Stocking Density, Nursery Duration Influence Shrimp Growth, Survival During Growout

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The nursery phase of each experiment was conducted in fiberglass tanks inside an unheated greenhouse.

Two-phase culture systems are becoming more common as culture intensity for marine shrimp increases. In these systems, postlarvae (PL) from hatcheries are transferred to nursery tanks for one to four weeks before being transferred to production ponds. The inclusion of a nursery phase is a significant management strategy that has been implemented by many shrimp farmers in tropical regions and is becoming standard practice in subtropical regions.

Indoor shrimp nurseries are often encouraged, especially prior to intensive and superintensive shrimp culture. Their potential benefits in subsequent growout include better control of stock inventory, better management of feed inputs, reduced predation, and the ability to extend the growing season. Since penaeid shrimp seem less susceptible to certain viral infections as they grow older, nurseries have also been recommended for biosecurity reasons.

The tank design used a centerline for water distribution and airlift for water column circulation.

Alabama Research

Suitable nursery protocols that optimize shrimp performance in indoor nurseries are available, but information linking various nursery practices with shrimp performance during the following pond production phase is limited. Consequently, the authors recently conducted a series of experiments at the Claude Poteet Mariculture Center in Gulf Shores, Alabama, USA, to evaluate the influences of nursery stocking rates and nursery duration on production characteristics in the nursery and subsequent pond growout.

Table 1. Production characteristics of three nursery densities and following growout phase. The same superscript letters in a row indicate the values are not significantly different.

	Density (PL/l)			
Nursery Phase	**25**	**38**	**65**	**Pr > F**
Final average weight (mg)	19.2^a	18.5^a	21.5^a	0.7072
Survival (%)	49^b	58^a	61^a	0.0182
Feed-conversion ratio	1.4^a	1.6^a	1.1^b	0.0362
Biomass loading (kg/m^3)	0.4^b	0.5^b	1.4^a	0.0002
Coefficient of variation (%)	106.3^a	156.0^a	66.6^a	0.2000
Growout Phase				
Final average weight (g)	10.7^b	13.6^a	12.5^{ab}	0.079
Survival (%)	83^a	68^b	89^a	0.035
Feed-conversion ratio	2.1^a	2.1^a	1.6^a	0.243
Yield (kg/ha)	$2,914^b$	$3,193^b$	$4,091^a$	0.070
Coefficient of variation (%)	23.56^a	13.91^b	14.08^b	0.010

Seedstock

High-health Pacific white shrimp, *Litopenaeus vannamei*, PL_{6-8} were purchased from commercial hatcheries in Texas and Florida for the experiments. To ensure accurate distribution of PL among treatments and verify the quantity of PL supplied, animals were quantified volumetrically before stocking.

Nursery

The nursery phase of each experiment was conducted in 3.0 x 1.5 x 0.9-m fiberglass tanks located inside an unheated greenhouse. The system design and management were similar to those of commercial operations.

Commercial feeds were offered four times daily. Feeding rates were adjusted every three days. They started at a rate of 50% of the estimated biomass and gradually reduced to 15% by the last feedings. Feed sizes varied from an initial 400 µ to a final size of 1,800 µ.

Before harvest, juveniles were acclimated to the salinity of the growout ponds over a 24-hour period. For the nursery harvest, PL were captured by hand nets and quantified gravimetrically.

Stocking Density

In experiment 1, replicate tanks were stocked at densities of 25, 38, and 65 PL/l. The higher densities were obtained by reducing the water depth, thus decreasing the tank volumes. The first nursery period lasted three weeks.

In experiment 2, three groups of PL were procured from the same hatchery. The first group was stocked into replicate tanks at a density of 30 PL/l and nursed for 21 days. A week after receiving the first group, a second group of PL were stocked into replicated tanks at the same density and nursed for 14 days. Two weeks later, a third group was received for direct stocking.

Pond Growout

Animals from each of the three treatments were stocked into 0.1-ha replicate ponds at a density of approximately 35 shrimp/m^2. The ponds were lined with high-density polyethylene sheeting covered with a 25-cm layer of sandy loam soil. Pond management consisted of minimal water exchange, primarily to replace evaporation losses.

Each pond had a 1-hp spiral paddlewheel aerator. Aerators were operated as needed to maintain oxygen concentrations above a critical limit of 3 mg/l. The culture period for the first experiment was 12 weeks and 16 weeks for the second experiment.

Results

Results from experiment 1 suggested that nursery densities of 25 and 38 PL/l had no influence on subsequent growth and survival during growout (Table 1). However, at 65 PL/l, improved feed and culture system utilization resulted, and a significantly higher biomass loading (1.3 kg/m^3) and highest observed survival (61%) were obtained.

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Nutrients and Feed

The tank environments were highly nutrient-enriched, reflecting the water volumes and feeding rates used. The increased aeration had no effect on the dissolved oxygen levels in the water.

As the biomass loading in the tanks increased and more feed was supplied, an increase in water circulation was helpful to keep feed particles suspended. PL from the best-performing nursery treatments had significantly higher yields and better observed feed conversion during growout.

Table 2. Production characteristics for a nursery and growout phase using two nursery durations and direct stocking. The same superscript letters in a row indicate the values are not significantly different.

	Nursery Length (days)			
Nursery Phase	**14**	**21**	**Direct**	**Pr > F**
Final average weight (mg)	10.5^{a}	16.4^{a}	1.23	0.138
Survival (%)	94.7^{a}	91.2^{a}	–	0.628
Feed-conversion ratio	1.6^{a}	1.5^{a}	–	0.719
Final biomass (kg/m^3)	1.42^{a}	2.67^{b}	–	0.011
Coefficient of variation (%)	53.8^{a}	70.8^{a}	58.5	0.054
Growout Phase				
Final average weight (g)	16.87^{a}	15.37^{a}	14.99^{a}	0.680
Survival (%)	62	63	64	0.929
Feed-conversion ratio	2.5^{a}	2.7^{a}	2.7^{a}	0.680
Yield (kg/ha)	4,005^{a}	3,592^{a}	3,374^{a}	0.355
Coefficient of variation (%)	16.8^{a}	17.3^{a}	18.2^{a}	0.601

Nursery Duration

When comparing nursery periods in experiment 2 (Table 2), the 21-day period produced larger juveniles and improved nursery biomass loading. Under the growout conditions that followed, nursed juveniles did not differ significantly in production characteristics and population size distribution from shrimp stocked directly from the hatchery. One benefit of headstarting PL, however, was that it extended the period during which PL could be acquired from the hatchery, helping prevent possible shortages in supply as the warmer season began.

Size Distribution

Previous research (Stern and Lettelier, 1992; Garza, 2001) has shown a clear improvement in the size distribution of nursed shrimp. In these nursery trials, the authors observed through calculated coefficients of variation (CV) an improvement of the population size distribution from the nursery to a more uniform distribution (lower CV) during the growout phase. However, the direct-stocking treatment in the second trial also showed such an improvement, and its animal size variation did not differ significantly from the nursery treatments.

Conclusion

The choice to include a nursery phase or directly stock in any production cycle is a complex decision. Based on experimental results, the authors recommend the use of unheated greenhouse nursery tanks to expand the time when PL can be purchased, possibly avoiding peak demand periods.

Test results showed slight but not significant increases in final weights and biomass during growout when nursed shrimp were used. Since size variability translated from the nursery to the pond, any positive management change in the nursery could help reduce variation in the growout phase.