0.022^c	0.96±0.017^d
75	2.78±0.025^a	2.59±0.020^a	2.12±0.011^b	1.21±0.006^c
90	3.47±0.014^a	3.23±0.012^a	2.64±0.018^b	1.48±0.023^c

Mean±SE. Mean values with the same letter(s) in each row is not significantly different (p>0.05)

Table 3: Effect of different stocking densities on mean weight gain (g/individual prawn) of *M. rosenbergii,* juvenile

	Stocking rate (prawn m^{-2})			
Period (day)	50	100	150	200
15	0.26±0.012^a	0.25±0.011^a	0.18±0.006^b	0.12±0.014^c
30	0.41±0.017^a	0.37±0.022^a	0.29±0.015^b	0.15±0.006^c
45	0.55±0.023^a	0.50±0.005^a	0.38±0.020^b	0.18±0.017^c
60	0.58±0.012^a	0.54±0.014^a	0.44±0.011^b	0.22±0.015^c
75	0.68±0.015^a	0.63±0.021^a	0.51±0.005^b	0.25±0.052^c
90	0.69±0.011^a	0.64±0.013^a	0.52±0.023^b	0.27±0.015^c

Mean±SE. Mean values with the same letter(s) in each row is not significantly different (p>0.05)

Table 4: Effect of different stocking densities on average daily weight gain (g day^{-1}) of *M. rosenbergii*, juvenile

	Stocking rate (prawn m^{-2})			
Period (day)	50	100	150	200
15	0.017±0.001^a	0.016±0.003^a	0.012±0.006^b	0.008±0.005^c
30	0.027±0.005^a	0.024±0.001^a	0.019±0.003^b	0.010±0.002^c
45	0.036±0.002^a	0.033±0.013^a	0.025±0.012^b	0.012±0.013^c
60	0.039±0.011^a	0.036±0.005^a	0.029±0.011^b	0.015±0.006^c
75	0.045±0.013^a	0.042±0.012^a	0.034±0.002^b	0.017±0.013^c
90	0.046±0.006^a	0.043±0.011^a	0.035±0.004^b	0.018±0.012^c

Mean±SE. Mean values with the same letter(s) in each row is not significantly different (p>0.05)

weight of the prawn obtained from the stocking density of 50, 100, 150 and 200 prawn m^{-2} were significant ($p\leq 0.05$). But, the difference was not significant between stocking rates of 50 and 100 prawn m^{-2}.

Mean Weight Gain

Table 3 shows the mean weight gain at 15 days intervals for all the stocking densities. The averages of weight gains were 0.26, 0.25, 0.18 and 0.12 g/prawn at the 1st period (15 days) and then gradually increase was observed reaching 0.69, 0.64, 0.52 and 0.27 g/prawn at the end of the trail period for the stocking densities 50, 100, 150 and 200 prawn m^{-2}, respectively. The data in Table 3 also indicated that the mean weight gain sharply decreased with increasing stocking densities. Such results has been confirmed by El-Sherif (2001). The statistical analysis indicated that there were significant ($p\leq 0.05$) differences among the stocking densities, but not between 50 and 100 prawn m^{-2}.

Average Daily Weight Gain

It can be shown from Table 4 that the average weight gain/prawn/day were 0.017, 0.016, 0.012 and 0.008 g for stocking densities 50, 100, 150 and 200 prawn m^{-2}, respectively during the first period (15 days). The data also indicated that, the average daily weight gain of prawn increased gradually reaching its maximum of 0.046, 0.043, 0.035 and 0.018 g at the end of the trail period for the

Table 5: Effect of different stocking densities on mean relative growth rate (growth %) of *M. rosenbergii*, juvenile

	Stocking rate (prawn m^{-2})			
Period (day)	50	100	150	200
15	86.66±0.12^{a}	83.33±0.17^{b}	60.00±0.01^{c}	40.00±0.03^{d}
30	73.21±0.14^{a}	67.27±0.05^{b}	58.00±0.17^{c}	37.50±0.12^{d}
45	56.70±0.05^{a}	54.35±0.13^{a}	48.10±0.14^{b}	31.57±0.17^{c}
60	38.16±0.17^{a}	38.03±0.11^{a}	37.61±0.15^{b}	29.72±0.05^{c}
75	32.38±0.17^{a}	32.14±0.02^{a}	31.67±0.06^{b}	26.04±0.01^{c}
90	24.82±0.11^{a}	24.71±0.06^{a}	24.25±0.04^{b}	22.31±0.02^{c}

Mean±SE. Mean values with the same letter(s) in each row is not significantly different (p>0.05)

Table 6: Effect of different stocking densities on mean specific growth rate (Percentage day^{-1}) of *M. rosenbergii*, juvenile

	Stocking rate (prawn m^{-2})			
Period (day)	50	100	150	200
15	4.16±0.011^{a}	4.04±0.006^{b}	3.13±0.004^{c}	2.24±0.025^{d}
30	3.66±0.017^{a}	3.43±0.013^{b}	3.05±0.021^{c}	2.04±0.017^{d}
45	3.12±0.005^{a}	2.89±0.018^{b}	2.62±0.035^{c}	1.74±0.012^{d}
60	2.15±0.012^{a}	2.14±0.015^{a}	2.12±0.018^{a}	1.73±0.018^{b}
75	1.87±0.017^{a}	1.85±0.020^{a}	1.83±0.012^{a}	1.54±0.005^{b}
90	1.48±0.005^{a}	1.47±0.011^{a}	1.46±0.017^{a}	1.34±0.013^{b}

Mean±SE. Mean values with the same letter(s) in each row is not significantly different (p>0.05)

four aforementioned populations, respectively. There were differences in the average daily weight gain of prawn among the different stocking densities (50, 100, 150 and 200 prawn m^{-2}). The gain per prawn per day decreased as the stocking density increased. Similar results were obtained by Zaki and Abdel-Halim (1997).The statistical analysis showed that there were significant differences among the average daily weight gain of the prawn at the different stocking densities. But the difference was not significant between stocking density of 50 and 100 prawn m^{-2}.

Relative Growth Rate (RGR)

It can be seen from the tabulated data in Table 5 that the percentages of weight gain of prawn at the stocking densities 50, 100, 150 and 200 prawn m^{-2} were 86.66, 83.33, 60.00 and 40.00%, respectively during the first period of the rearing. Thereafter, the weight gain percentage of prawn being gradually decreased by time. Similar results were obtained by Khouraibe *et al*. (1996), who indicated that the RGR of shrimp (*P. japonicus*-juvenile) was initially high and then gradually declined. From data obtained in Table 5. It could be noticed that the RGR of *M. rosenbergii*-juvenile varied by varying the stocking density, since the RGR decreases as the stocking density increases (50, 100, 150 and 200 prawn m^{-2}). It can be shown from the Table 5 that the RGR at the end of the trail period was decreased (24.82, 24.71, 24.25 and 22.31%) by increasing stocking densities from 50, 100, 150-200 prawn m^{-2}, respectively. The statistical analysis showed that the differences among the stocking densities were significant. But, the difference between stocking density 50 and 100 prawn m^{-2} was not significant. This is in full agreement with that found by Tidwell *et al*. (2003).

Specific Growth Rate SGR

The results in Table 6 shows that the SGR values of prawn at the end of the trail period were decreased (1.48, 1.47, 1.46 and 1.34%) for stocking densities 50, 100, 150 and 200 prawn m^{-2}, respectively. The statistical analysis showed that the differences among the stocking densities of the specific growth rates of prawn were significant. But the difference between stocking densities 50 and 100 prawn m^{-2} was not significant. Similar results were obtained by Tidwell *et al*. (2004).

Table 7: Effect of different stocking densities on survival rate (%) of *M. rosenbergii*, juvenile

	Stocking rate (prawn m^{-2})			
Period (day)	50	100	150	200
15	89.0±0.115^a	86.1±0.112^a	79.6±0.123^b	66.6±0.152^c
30	83.3±0.120^a	80.6±0.170^a	74.1±0.057^b	61.1±0.116^c
45	82.0±0.057^a	78.2±0.120^a	72.2±0.174^b	59.7±0.231^c
60	81.2±0.110^a	77.7±0.231^a	70.4±0.115^b	56.9±0.211^c
75	77.7±0.173^a	75.0±0.017^a	66.6±0.180^b	54.2±0.059^c
90	72.2±0.116^a	69.4±0.123^a	62.9±0.113^b	51.4±0.173^c

Mean±SE. Mean with the same letter(s) in each row is not significantly different ($p>0.05$)

Table 8: Effect of different stocking densities on mean feed conversion ratio of *M. rosenbergii*, juvenile

	Stocking rate (prawn m^{-2})			
Period (day)	50	100	150	200
15	2.37±0.040^c	2.43±0.017^c	3.49±0.051^b	4.02±0.011^a
30	2.39±0.337^c	2.46±0.035^c	3.53±0.017^b	4.12±0.012^a
45	2.35±0.028^c	2.42±0.011^c	3.47±0.040^b	3.94±0.023^a
60	3.38±0.046^c	2.45±0.029^c	3.51±0.005^b	4.16±0.035^a
75	2.46±0.034^c	2.51±0.006^c	3.56±0.028^b	4.35±0.023^a
90	3.19±0.052^d	3.32±0.012^c	4.63±0.017^b	5.80±9.006^a

Mean±SE. Mean with the same letter(s) in each row is not significantly different ($p>0.05$)

Survival Rate (%)

From the tabulated data in Table 7, it can be seen that the survival rates of prawn during the trail period were high in all densities. This is mainly due to:

- The acclimation of the prawn prior to the start of stocking in tanks
- This experiment started with *M. rosenbergii*-juveniles of an initial average weight 0.3 g, such size shows high tolerance to the unfavourable conditions (Zaki and Abdel-Halim, 1997)
- The ecological conditions throughout the experimental period were suitable for prawn rearing, especially the average water temperatures (which ranged between 27.6 and 26.5°C), since Marques *et al*. (2000) noted that optimal water temperatures for optimum growth and survival of *M. rosenbergii* are 26-31°C

The results in Table 7 shown that the survival (%) decreased with increasing of the stocking density. This is in full agreement with the results reported before by Tidwell *et al*. (2004). On the other hand, Gopal Rao *et al*. (1986) found that the survival rates of *M. malcolmsonii* in ponds ranged from 44.2 to 57.2% for the 390 days grow-out period. Low survival was due to algal blooms of *Spirogyra* sp. and *Euglena* sp., which led to depletion of dissolved oxygen and consequent by ecological imbalance. The statistical analysis showed that significant differences in survival (%) were observed among the densities tested (50, 100, 150 and 200 prawn m^{-2}). While the differences between stocking density 50 and 100 prawn m^{-2} was non significant.

Feed Conversion Ratio FCR

Data in Table 8 shows that the mean food conversion ratio of prawn increased as densities increased, sine the FCR achieved in the fourth density (200 prawn m^{-2}) was significantly higher than that achieved in the first one (being 5.80 and 3.19, respectively). Such results coincide with those of Tidwell *et al*. (2004).

Trail 2 (Polyculture)

Mean Individual Weight

From the tabulated results in Table 9, it can be concluded that the maximum (3.12±0.03 g) and the minimum (1.22±0.4 g) average size of prawn was attained at the end of rearing period, at the lowest

Table 9: Mean individual weight (g) results for polyculture of prawn with *O. niloticus* reared in tanks under different treatments

	Stocking rate (prawn m^{-2})							
	50		100		150		200	
Period (day)	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*
0	0.30 ± 0.02	0.35 ± 0.03	0.30 ± 0.02	0.35 ± 0.03	0.30 ± 0.02	0.35 ± 0.03	0.30 ± 0.02	0.35 ± 0.03
15	0.53 ± 0.02^{a}	1.42 ± 0.01^{a}	0.50 ± 0.03^{a}	1.35 ± 0.03^{a}	0.44 ± 0.02^{b}	1.15 ± 0.03^{b}	0.40 ± 0.02^{b}	1.07 ± 0.02^{c}
30	0.92 ± 0.03^{a}	3.80 ± 0.04^{a}	0.82 ± 0.01^{a}	3.59 ± 0.02b	0.64 ± 0.02^{b}	2.91 ± 0.03c	0.51 ± 0.01^{d}	2.59 ± 0.01^{c}
45	1.37 ± 0.02^{a}	8.15 ± 0.03^{a}	1.21 ± 0.01^{a}	7.64 ± 0.01^{b}	0.91 ± 0.03^{b}	6.01 ± 0.04^{c}	0.64 ± 0.02^{c}	5.15 ± 0.02^{d}
60	1.90 ± 0.01^{a}	15.15 ± 0.02^{a}	1.67 ± 0.04^{b}	14.13 ± 0.02^{b}	1.22 ± 0.03^{c}	10.90 ± 0.05^{c}	0.80 ± 0.02^{d}	9.30 ± 0.01^{d}
75	2.49 ± 0.01^{a}	23.88 ± 0.05^{a}	2.17 ± 0.03^{a}	22.15 ± 0.03^{b}	1.58 ± 0.01^{b}	16.94 ± 0.02^{c}	0.99 ± 0.01^{c}	14.40 ± 0.02^{d}
90	3.12 ± 0.03^{a}	33.38 ± 0.02^{a}	2.76 ± 0.01^{a}	30.55 ± 0.02^{b}	1.96 ± 0.02^{b}	23.19 ± 0.05^{c}	1.22 ± 0.04^{c}	19.60 ± 0.03^{d}

Mean±SE. *The stocking density of tilapia was 12 / m^2 for all treatments. Mean values (within the same animal species) with the same letter in each row is not significantly different ($p>0.05$)

Table 10: Mean weight gain (g /indiviual prawn) results for polyculture of prawn with *O. niloticus* reared in tanks under different treatments

	Stocking rate (prawn m^{-2})							
	50		100		150		200	
Period (day)	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*
15	0.23 ± 0.02^{a}	1.07 ± 0.04^{a}	0.20 ± 0.02^{a}	1.00 ± 0.03^{a}	0.14 ± 0.02^{b}	0.80 ± 0.03^{b}	0.10 ± 0.01^{b}	0.72 ± 0.01^{c}
30	0.39 ± 0.02^{a}	2.38 ± 0.05^{a}	0.32 ± 0.01^{a}	2.24 ± 0.02^{b}	0.20 ± 0.01^{b}	1.76 ± 0.03^{c}	0.11 ± 0.02^{b}	1.45 ± 0.03^{d}
45	0.45 ± 0.03^{a}	4.35 ± 0.02^{a}	0.39 ± 0.04^{a}	4.05 ± 0.02^{b}	0.27 ± 0.02^{b}	3.10 ± 0.01^{c}	0.13 ± 0.02^{c}	2.63 ± 0.02^{d}
60	0.53 ± 0.01^{a}	7.00 ± 0.01^{a}	0.46 ± 0.03^{a}	6.49 ± 0.05^{b}	0.31 ± 0.01^{b}	4.89 ± 0.05^{c}	0.16 ± 0.03^{c}	4.15 ± 0.02^{d}
75	0.59 ± 0.01^{a}	8.73 ± 0.02^{a}	0.50 ± 0.03^{a}	8.02 ± 0.01^{b}	0.36 ± 0.03^{b}	6.04 ± 0.02^{c}	0.19 ± 0.02^{c}	5.10 ± 0.01^{d}
90	0.63 ± 0.05^{a}	9.50 ± 0.03^{a}	0.53 ± 0.02^{b}	8.40 ± 0.03^{b}	0.38 ± 0.05^{c}	6.25 ± 0.02^{c}	0.23 ± 0.03d	5.20 ± 0.02^{d}

Mean±SE. *The stocking density of tilapia was 12/m^2 for all treatments. Mean values (within the same animal species) with the same letter(s) in each row is not significantly different ($p> 0.05$)

(50 prawn m^{-2}) and the highest stocking rates (200 prawn m^{-2}), respectively. Also, The highest FBW for fish (33.38 g) was attained at the lowest prawn stocking rate (50 prawn m^{-2}) and the lowest (19.60 g) at the highest prawn stocking rate (200 prawn m^{-2}). Regarding the stocking densities, from the mean data obtained in Table 9, it is clear that the average weight of prawn and fish observed in the experimental groups was found to be inversely related to stock density. The statistical analysis showed that the difference between the stocking density of 50 and 100 prawn m^{-2} was not significant for prawn. Generally, the differences among the stocking densities (of 50, 100,150 and 200 prawn m^{-2}) were significant for prawn and fish. Finally, it can be shown from Table 2 and 9 that differences in the size of the prawn attained at the end of both trail 1 and 2. It is clear from the tabulated data that the prawn at different stocking densities did not increase much in size during the both trail 1 and 2, so, these results cleared that the polyculture was more suitable than monoculture at prawn stocking density 100 prawn m^{-2}.

Mean Weight Gain

Table 10 shows that the average weight gain per prawn and fish in the experimental groups was decreased with increasing stocking densities. Such results coincide with the previous findings of Mei Chen and Chu Chen (2003). Generally, significant ($p\leq 0.05$). differences were found among the stocking rate of 50, 100, 150 and 200 prawn m^{-2}. The comparison between Table 3 and 10, concerning the mean weight gain of prawn reared in the trails 1 and 2 indicates that the figures were lower for prawn reared in the trail 2 than those reared in the trail 1. Therefor, the trail 2 (polyculture) was greater than trail 1 (monoculture) due to the differences for mean weight gain of prawn between trail 1 and trail 2 were slight add to the fish, so, these results cleared that the polyculture was more suitable than monoculture at prawn stocking density 100 prawn m^{-2}.

Table 11: Average daily weight gain (g day^{-1}) results for polyculture of prawn with *O. niloticus* reared in tanks under different treatments

	Stocking rate (prawn m^{-2})							
	50		100		150		200	
Period (day)	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*
15	0.015±0.006a	0.071±0.001^{a}	0.013±0.002^{a}	0.067±0.002^{a}	0.009±0.003^{b}	0.053±0.004^{b}	0.006±0.003^{b}	0.048±0.005^{b}
30	0.026±0.001^{a}	0.159±0.002^{a}	0.021±0.005^{a}	0.149±0.004^{b}	0.013±0.002^{b}	0.117±0.001^{c}	0.007±0.002^{b}	0.097±0.001^{d}
45	0.030±0.002^{a}	0.290±0.001^{a}	0.026±0.003^{a}	0.270±0 .001^{b}	0.018±0.002^{b}	0.207±0.004^{c}	0.009±0.001^{c}	0.175±0.003^{c}
60	0.035±0.003^{a}	0.467±0.004^{a}	0.031±0.006^{a}	0.433±0.002^{b}	0.021±0.001^{b}	0.326±0.003^{c}	0.011±0.001^{c}	0.277±0.002^{d}
75	0.039±0.005^{a}	0.582±0.001^{a}	0.033±0.002^{a}	0.535±0.003^{b}	0.024±0.002^{b}	0.407±0.004^{c}	0.013±0.001^{c}	0.340±0.019^{d}
90	0.042±0.001^{a}	0.633±0.002^{a}	0.035±0.003^{b}	0.560±0.001^{b}	0.025±0.002^{c}	0.417±0.004^{c}	0.015±0.002^{d}	0.347±0.003^{d}

Mean±SE. *The stocking density of tilapia was 12 / m^{2} for all treatments. Mean values (within the same animal species) with the same letter(s) in each row is not significantly different ($p>0.05$)

Table 12: Percentag weight gain (RGR%) results for polyculture of prawn with *O. niloticus* reared in tanks under different treatments

	Stocking rate (prawn m^{-2})							
	50		100		150		200	
Period (day)	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*
15	76.7±0.40^{a}	305.7±0.12^{a}	66.7±0.35^{b}	285.7±0.33^{b}	46.7±0.17^{c}	228.6±0.29^{c}	33.3±0.17^{d}	205.7±0.29^{d}
30	73.6±0.51^{a}	167.6±0.17^{a}	64.0±0.35^{b}	165.9±0.46^{b}	45.5±0.29^{c}	153.0±0.52^{c}	27.5±0.23^{d}	135.5±0.12^{d}
45	48.9±0.52^{a}	114.5±0.29^{a}	47.6±0.35^{b}	112.8±0.46^{b}	42.2±0.12^{c}	106.5±0.23^{c}	25.5±0.17^{d}	104.4±0.23^{d}
60	38.7±0.35^{a}	85.9±0.46^{a}	38.0±0.40^{a}	84.9±0.52^{b}	34.1±0.17^{b}	81.4±0.23^{c}	25.0±0.46^{c}	80.6±0.35^{d}
75	31.1±0.17^{a}	57.6±0.35^{a}	30.5±0.29^{b}	56.7±0.40^{b}	29.5±0.23^{c}	55.4±0.12^{c}	23.8±0.46^{d}	54.8±0.17^{d}
90	25.3±0.17^{a}	39.8±0.40^{a}	24.4±0.23^{b}	37.9±0.46^{b}	24.0±0.35^{b}	36.9±0.52^{c}	23.2±0.12^{c}	36.1±0.17^{d}
0-12	49.1±4.81^{a}	128.5±21.70^{a}	45.2±3.90^{b}	123.9±20.31^{b}	37.6±2.10^{c}	110.3±15.70^{c}	26.4±0.83^{d}	102.8±13.61^{d}

Mean±SE. *The stocking density of tilapia was 12/m^{2} for all treatments. Mean values (within the same animal species) with the same letter(s) in each row is not significantly different ($p>0.05$)

Average Daily Weight Gain

From the data in Table 11, it can be seen that the averages of daily weight gains of the prawn at the end of the trail period were decreased (0.042, 0.035, 0.025 and 0.015 g/prawn) by increasing the stocking densities from 50, 100, 150-200 prawn m^{-2}, respectively. Also, the averages of daily weight gains of the fish at the end of the trail period were decreased (0.633, 0.560, 0.417 and 0.347 g/fish) at same stocking densities of prawn, respectively. The statistical analysis showed that there were significant differences among the average daily weight gains of the prawn and of the fish at the different stocking densities of prawn. This is in agreement with the finding of Sadek and Moreau (1998). On the other hand, Guerrero *et al*. (1982) reported that the *M. lanchesteri* cultured in irrigated paddies had an individual daily weight gain of 80 mg day^{-1}. A comparison between the growth (average daily weight gain) of prawn reared in the trail 1 and 2 proved that there were slight differences. So, the polyculture was more suitable than for monoculture.

Relative Growth Rate (RGR)

The data in Table 12 showed that the RGR of *M. rosenbergii* and *O. niloticus* varied by varying the prawn stocking density, since the RGR decreases as the prawn stocking density increases. The statistical analysis showed that there were significant differences among the weight gain percentages of the prawn and fish at the different prawn stocking densities. Similar results were obtained by Posadas (2002). A comparison between the weight gain percentage of prawn reared in the trail 1 and 2 proved that slight variation was observed in total average weight gain percentage of individual prawn. So, these results showed that polyculture was more suitable at stocking density 100 prawn m^{-2} than monoculture.

Table 13: Specific growth rate (SGR, % day^{-1}) results for polyculture of prawn with *O. niloticus* reared in tanks under different treatments

	Stocking rate (prawn m^{-2})							
	50		100		150		200	
Period (day)	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*
15	3.79 ± 0.05a	9.34 ± 0.02^{a}	3.41 ± 0.01^{b}	8.99 ± 0.05^{b}	2.55 ± 0.03^{c}	7.93 ± 0.02^{c}	1.92 ± 0.01^{d}	7.45 ± 0.01^{d}
30	3.68 ± 0.05^{a}	6.56 ± 0.04^{a}	3.30 ± 0.05^{b}	6.52 ± 0.01^{a}	2.50 ± 0.02^{c}	6.19 ± 0.05^{b}	1.62 ± 0.01^{d}	5.07 ± 0.04^{c}
45	2.65 ± 0.03^{a}	5.09 ± 0.05^{a}	2.59 ± 0.04^{a}	5.03 ± 0.02^{a}	2.35 ± 0.03^{b}	4.84 ± 0.02^{b}	1.51 ± 0.02^{c}	4.58 ± 0.05^{c}
60	2.18 ± 0.05^{a}	4.13 ± 0.02^{a}	2.15 ± 0.01^{a}	4.10 ± 0.01^{a}	1.95 ± 0.03^{b}	3.97 ± 0.04^{b}	1.49 ± 0.05^{c}	3.94 ± 0.02^{b}
75	1.80 ± 0.04^{a}	3.03 ± 0.02^{a}	1.75 ± 0.03^{a}	2.99 ± 0.05^{b}	1.72 ± 0.04^{a}	2.94 ± 0.02^{b}	1.42 ± 0.01^{b}	2.91 ± 0.01^{b}
90	1.50 ± 0.03^{a}	2.23 ± 0.02^{a}	1.46 ± 0.03^{a}	2.14 ± 0.02^{b}	1.44 ± 0.01^{a}	2.09 ± 0.05^{c}	1.39 ± 0.01^{b}	2.06 ± 0.03^{c}

Mean±SE. *The stocking density of tilapia was 12/m^2 for all treatments. Mean values (within the same animal species) with the same letter(s) in each row is not significantly different ($p>0.05$)

Table 14: Survival rate (%) results for polyculture of prawn with *O. niloticus* reared in tanks under different treatments

	Stocking rate (prawn m^{-2})							
	50		100		150		200	
Period (day)	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*
15	86.1 ± 0.16^{a}	100.0 ± 0.00^{a}	81.9 ± 0.52^{b}	100.0 ± 0.00^{a}	70.5 ± 0.29^{c}	100.0 ± 0.00^{a}	65.1 ± 0.17^{d}	91.6 ± 0.34^{b}
30	77.0 ± 0.46^{a}	100.0 ± 0.00^{a}	69.2 ± 0.12^{b}	100.0 ± 0.00^{a}	61.3 ± 0.17^{c}	91.6 ± 0.16^{b}	58.4 ± 0.23^{d}	91.6 ± 0.28^{b}
45	75.4 ± 0.23^{a}	100.0 ± 0.00^{a}	67.4 ± 0.12^{b}	100.0 ± 0.00^{a}	59.1 ± 0.16^{c}	91.6 ± 0.35^{b}	55.6 ± 0.29^{d}	83.3 ± 0.17^{c}
60	72.5 ± 0.17^{a}	100.0 ± 0.00^{a}	65.5 ± 0.29^{b}	100.0 ± 0.00^{a}	56.0 ± 0.46^{c}	91.6 ± 0.23^{b}	52.3 ± 0.15^{d}	83.3 ± 0.15^{c}
75	69.4 ± 0.23^{a}	100.0 ± 0.00^{a}	62.3 ± 0.17^{b}	100.0 ± 0.00^{a}	54.6 ± 0.35^{c}	91.6 ± 0.17^{b}	49.0 ± 0.52^{d}	83.3 ± 0.17^{c}
90	65.2 ± 0.12^{a}	100.0 ± 0.00^{a}	58.5 ± 0.29^{b}	100.0 ± 0.00^{a}	50.4 ± 0.23^{c}	91.6 ± 0.12^{b}	46.7 ± 0.40^{d}	83.3 ± 0.12^{c}

Mean±SE. *The stocking density of tilapia was 12/m^2 for all treatments. Mean values (within the same animal species) with the same letter(s) in each row is not significantly different ($p>0.05$)

Specific Growth Rate (SGR)

It can be noticed from the tabulated in Table 13 results that SGR of prawn were 3.79, 3.41, 2.55 and 1.92% per day for stocking densities 50, 100, 150 and 200 prawn m^{-2}, respectively at the 1st period. Then a gradual decrease in SGR was observed by time to reach 1.50, 1.46, 1.44 and 1.39% per day at the end of the experimental period for stocking densities 50, 100, 150 and 200 prawn m^{-2}, respectively. El-Sherif (2001) showed that, SGR values of prawn *M. rosenbergii* stocked at a density of 25 L/L were higher ($p<0.05$) than those stocked at 50 L/L. The statistical analysis showed that there were significant differences among SGR of prawn as well as among fish at the different prawn stocking densities. This is in full agreement with that found by Tidwell *et al.* (2004). Also, the results in Table 6 and 13 shown that in polyculture (Table 13) the SGR was slightly lower than that for monoculture (Table 6). So, these results showed that polyculture was more suitable at stocking density 100 prawn m^{-2} than monoculture.

Survival Rate

From the data in Table 14, it can be seen that the survival rate of fish at the end of the experimental period was high in all the densities (100, 100, 91.6 and 83.3% for prawn stocking densities 50, 100, 150 and 200 prawn m^{-2}, respectively). This is mainly due to:

- The ecological conditions throughout the experimental period were suitable for tilapia fish rearing especially the average water temperatures, which ranged during this period between 26.5 and 27.6°C (Marques *et al.*, 2000)
- The acclimation of the fish perior to the start of stocking in tanks

Regarding of stocking density separately, the average data in Table 14 shown that the survival rate of prawn and fish was decreased as the stocking densities increased. Similar results were obtained

Table 15: Mean food conversion ratio results for polyculture of prawn with *O. niloticus* reared in tanks under different treatments

	Stocking rate (prawn m^{-2})							
	50		100		150		200	
Period (day)	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*	Prawn	Tilapia*
15	2.35 ± 0.03^{d}	1.75 ± 0.02^{d}	2.48 ± 0.05^{c}	1.83 ± 0.02^{c}	3.54 ± 0.02^{b}	2.35 ± 0.01^{b}	3.89 ± 0.05^{a}	3.05 ± 0.03^{a}
30	2.38 ± 0.04^{d}	1.78 ± 0.05^{d}	2.42 ± 0.01^{c}	2.15 ± 0.01^{c}	3.49 ± 0.05^{b}	2.46 ± 0.04^{b}	4.05 ± 0.03^{a}	3.25 ± 0.02^{a}
45	2.31 ± 0.01^{c}	2.20 ± 0.02^{d}	2.37 ± 0.04^{c}	2.29 ± 0.05^{c}	3.41 ± 0.01^{b}	2.75 ± 0.03^{b}	3.90 ± 0.02^{a}	3.52 ± 0.01^{a}
60	2.40 ± 0.02^{c}	2.36 ± 0.03^{d}	2.44 ± 0.02^{c}	2.41 ± 0.02^{c}	3.45 ± 0.03^{b}	2.91 ± 0.01^{b}	4.10 ± 0.01^{a}	3.66 ± 0.04^{a}
75	2.43 ± 0.02^{c}	2.45 ± 0.03^{d}	2.49 ± 0.05^{c}	2.55 ± 0.03^{c}	3.53 ± 0.02^{b}	3.09 ± 0.05^{b}	4.27 ± 0.04^{a}	4.03 ± 0.02^{a}
90	3.11 ± 0.05^{c}	2.56 ± 0.04^{d}	3.23 ± 0.02^{c}	2.94 ± 0.01^{c}	4.50 ± 0.03^{b}	3.24 ± 0.02^{b}	5.68 ± 0.05^{a}	4.12 ± 0.01^{a}
0-12	2.49 ± 0.07^{c}	2.18 ± 0.08^{d}	2.57 ± 0.02^{c}	2.36 ± 0.08^{c}	3.65 ± 0.09^{b}	2.80 ± 0.08^{b}	4.32 ± 0.15^{a}	3.61 ± 0.09^{a}

Mean±SE. *The stocking density of tilapia was $12/m^2$ for all treatments. Mean values (within the same animal species) with the same letter(s) in each row is not significantly different ($p>0.05$)

by Tidwell *et al.* (2004). Generally, there were significant differences in survival rate of prawn and of fish among stocking densities of 50, 100, 150 and 200 prawn m^{-2}. The 2nd period of trial was characterized by high number of mortalities of prawn for all densities (low survival (%) of the prawn). This poor prawn survival (%) was adversely affected by tilapia stocking size. Predation by tilapia fry on the small prawns, increasing the density usually exacerbates problems with water quality (Wyban and Sweeney, 1989), the susceptibility of prawn to disease (Doubrovsky *et al.*, 1988) and competition for food may affect the growth at higher densities, may have been responsible for the reduced survival of prawns. Rouse *et al.* (1987) found that, tilapia fry feed on small invertebrates, especially crustaceans. Then, transition from an invertebrate diet to an adult diet of plant matter or detritus of plant origin occurs in tilapia fingerlings of about 2-3 g or above (Balarin and Hatton, 1979). Comparing between the survival (%) of prawn reared in trail 1 and 2 proved that the trail 1 (monoculture) was characterized by good survival rate, since the ecological conditions were adequate during this period. While during the trial 2 (polyculture), the survival % was low. This poor survival was due to predation by tilapia fry on the small prawn. Finally, from previously results, it might be concluded that the polyculture stocking density 100 prawn m^{-2} were more suitable than monoculture.

Feed Conversion Ratio (CFR)

The stocking density of 50 prawn m^{-2} showed the best feed conversion ratio for prawn (3.11 :1), followed by stocking 100 prawn m^{-2} (3.23 :1), then stocking 150 prawn m^{-2} (4.50 :1), while the stocking 200 prawn m^{-2} showed highest food conversion ratio (5.68 :1) during the whole 90 days. While, the food conversion ratios for fish were increased (2.56, 2.94, 3.24 and 4.12) for stocking densities 50, 100, 150 and 200 prawn m^{-2}, respectively during the trail period. The data in Table 15 showed that the feed conversion ratio for prawn and fish increased with increasing stocking density, since, the differences were significant among the four stocking densities. These results are in agreement with those obtained by Tidwell *et al.* (2004). On the other hand, Cohen (1984) reported that, feed conversion ratios in polyculture ranged around 0.87: 1. In other works, New (2005) found that, food conversion ratios fluctuated between 2 and 4:1 for dry diets. Regarding the comparison between the food conversion ratio in trail 1 and trail 2, data in Table 8 and 15 showed that the FCR for prawn in the trail 1 was higher than those obtained in the trail 2.

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