Intensive production of shrimp is getting increased attention worldwide as a potential means to improve aquaculture production through application as a transitional nursery system between the hatchery and grow-out ponds (Correia et al. 2014). The use of nurseries for shrimp culture is on the rise because a nursery phase contributes to rapid growth. In addition, it is possible to manage higher stocking densities to reduce unit production cost, potentially increase the number of annual crops though reduced duration of grow-out, head start production in cooler months in controlled temperature systems, and provide disease control and increased survival at the end of the nursery period. However, high stocking densities in nurseries may decrease growth and survival of shrimp because of decreased available space, the availability of natural food, cannibalism, degradation of water quality and accumulation of organic matter on the tank bottom (Nga et al. 2005, Arnold et al. 2006).

It is not known if high stocking densities in shrimp culture with clearwater recirculation produces similar results to those reported in the literature because several nursery systems used involve high microorganism concentrations (biofloc) and some have been managed poorly. Furthermore, failure in water oxygenation could impact shrimp postlarvae performance in nursery tanks. This article describes a study that investigated the performance of Litopenaeus vannamei postlarvae reared in indoor nursery tanks at different stocking densities in a clearwater recirculation system.

**Clearwater Recirculating System and Experimental Design**

Experiments were performed in indoor tank facilities of the Marine Aquaculture Station Prof. Marcos Alberto Marchiori (EMA) of the Federal University of Rio Grande, Brazil. The effects of stress caused by population density were evaluated in a clearwater recirculating system of indoor shrimp nursery tanks. This system was used because the main objective of the study was to determine the productive performance of shrimp postlarvae in terms of tolerance to crowding and to maintain the same water quality to detect the maximum stocking density for the nursery phase.

The system included twelve 0.15-m$^3$ circular tanks with a bottom area of 0.5-m$^2$ diameter that were provided with diffused aeration (Fig. 1). A biological filter, consisting of two 100-L tanks filled to 40 percent with 1-inch Bio-Balls and provided with intense aeration, was placed in a 4-m$^3$ matrix tank.

Each experimental tank was supplied by water pumped from the matrix tank. A submersible pump distributed water to tanks and
this water returned via gravity to a drain directed to the matrix tank. Water was completely recirculated about 20 times each day (flow rate ≈ 2.1 L/min/tank). The system was filled with water pumped from a nearby beach and filtered through a sand filter and a 5-µm pore cartridge filter. There was no renewal of water during the study, only replacement of water lost by evaporation with dechlorinated freshwater. Water temperature was maintained with two heaters immersed in the matrix tank. The photoperiod for the experimental room was 12/12 h light/dark cycle, with 200 lux intensity at the water surface provided by artificial lighting.

Shrimp nauplii were obtained from a commercial hatchery (Aquatec Ltda., Canguaretama, Rio Grande do Norte, Brazil) and maintained in the EMA hatchery until reaching post-larval stage PL25. These post-larvae (mean initial weight = 9 ± 2 mg) were stocked into experimental tanks at 1500, 3000, 6000, and 9000 PLs/m³. There were three replicate tanks for each stocking density. Shrimp were fed twice daily at 0800 and 1600 h with a commercial, 40 percent protein feed for 42 days. Feeding rate was adjusted daily according to consumption.

During the study, physicochemical parameters were monitored in the matrix tank and experimental tanks. Dissolved oxygen concentration, temperature, pH and salinity were monitored twice daily at around 0800 and 1600 h with a multi-parameter analyzer. Concentrations of total ammonia (NH₃ + NH₄⁺), nitrite, nitrate and phosphate were measured weekly (UNESCO 1983). Total suspended solids and alkalinity were determined weekly (Strickland and Parsons 1972, APHA 1998).

Shrimp growth was determined by weighing 50 shrimp from each experimental tank individually on a digital balance every week. Shrimp were returned to tanks after weighing. At the end of the study, shrimp that survived in each experimental tank were weighed and counted to evaluate growth (final weight, specific growth rate), survival, feed conversion ratio and tank production.

Shrimp biological performance and water quality parameters were analyzed with a one-way analysis of variance for a completely randomized design and with a Tukey test (Sokal and Rohlf 1969) when a significant difference was detected among treatments. Differences were considered significant at 95 percent.

**Results**

An inverse relationship between stocking density and growth was observed. Shrimp growth was best at lower densities, with growth of 11.8 percent/d at 1500 PLs/m³ and 10.8 percent/d at 3000 PLs/m³. There were significant differences between lower densities of 1500-3000 PLs/m³ and higher densities of 6000-9000 PLs/m³. There were no differences between treatments at the highest stocking densities (6000 and 9000 PLs/m³). Production was significantly different among treatments with a similar trend to shrimp growth. Final biomass increased with stocking density, ranging from 1.4 to 4.1 kg/m³.

Shrimp survival was good in all treatments (85 to 92 percent) and there were no significant differences in survival among stocking densities between 1500 to 9000 PLs/m³ (Fig. 2). Feed conversion was also not significantly different among density treatments, ranging from 0.9 to 1.2.

The measured physicochemical parameters were not different between treatment tanks and the matrix tank (Fig. 3).

Total ammonia concentration did not exceed 1.5 mg/L. Good water quality in all tanks was maintained because of the high recirculation rate between experimental tanks and the matrix tank (recirculation rate = 20 times per day).

This study demonstrated that good growth, survival and production in the nursery phase of shrimp can be obtained using a clearwater recirculation system.

**Notes**

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1 Coralife®, 5401 W. Oakwood Park Drive, Franklin, WI 53132 USA

2 Model 556 MPS, YSI Inc., Yellow Springs, OH, USA

**References**


