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The study effect of sun light on growth performance and survival of postlarval white leg shrimp (*Litopenaeus vannamei)* and salinity stress resistance

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ABSTRACT

Investment in the Iranian fisheries sector during past decade lead to Aquaculture development (specially shrimp farming). Light is an important biological factor for living of aquatic animals. Photoperiod parameters such as intensity, duration, and spectrum have important influences on growth, survival, maturation, reproduction and sex ratio of aquatic animals. This study has been done to Study the effect of sun light on growth performance, survival and salinity stress resistance of post larvae of White leg shrimp (Litopenaeus vannamei). For this means we used 2 treatments of direct sun light and blank treatment covering with black plastic upper the rearing tanks as a control treatment in 3 replicates. This study was carried out in Pardis Maigo shrimp hatchery in Jask. At the beginning and the end of the rearing period (20 days), the specific growth rate, weight gain, the final weight and survival rate were determined. Results showed that direct sun light has positive influence on growth performance factors as those factors were significantly higher than control treatment ($P < 0.05$). In addition this treatment had higher survival rate in rearing period and salinity tests. Based on the results of this study this method can increase the growth, survival and tolerance against unsuitable environmental factors such as salinity fluctuation in L. vannamei post larvae.

Key words: Growth, Survival, Sun light, larvae, *Litopenaeus vannamei.*

INTRODUCTION

Aquaculture has increasingly grown during past decade while production through capture has stayed stable. Investment on fisheries and aquaculture since the beginning of past decade in Iran has led aquaculture (especially shrimp culture) toward a considerable and stable progress. Meanwhile, crustacean's production also progressed increasingly as result of more demand so that crustacean production through aquaculture increased from the annual rate of 1.6 million tons in 2000 to 5 million tons in 2008. Moreover, resounding increase in *Litopenaeus vannamei* culture in China, Thailand and Indonesia contributes considerably to this growth [1]. Currently, several species of shrimps are being cultured throughout the world but the predominant one in most countries and Iran is *Litopenaeus vannamei* because of supreme culture characteristics, simplicity of naturalization and developing diseases-free livestock [2].

Light is a main bio-factor for aquatic animals and organisms. Several studies have investigated various light conditions on aquatics and found significant differences in their behavior, nutrition and growth. Giri *et al* [3] suggest that different light parameters such as severity, spectrum and length of light period have considerable effects on growth, survival, sexual maturity, regeneration and even sexual ratio of aquatic organisms [4]. Access to information on the effect of light periods and light color with specific lamination can provide valuable data which enable production of high quality aquatics which have proper growth and survival in their lifespan. Unfortunately, little research is performed on the effect of different lights on shrimps. Therefore, the present paper aims to evaluate growth performance (increase in length and weight) and survival in post larval *Litopenaeus vannamei* using sun light.

MATERIALS AND METHODS

Experimental design

The experimental part of this study was performed in Pardis Jask shrimp hatchery in Hormozgan province (South East of Iran) for 20 days and included a full process of larvae culture (since stocking recently hatched nauplius until they turn to 10-day post larvae). 10-tone tanks were used for this research and culture and feeding system (nauplius density, water temperature, feeding style and nutrient type) were as same as conventional ones for other culture tanks available in the center. Organisms were feed 6 times per day, every 4 hours (4, 8, 12, 16, 20, and 24). The nutrient used in this center was a combination of Artemia live food and phytoplankton and a kind food formulated by INVE Company in various sizes depending on larval stages. Moreover, two treatments were used in this paper to examine the effect of sun light on larvae and every treatment was repeated 3 times.

1. Treatment A: In this treatment the 50 × 70 slit on top the tank was opened and the sun shined to tanks during the day (12 hours of light and 12 hours of darkness). Shrimp larvae were cultured until reaching 10-day post larval period and transparent plastic was used to cover tanks.
2. Control treatment B: In this treatment, having nauplius stocked a dark plastic sheet was used to cover the tank and prevent light from entering it (the same as what is traditionally done in other hatcheries) (24 hours of darkness). Here, the larvae's were cultured under normal conditions according to the traditional system until they turn to 10-day post larval.

Larva feeding

Larvae had same feedings in both treatments; feeding with the microscopic algae (chetocerous) during Zoa2 and Zoa 3 and with atremia nauplius during meiosis. A formulated food by INVE Company was fed as a specific nutrition to both larvae and post larvae; formulated Spirolina and ZM food during zoa2 and zoa3, 2cd formulated food during meiosis and PL 150 during post larval period (PL 150 is specific to 1– 5 post larval stages). The formulated nutrients were fed every 4 hours during zoa and every 2 hours during post larval stages. Besides, the chetocerous algae were fed in zoa and meiosis stages with 3 liters / 12 hours and 1 liter / 12 hours rate, respectively. The feeding rate of artemia nauplius during meiosis and post larval stages was 1g for 2000 larvae and 2g for 2000 larvae, respectively. During post larval stage in which organisms must be fed every 2 hours artemia nauplius was fed every 2 other hours [1].

Measuring growth and survival factors

Specific growth rate, weight gain and final weight were considered as growth measurement factors. A total number of 100 organisms from each treatment were selected through following formulations for growth factor valuation [5].

$$SGR\ (\%\ /\ day) = 100\times (\ln W_2 - \ln W_1)\ /\ days$$

$$WG\ (\%) = 100\times (W2 - W_1)\ /\ W_1$$

In the equations above WG is the weight gain, SGR is the specific growth rate, W_2 is the final weight, W_1 represents the initial weight and the phrase "days" shows number of experiment days. The final weight is obtained by dividing the weight of each treatment by the number of post larvae. Survival is obtained by counting shrimps at the beginning and end of the experiment using the following equation [6].

$$Survival\ (\%\ /\ day) = 100 \times (final\ shrimp\ number)\ /\ (initial\ shrimp\ number)$$

Salinity stress test was performed according to Alvarez *et al* [7] with 3 repetitions for every treatment. The total number of shrimps undergone salinity stress test was 15 in every repetition. In order to evaluate salinity resistance shrimps were picked from water with 40 ppt salinity and immersed in fresh water for 30 minutes and then transferred back to the salt water (40 ppt salinity) for another 30 minutes. Post larvae with no response to the external stimulus were considered dead [7].The present research was performed in the form of Completely Randomized Block Design (CRBD). Data obtained at the end of experiment period was analyzed using average comparison of all treatments by Tukey Test and Excel and SPSS software. Presence or absence of a significant difference was determined in 5% level.

RESULTS

Results showed that shrimps in the light receiving treatment (A) have longer length and a significant difference with those in the control treatment (B) ($P < 0.05$).

Table 1. Average total length (mm) at the end of treatment (PL 10)

Treatment	Quantity	Initial Length	(Mean±SD)
A	90	2.74 ± 0.05	9.89 ± 0.28 *
B	90	2.75 ±0.06	9.68 ±0.22

A: receiving sun light treatment and B: Dark plastic sheet (Control treatment)
**Correlation is significant at the 0.05 level*

Shrimps in treatment A, receiving sun light through a slit on top of the culture tank had the longest average total length (9.89±0.28 mm) among all treatments (Table 1, fig 1).

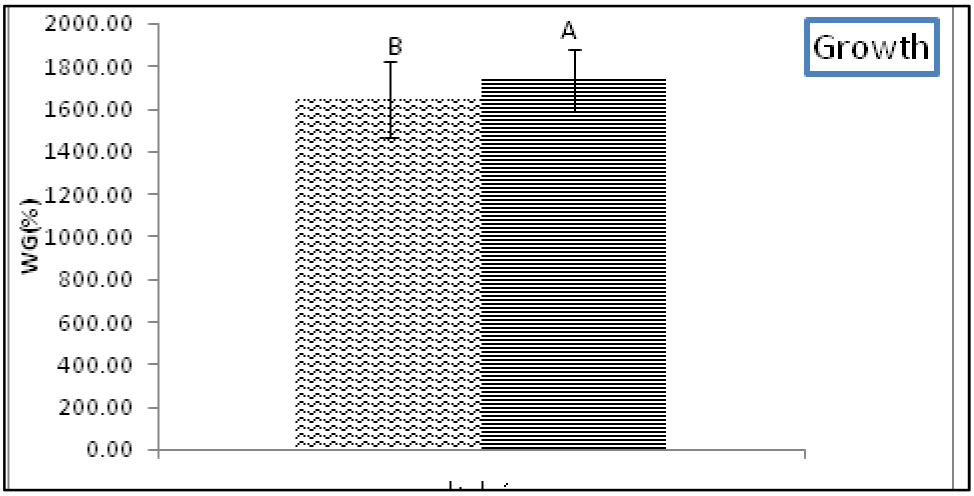

Fig 1. The comparison of growth rate in receiving sun light treatment (A) and control treatment (B)

As to wet weight of shrimp larvae treatment A led to better results compared to control treatment B with average wet weight of 4.38±0.34 mg and the difference between the two treatments was significant ($P<0.05$)(Table 2, fig 2).

Table 2. Average weight (g) at the end of treatment (PL 10)

Treatment	Quantity	Initial weight	(Mean±SD)	Growth gain	SGR
A	90	0.25 ± 0.01	4.66 ± 0.15 *	1733.53 ± 145.94 *	14.52 ± 0.39 *
B	90	0.25 ±0.01	4.38 ±0.34	1664.14 ±179.15	14.25 ±0.75

A: receiving sun light treatment and B: Dark plastic sheet (Control treatment)
**Correlation is significant at the 0.05 level*

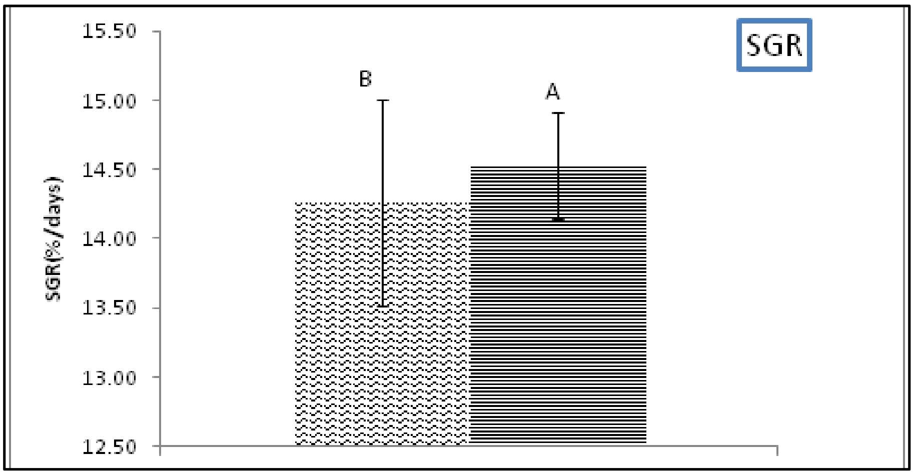

Fig 2. The comparison of specific growth rate in receiving sun light treatment (A) and control treatment (B)

Moreover, there was a significant difference between treatment A (with wet weight of 4.66±0.15 and specific growth of 14.59±0.33) and the control treatment B in terms of weight gain and specific growth rate increase ($P<0.05$). Treatment survival rate at the end of experiment period was 48±2.3% for the light receiving treatment and 37±2.1% for the control treatment (Table 3, fig 3).

Table 3. Average survival rate (%) at the end of treatment (PL 10)

Treatment	Quantity	(Mean±SD)
A	3	48 ± 2.3 *
B	3	37 ±2.1

A: receiving sun light treatment and B: Dark plastic sheet (Control treatment)
**Correlation is significant at the 0.05 level*

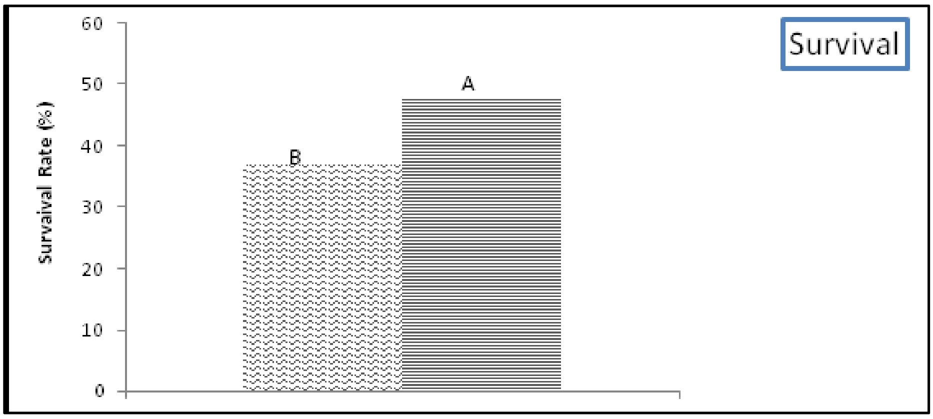

Fig 3. The comparison of survival rate in receiving sun light treatment (A) and control treatment (B)

On the other hand, results of Tukey Test indicated a significant difference in larvae survival in 5% level between the two treatments ($p<0.05$). Shrimp larvae showed different levels of salinity resistance and it was significantly higher in all experimental treatments influenced by sun light than the control ($P<0.05$). Besides, light receiving larvae showed considerably higher resistance against 40 ppt salinity stress than those in the control treatment ($P<0.05$) so that survival rate of this test in treatments A and B was estimated to be 76.66±3.33 and 65.55±1.52, respectively (Table 4, Chart 4).

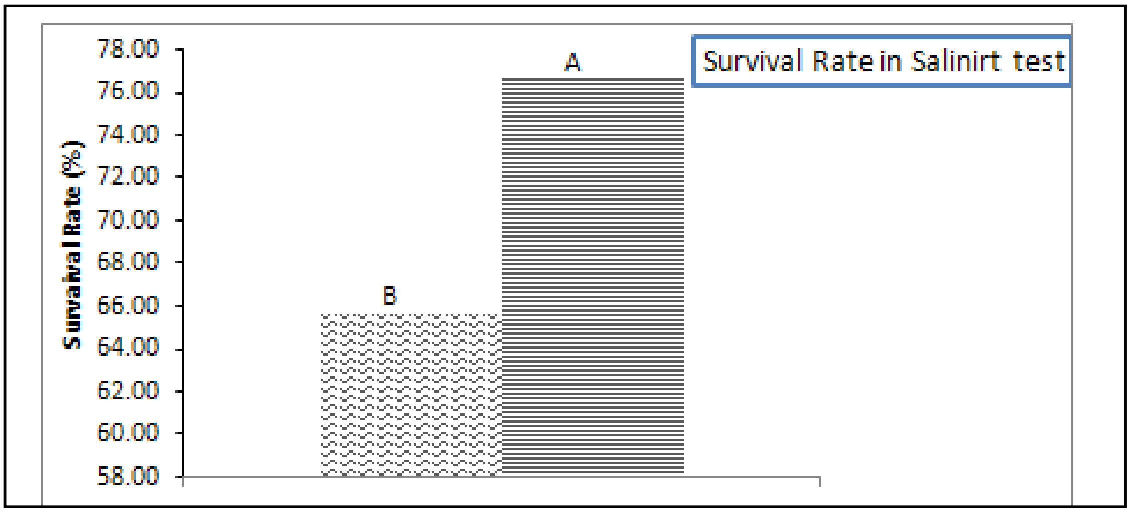

Fig 4. The comparison of survival rate in receiving sun light treatment (A) and control treatment (B) in salinity test

Table 4. Average survival rate (%) at the Salinity test

Treatment	Quantity	(Mean±SD)
A	3	76.66 ± 3.33 *
B	3	65.55 ±1.52

A: receiving sun light treatment and B: Dark plastic sheet (Control treatment)
**Correlation is significant at the 0.05 level*

DISCUSSION

Traditionally, most shrimp hatcheries use black (transparent) plastic during culture process to cover larvae rearing tanks. The plastic cover is used to prevent contaminants from entering the tanks and also to maintain water temperature. Results of the present research, examining growth factors, survival and resistance of western white shrimp (*Litopenaeus vannamei*) while introducing sun light to the larval and post larval rearing tanks, showed that the above mentioned factors in the light receiving treatment (A) significantly differed from those in control treatment (B) ($P<0.05$). As results indicate sun light can greatly influence survival and growth rate of larvae. Light is considered as a main physical factor for all aquatic organisms. Light parameters such as severity, spectrum and length of light period have considerable effects on growth, survival, sexual maturity, regeneration and even sexual ratios of aquatics. One of the most effective factors on aquatic life is the length of light period [4]. Several studies have demonstrated that aquatics express specifically different behavior, food intake, and growth and survival rates under various light conditions. Britz and Piennar [8] implemented different light designs on *Clarias gariepinu*s larvae and found that the animals best grow under low severity light and this result is similar to findings of studies of Maguire and Gardner [9] on *Pseudocarcinus gigas* and those of Giri *et al*., [3] of cat fish larvae (*Wallago attu*). They also reported that fish better grow in illuminated treatments than in those dark ones. Small amount of research work is performed on the effect of different light factors (such as severity, spectrum and length of light period) on crustaceans. On the other hand, light mechanisms likely to affect crustaceans are almost unknown [10]. It seems that shrimps express less mobility being exposed to normal light severity while cleaning culture tanks and this leads to consuming more energy for body and somatic growth and ultimately results in growth improvement in shrimps [10]. In the present paper higher specific growth coefficient in light receiving treatments indicates this fact. Subjective observations of the present research demonstrated a growth increase of algae on the tank wall. The algae are used by shrimps as a proper food resource [4]. Of course, light severity was also effective on this correlation. Wang *et al* [4] stated that, in fact, shrimps save more energy for their growth in lower light severity and require less for breathing. Therefore, Post larvae of (*F. chinensis*) undergone treatments with lower light severity consume more energy to grow and develop and, hence, possess higher specific growth rate. Golshahi *et al*., [11] found that despite differences in light periods of the two treatments (24 h and 12 h illumination with severity of 50 lux) no significant difference was observed in specific growth rates. This indicates lack of significant effect of light periods on Indian white shrimp (*F. indicus*). Vijan and Divan [12] reported that 24h and 12h illumination light periods had no significant effect on the delay between molting and growth of *F. indicus*. Moreover, various illumination and darkness did not influence growth rate of larval *Penaeus monodon* [13]. However, the effect of natural light on shrimp larvae in this study differed from those mentioned in other literature which used superficial lights. Among light severity and length of light period the effect of the former is more prominent on growth of shrimps [10]. Results of this paper, also, confirm the importance of light severity and making use of natural light. Another hypothesis on examining effects of illumination says that the two factors (light severity and length of light period) affect nutritional activities of the organism. Gardner and Maguire [14] investigated the influence of a light diet with different severities on big, circular Australian crab (*Pseudocarcinus gigas*) larvae and concluded that they grow better under lower light severity. As to survival rate, using sun light has a considerable impact on shrimp survival during larval culture stages. Since larval stages of shrimp culture are critical and essential step in which high rate of mortality are observed [10] it is important to employ methods leading to an increase in shrimp growth and survival. Therefore, according to evidence, the present method enhances growth, survival and resistance no unfavorable environmental conditions (such as salinity stresses) in post larval *L. vannamei*. The present paper provides evidence that growth of *L. vannamei* can be enhanced potentially by manipulating light severity and length of light period (using natural light) in culture centers without influencing survival rate. However, more studies are required on the effect of severity and length of light period on survival and growth of shrimps and their impact on sexual maturity steps of parental shrimps.

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