JOURNAL OF THE
ARABIAN AQUACULTURE SOCIETY

Vol. 8 No 2 Arabian Aquaculture Conference June 2013

Pilot Experiment on Shrimp *P. semisulcatus* Production at Al – Deba Farm Site

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ABSTRACT

The growout experiment was conducted by the default farming practices common in AL-Deba marine aquaculture and shrimp farming Zone. Famers who are willing to culture shrimp are doing the farming only at low stocking density as the usual stocking rate, ranging from few thousands of shrimp PL to ten thousands of shrimp PL. In this study, four nursery ponds were used with an average area of 4000 m^2. The production parameters of two different stocking densities were estimated (1.5/m^2 and 2.5 m^2 for nurseries A and B, respectively). There were no differences (P > 0.05) between the two nurseries in terms of growth parameters and final body weight at harvest. On the other hand, the economics of shrimp farming at nursery B is better than nursery A, due to the higher stocking number that led to higher production and economic return. Also, at higher stocking densities, the chance to have higher number of shrimp harvested and biomass were larger than low stocking density. The attained harvest weight of both nurseries achieved same sale price. Considering all production variables in this study, we noticed that the total revenue (L.E) for nursery B is higher than Nursery A at the same production period. From these results we expect that there is still chance to achieve higher production, if higher stocking density used. But, due to the risk that farmers feel, they are doing this level of production.

Keywords: ***Shrimp, P. semisulcatus, AL-Deba, Egypt, pilot experiment***

INTRODUCTION

According to UN World Population Prospects 2006 Revision, world population will grow significantly up to 9.2 billion by 2050. The FAO predicted that aquaculture production could contribute significantly to bridge the gap between demand and supply of aquatic food. Since farmed fish have the lowest feed conversion efficiency (kg of grain per kg of body weight) among intensively fed livestock animals, aquaculture has an important role to play in poverty reduction and food security. It can provide fish and other marine and freshwater products, which commonly are rich sources in protein, essential fatty acids, vitamins and minerals, and provide incomes and employment opportunities (FAO, 2003). Today, aquaculture is the fastest growing food-producing sector in the world, with an average annual growth rate of 8.9% since 1970, compared to only 1.2% for capture fisheries and 2.8% for terrestrial farmed meat production systems over the same period. Aquaculture expansion in Egypt has been actively promoted by the government to provide food security (Sadek *et al*., 2002).

Total world shrimp production increased significantly during the last two decades. World shrimp aquaculture production has grown tremendously from a production of 200,000 tons in 1985 to approximately 2.7 millions tons in 2005.

Many countries shifted from *P. monodon* to the white shrimp *Litopenaeus vannamei* as a main species in their shrimp farming. Recently, *L. vannamei* became more important compared to *P. monodon* in terms of contribution to the total world shrimp aquaculture production. *L. vannamei* is now farmed everywhere in Southeast Asia, except for Bangladesh (Rosenberry, 2004). In 2002, both species contributed equally, with about 500,000 tons. However, in 2005 production reached about 1.6 millions tons for *L. vannamei*, whereas only few thousand tons of *P. monodon* was produced. As a result, *L. vannamei* contributed 60% of shrimp aquaculture production, followed by *P. monodon* (27%). The other 13% are other species. Nowadays, shrimp production is dominating world crustacean culture. According to the FAO report of the year 2007, shrimps and prawns take the major share (39.03%) of the total world crustaceans production followed by freshwater crustaceans and crab/sea-spiders with a share of 25.38% and 13.80% respectively. Recently, most of the shrimp aquaculture production comes from Asian countries. The lead countries with shrimp aquaculture production are China, Thailand and Vietnam. In 2005, 68 countries reported penaeid shrimp aquaculture production, 22 countries reported producing *L. vannamei*, while 23 countries were producing *P. monodon* (FAO, 2007).

The aim of this study was to carry out extensive filed study at AL-Deba site with history of shrimp production and suffered from failure of marine shrimp farming. The overall goal of this study was to contribute to the sustainable development of the *P. semisulcatus* farming sector in Egypt.

MATERIALS AND METHODS

The experiment was conducted at commercial marine fish farm at AL Deba Triangle Zone (Figure 1). Green tiger shrimp *P. semisulcatus* (PL24) postlarvae were purchased from Haraz's marine fish and shrimp hatchery transferred and stocked in four nursery ponds of marine fish farm (Figure 1). The stocking were done in these nursery ponds from November to April (normal nursery practice of collected wild meager and sea bream and sea bass larvae).

The trial was carried out for 3 months. The stocking density and farming practices were done according to the default practices and farm management of the fish farmer at this farming region. Information collected from shrimp provider hatcheries and shrimp farmers before the start of the trials indicated that the stocking density does not exceed 6000-10000 shrimp postlarvae (PL) per nursery pond. Nursery ponds used in this study of almost 4000 m^2 according to the area of the farm used for growout. Fish farmers allow us to perform the trial using our costs (we have provided them with shrimp postlarve) and follow-up the trial till the end of the 3 month period.

Feeding type

Shrimp were fed once daily in the evening using fresh trash fish. Surface water temperature (minimal and maximal values), salinity, dissolved oxygen (DO) and pH values were recorded daily (0900). Water samples were collected weekly to evaluate the concentrations of total ammonia and Alkalinity (UNESCO, 1983), nitrite and nitrate (Benschneider and Robinson, 1952) and phosphate (Aminot, 1977).

Figure 1. Nursery ponds layout (N1, N2, N3 and N4) used in the shrimp experiment at AL- Deba site.

Sampling and estimation of growth parameters

Shrimp growth was monitored during the 90-day culture period (from May 15, 2010 to August, 15, 2010) by randomly sampling of 30 individuals from each experimental nursery at approximately 15-day intervals. As soon as body wet weight (g) was measured, shrimp were returned to their original experimental pens. Growth rates were calculated for each sampling interval by the formula G = (Wf _ Wi)/T, where G = growth rate in g/week, Wf = mean final weight (g), Wi = mean initial weight (g) and T = time in weeks. Survival was determined at the end of the experiment. Food conversion ratio was calculated for each sampling interval by the formula FCR = Total feed used/Total weight of the sampled shrimp. Analysis of variance (ANOVA) was used to detect differences within replicates and between treatments at 5% significance level.

RESULTS

Growout production at AL – Deba Triangle zone

Growth parameters

The growout experiment was conducted by the default farming practices common in AL-Deba marine aquaculture and shrimp farming Zone. Famers who are willing to culture shrimp are doing the farming only at low stocking density as the usual stocking rate, ranged from few thousands of shrimp PL to ten thousands of shrimp PL. In this study, four nursery ponds were used with an average area of 4000 m^2. Table 1, shows the production parameters of the two different stocking densities (1.5/m^2 and 2.5 m^2 for nurseries A and B, respectively). There were no differences ($P > 0.05$) between the two nurseries in terms of growth parameters and final body weight at harvest (Table 1). On the other hand, the economics of shrimp farming at

Table 1. ***Production and economic values of the green tiger shrimp P. semisulcatus farming pilot study at AL-Deba Triangle Zone.***

Parameters	Nursery A		Nursery B	
	A1	A2	B1	B2
Initial number (PL_{21}) stocked	6000	6000	10000	10000
Initial body weight PL_{21} (mg)	34 ± 0.01^a	34 ± 0.01^a	34 ± 0.03^a	34 ± 0.03^a
Initial biomass stocked (g)	204	204	340	340
Final mean body weight (g/shrimp)	13.85 ± 0.75^a	13.38 ± 0.64^a	13.43 ± 0.44^a	13.27 ± 0.33^a
Survival (%)	85.3 ± 5.7^a	86.6 ± 4.3^a	85.7 ± 3.5^a	82.4 ± 3.7^b
Final biomass (kg)	70.88 ± 14.5^a	69.52 ± 7.8^a	115.09 ± 11.4^b	109.34 ± 9.8^c
Total feed (kg)	215 ± 12.5^a	215 ± 12.6^a	310 ± 3.9^b	328 ± 6.5^c
FCR	3.02 ± 0.11^a	3.07 ± 0.08^a	2.69 ± 0.36^b	3.00 ± 0.09^a
Growth rate (g/week)	0.78 ± 0.01^a	0.77 ± 0.01^a	1.27 ± 0.03^b	1.21 ± 0.01^b
Sale price (LE/kg)	45	45	45	45
Total sale price (LE)	3195	3150	5175	4905
Cost of shrimp postlarvae (LE/1000 PL_{21})	450	450	750	750
Feed cost (4 LE/kg feed)	860	860	1240	1312
Other costs LE (Fuel and transportation)	300	300	300	300
Total costs (LE)	1610	1610	2290	2362
Revenue (LE)	1585	1540	2885	2543

Means with different superscripts differ significantly (P<0.05).

nursery B is better than nursery A, due to the higher stocking number that led to higher production and economic return. Also, at higher stocking densities, the chance to have higher number of shrimp harvested and biomass are larger than low stocking density.

No significant differences were found in growth parameters and survival (ANOVA; $P > 0.05$) between treatments. The stocking weight of shrimp postlarvae presented no significant difference ($P > 0.05$) between treatments (Table 1). Differences in final yield were influenced by the higher survival rate and stocking density of the green tiger shrimp *P. semisulcatus* of both treatments (Table 1). FCR was significantly ($P < 0.05$) higher for both treatments (Table 1). There were no significant difference ($P > 0.05$) in growth rates was observed between treatments (Table 1). The Nursery B achieved higher growth rate (1.27 ± 0.03 and 1.21 ± 0.01 for ponds B1 and B2, respectively) than nursery A (0.78 ± 0.01 and 0.77 ± 0.01 for ponds A1 and A2, respectively). Stocking density in Nursery B is higher than Nursery m but all of them are classified as extensive farming systems.

The attained harvest weight of both nurseries achieved same sale price. Considering all production variables in this study, we noticed that the total revenue (L.E) for nursery B is higher than Nursery A at the same production period. From these results we expect that there is still chance to achieve higher production, if higher stocking density used. But, due to the risk that farmers feel, they are doing this level of production.

We modeled the production status at AL-Deba farming condition by choosing parameters that contribute more to the real situation at AL-Deba farming site.

$$Y_{ijkl} = \mu + R_i + F_j + G_k + W_l + \varepsilon_{ijkl} \ldots \textbf{Model (2)},$$

Where; $\mathbf{Y_{ijkl}}$ is the trait under study (production); μ is the overall mean; R_i effect of survival; F_j effect of FCR; G_k effect of growth rate; W_l effect of harvest weight and $\boldsymbol{\varepsilon_{ijkl}}$ is the residual error term.

Water quality parameter

Water quality during the experimental period was considered acceptable for shrimp culture. No wide variations in mean water quality parameters were observed **(**Tables 2, 3, 4,5,6,7 and 8). The measured water quality parameters were measured in some cases all round the year as these nursery ponds were not empty before shrimp farming, but was used as a nursery for marine fish fry collected from the wild. The ammonia, nitrite, nitrate, alkalinity are in the optimal range for shrimp and crustacean growth **(**Tables 2, 3, 4,5,6,7 and 8).

Table 2. Ammonia –N (TAN) mg/L concentration in the nursery water during 12 months.

Farm / pond	May	Jun	Jul	Aug
A1	0.11 ± 0.00^{a}	0.14 ± 0.00^{b}	0.08 ± 0.01^{d}	0.08 ± 0.00^{c}
A2	0.13 ± 0.04^{a}	0.26 ± 0.14^{a}	0.20 ± 0.14^{b}	0.12 ± 0.04^{b}
B1	0.05 ± 0.00^{b}	0.16 ± 0.04^{b}	0.23 ± 0.05^{a}	0.17 ± 0.02^{b}
B2	0.04 ± 0.00^{b}	0.11 ± 0.05^{c}	0.13 ± 0.07^{c}	0.21 ± 0.18^{a}

Means with different superscripts differ significantly (P<0.05).

Table 3. Nitrite mg/L concentration in the nursery water during 12 months.

Farm / Pond	May	Jun	Jul	Aug
A1	0.01 ± 0.01^{b}	0.26 ± 0.24^{a}	3.20 ± 0.14^{b}	4.55 ± 0.07^{b}
A2	0.01 ± 0.00^{b}	0.04 ± 0.00^{b}	3.15 ± 0.07^{b}	4.15 ± 0.21^{b}
B1	0.05 ± 0.01^{a}	0.00 ± 0.01^{c}	3.65 ± 0.07^{a}	4.9 ± 1.5^{a}
B2	0.05 ± 0.00^{a}	0.01 ± 0.00^{c}	3.70 ± 0.14^{a}	4.9 ± 0.14^{a}

Means with different superscripts differ significantly (P<0.05).

Table 4. Nitrate mg/L concentration in the nursery water during 12 months.

Farm / Pond	May	Jun	Jul	Aug
A1	0.03 ± 0.00^{b}	0.03 ± 0.00^{b}	0.03 ± 0.00^{b}	0.25 ± 0.07^{b}
A2	0.06 ± 0.05^{a}	0.3 ± 0.00^{b}	0.15 ± 0.07^{b}	0.3 ± 0.00^{a}
B1	0.02 ± 0.00^{b}	0.25 ± 0.07^{a}	0.30 ± 0.00^{a}	0.3 ± 0.00^{a}
B2	0.01 ± 0.00^{b}	0.009 ± 0.00^{c}	0.01 ± 0.00^{b}	0.25 ± 0.07^{b}

Means with different superscripts differ significantly (P<0.05).

Table 5. Alkalinity mg/L concentration in the nursery water during 12 months.

Farm / Pond	May	Jun	Jul	Aug
A1	118.5 ± 6.36^{b}	121.5 ± 13.44^{a}	104 ± 19.80^{a}	123 ± 0.00^{b}
A2	120.5 ± 3.54^{a}	123.5 ± 4.95^{a}	108 ± 8.49^{a}	127 ± 5.66^{a}
B1	120.5 ± 3.54^{a}	121.5 ± 2.12^{a}	106 ± 2.83^{a}	123.5 ± 4.95^{b}
B2	116 ± 0.00^{b}	118.5 ± 3.54^{b}	99 ± 1.41^{b}	123.5 ± 10.61^{b}

Means with different superscripts differ significantly (P<0.05).

Table 6. pH values in the nursery water during 12 months.

Farm / Pond	May	Jun	Jul	Aug
A1	6.64 ± 0.49^{c}	6.78 ± 0.16^{a}	6.88 ± 0.02^{a}	7.18 ± 0.11^{a}
A2	7.15 ± 0.07^{b}	6.94 ± 0.02^{a}	6.89 ± 0.05^{a}	7.06 ± 0.05^{b}
B1	7.13 ± 0.02^{b}	6.95 ± 0.01^{a}	6.91 ± 0.00^{a}	7.23 ± 0.03^{a}
B2	7.33 ± 0.06^{a}	6.97 ± 0.01^{a}	6.88 ± 0.02^{a}	7.15 ± 0.02^{a}

Means with different superscripts differ significantly (P<0.05).

Table 7. Do mg/L in the nursery water during 12 months.

Farm / Pond	May	Jun	Jul	Aug
A1	4.88 ± 0.16^{a}	4.19 ± 0.87^{a}	4.19 ± 0.02^{a}	3.47 ± 0.79^{a}
A2	4.67 ± 0.21^{a}	4.44 ± 0.33^{a}	3.65 ± 0.27^{b}	2.76 ± 0.19^{b}
B1	4.19 ± 0.39^{a}	3.82 ± 0.41^{b}	3.12 ± 0.64^{b}	3.66 ± 0.84^{a}
B2	4.59 ± 0.01^{a}	4.32 ± 0.11^{a}	3.66 ± 0.21^{b}	3.06 ± 0.28^{b}

Means with different superscripts differ significantly (P<0.05).

Table 8. Temperature (T^{o}C) in the nursery water during four months of the growout period.

Farm / Pond	May	Jun	July	Aug
A1	25.77 ± 0.96^{a}	27.03 ± 2.99^{a}	29.43 ± 1.14^{a}	29.67 ± 1.36^{a}
A2	25.62 ±1.28^{a}	25.84 ± 2.15^{b}	26.16 ± 1.54^{b}	29.56 ± 0.95^{a}
B1	25.06 ± 0.82^{b}	26.5 ± 0.48^{b}	26.81 ± 0.21^{b}	26.82 ± 0.20^{b}
B2	26.54 ± 0.38^{a}	24.46 ± 3.34^{c}	25.63 ± 1.85^{b}	29.1 ± 0.57^{a}

Means with different superscripts differ significantly (P<0.05).

The reference values of each water quality parameter were used to compare the measured values. The obtained parameters in this study compared with the reference values were in the suitable range from shrimp production. Also, we could say that the low stocking densities used in this study did not deteriorate water quality, because there was no effect of uneaten food or excretion for the shrimp at low stocking densities. The pH , Do and temperature are recorded in the ursery ponds and it is observed that the parameters are in the optimal range for the growth of crustaceans and shrimp and also there is few fluctuations in the values due to pond dynamics and the daytime situation and the weather condition of this area (31º 28֒ 22.62֒֒ N and 31º 55֒ 13.2486֒֒ E) which affect plankton growth Tables 2, 3, 4,5,6,7 and 8).

DISCUSSION

Pilot shrimp farming study at AL Deba triangle farm

Overall means of physical and chemical water parameters were within optimal growing conditions for the *P. semisulcatus.* Boyd (1989) recommended that, for penaeid shrimp culture, water temperature should range from 24-32°C, salinity from 5-55 ppt, dissolved oxygen above 3 mg/L, and pH from 7-9. The variations of salinity observed here were mostly related to evaporative losses, dilutions from water comes from Lake Manzala, which caused salinity levels to rise and drop nearly to the tolerance limits of the green tiger shrimp *P. semisulcatus* (Wasielesky, 2000; Bray *et al.* 1994). Nevertheless, no effects on shrimp growth could be associated with this parameter. Temperature tolerance, however, deserves a closer investigation, as the species present a marked difference in their latitudinal distribution. The growth rate of green tiger shrimp was negatively affected when the water temperature was below 23°C. Wyban *et al.* (1995) demonstrated that the growth rate of Pacific white shrimp is extremely sensitive to temperature, with an optimal range from 27-30°C.

Low temperatures in North Nile Delta are generally caused by periodic cold fronts coming from Europe. However, this phenomenon usually occurs with less frequency and intensity during the summer period. Moreover, based on the present results, it is possible to conclude that the growing season is long enough to produce one cycle per year of large-sized (>14 g) shrimp or even two cycles of market-sized (7-10 g) shrimp, as long as the level of management procedures are improved. However, to achieve this goal, another issue concerning shrimp production must be considered to decide the species of choice for culture in a given area. Comparing the culture potential of the native green tiger shrimp, *Penaeus semisulcatus*, and the exotic Indian white shrimp, *Penaeus indicus*, we found that at a density of 12 shrimp/m^2, growth rates were 0.91 g/week for green tiger shrimp and 0.64 g/week for Indian white shrimp, with final yields of 1500 and 2400 kg/ha, respectively. Despite the obviously more favorable results for wild green tiger shrimp, the use of the domesticated native species was also recommended because it presents some advantages, such as a greater tolerance to environmental conditions and a longer growing season.

Opposite to development strategies in the field of shrimp farming and environmental protection. The introduction of Indian white shrimp in AL-Deba triangle zone has been described by GAFRD (General Authority for Aquaculture Development) as a new alternative for native species in pond culture. Costa *et al.* (2000) declared that, the fast increase in shrimp production between 1998 and 2000 in Brazil was reached due only to the introduction of Pacific white shrimp. We found in our study that the production of local farms in Egypt of market-sized (11-12 g) shrimp can be reached from 50 up to 90 days at densities between 9-20 shrimp/m^2 and yields ranging from 700-1,280 kg/ha. Based on the above, it is concluded that the culture of the green tiger shrimp in SAFICO (Gulf of Aqaba) has a production cycle comparable to that of AL-Deba (Mediterranean), especially after the first 30 days of growth period. Nevertheless, if the estimated yield for native and imported shrimp and the similarity of growth parameters between them are considered, the native species could not be totally replaced for pond culture in Egypt.

The lack of a specific commercial feed has been cited as a problem by those who tried to invest in an unknown (introduced) shrimp species. Effective diets based on response of different shrimp species, to changes in dietary energy levels may offer many advantages, such as better feed conversion and faster growth (D'Abramo *et al.* 1997). Accordingly, use of a commercial feed specially designed for the green tiger shrimp in the present study may have contributed to better FCR's than those of introduced species. On the other hand, green tiger shrimp were probably favored by the fresh frozen mix added to the diet, as reported in a previous study (Wasielesky, 2000). This hypothesis is reinforced by the discrepancies between the green tiger shrimp FCR of 1.7 under this study's conditions and that of 4.3 reported by Ostrensky *et al.* (1992) in pond culture with non-specific commercial diet. Many advantages and disadvantages regarding the potential for pond culture of green tiger shrimp and Indian white shrimp in Egypt were pointed out in the present study. Considering the present stage of knowledge about Indian white shrimp requirements during culture, it was concluded that green tiger shrimp are probably the best choice for local pond culture. Regardless of the positive results obtained here for green tiger shrimp, this conclusion was based on the research and technology concerning Indian white shrimp, whose culture thus results in less risk. Nevertheless, green tiger shrimp remain a viable species compared to the introduced species discussed here. Further studies, especially about nutritional requirements, are necessary to improve green tiger shrimp's growth performance under culture conditions.

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تجارب استزراع استكشافية للجمبرى السويسى فى منطقة مثلث الديبة

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اجريت تجربة استكشافية لاستزراع الجمبرى السويسى فى منطقة مثلث الديبة للكشف عن معوقات انتاج الجمبرى فى تلك المنطقة الهامة للاستزراع البحرى فى مصر. تم الاستزراع بواسطة نفس الاسلوب المتبع لدى المزارعين لكى نصل الى اسباب فشل انتاج الجمبرى بتلك المنطقة. كثافة الاستزراع المعتادة لدى المزارعين الراغبين فى استزراع الجمبرى منخفضة (الاستزراع بالطريقة الموسعة) فى احواض تحضين الاسماك بمساحة ٤٢٠٠ متر مربع. كانت كثافة الاستزراع (١,٥ ، ٢,٥ وحدة زريعة لكل متر مربع فى نوعين من الاحواض بنفس المساحة). لم توجد اى اختلافات بين المعاملات من حيث مقاييس النمو والانتاج ووزن الحصاد. على الجانب الاخر، ان اقتصاديات الانتاج للكثافة الاعلى كانت الافضل حيث حققت اعلى عائد اقتصادى تحت نفس ظروف الاستزراع. كما ان وزن الحصاد حقق نفس السعر بالتالى الكثافة الاعلى حققت اعلى عائد اقتصادى. كما نستنتج من هذه التجربة انه مازال هناك فرصة للتكثيف اعلى من الكثافة الحالية دون تاثير على كفاءة النمو للجمبرى مما يحقق اعلى عائد واستغلال امثل للموارد الموجودة فى بيئة الحوض مما يحتويه من غذاء ومساحة للجمبرى يعيش عليها فى الحوض دون منافسة.