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Health & Welfare

Raceway nursery production increases shrimp survival and yields in Ecuador

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Concept increases average pond survival rates and yields in WSSV-infected areas

The use of intensive nursery systems for the production of juvenile shrimp under biosecure conditions is an important WSSV management tool. Preliminary production results from several WSSV-infected shrimp farms in Ecuador suggest that stocking juveniles in grow-out ponds significantly improves shrimp survival and yields.

Here we describe the use of raceway systems for the production of juvenile Pacific white shrimp (*Litopenaeus vannamei*) in Ecuador. Most data presented are based on over 40 intensive nursery production cycles at the Semacua maturation/hatchery complex in Salinas, Ecuador. Supplemental data is also included from several nursery trials and pond productions at the Pesquera Industrial Bravito S.A. shrimp farm near Machala, Ecuador.



A worker collects PL samples from a raceway.

Semacua complex raceway system

This facility is currently producing a stronger WSSV-free juvenile shrimp to stock about 3,000 ha of grow-out ponds with three production cycles targeted per year. This system also has the potential to shorten the production cycle in the grow-out ponds.

The system has 12 concrete, 120-cubic-meter (30 x 3.35 x 1.2 m) HDPE-lined raceways enclosed in greenhouses. Aeration is provided by two regenerative air blowers (total capacity 25 hp). Each raceway is equipped with seawater and freshwater intakes, a 10.2-cm outlet, six banks of four 7.6-cm airlift pumps, six 0.9-meter-long air diffusers, a center partition, a bottom spray bar manifold, a Venturi injector with check valve, a 3-hp high-head pump, and a 83-cm rapid sand filter (0.56 square meters – 454 lpm).

System management

Management of the system includes water chlorination, algal inoculation, water quality and feed monitoring and PL health and growth monitoring. Seawater from the facility well point is used to fill the raceways. Culture water is treated with 10 to 15 ppm chlorine followed by dechlorination after 24 hours using sodium thiosulphate. Raceways are maintained with no water exchange throughout the nursery period. Limited (chlorinated) makeup water is used to replace water lost to evaporation and backwashes of the sand filter.

Twenty-four hours before stocking, water is fertilized (NaNO_3 , NaH_2PO_4 , Na_2SiO_3 and Sequestrine at concentrations of 2.0, 0.2, 0.5 and 1.0 ppm, respectively) and inoculated with marine diatoms (*Chaetoceros muelleri* or *C. gracilis*) at an initial algal density of 4.0×10^4 cells per milliliter. Newly hatched artemia nauplii and commercial feeds (Zeigler PL Ready Reserve and Rangen #0 crumble) are added to the raceway prior to PL stocking.



Inside view of a nursery system.

Stocking and feeding

Raceways are stocked with PL7-15 at densities ranging between 20 and 80 PL per liter. All PL are tested for WSSV infection two to three days prior to stocking using one- or two-step PCR tests. WSSV-positive and WSSV-negative animals are stocked into different raceways. Commercial feeds are offered every four hours. Daily rations are reduced gradually from 25 percent of the total biomass to 12.5 percent before harvest.

Growth samples are checked every three days and feed is adjusted as needed. Dissolved oxygen, pH, temperature, salinity, and PL health are checked daily, while TAN, NO_2 , and NO_3 are checked every three to five days. Nursery duration varied in most cases between 14- and 16-day cycles. Shrimp survival at harvest was estimated using both volumetric and weight methods.

Bravito production facility

Several nursery productions at the Bravito facility were conducted in nursery facilities and in six 50-cubic-meter ($15 \times 3.5 \times 1.12$ meters) HDPE-lined, greenhouse- enclosed raceways. Unlike the water management used at Semacua, raceways were maintained with 40 percent daily water exchange using untreated water passed through a series of filters going down in mesh size from 500 to 100 microns in a 25-cubic-meter sedimentation chamber.

Shrimp were fed artemia nauplii enriched with Aquagrow DHA, astaxanthin, and cod liver oil from 18 to 24 hours after hatching and Zeigler PL Ready Reserve No. 0 and No. 1. Raceways were stocked with both WSSV-free and WSSV-infected PL at 30 to 50 PL per liter. Nursery duration varied between 12 and 30 days.

Water quality

During the first week after stocking, only minimal water circulation was needed to maintain adequate water quality. Daily water usage was reduced from 300 percent to less than 1 percent per day. Raceway water filtration and circulation were initiated after seven to eight days. Throughout the nursery trials there was no need for medicated feed to control disease outbreaks.

Although ammonia and nitrite levels in the raceways were occasionally observed within ranges reported to be lethal to juvenile shrimp, shrimp growth and survival in all but one case was high.

Survival and growth

Survival rates averaged 69 percent (volumetric estimation method) and 80.5 percent (weight technique). The weight technique was found to be more accurate than the volumetric method. Although stocking density negatively affected the mean weight of the PL at harvest, PL growth stayed exponential for the stocking densities tested as PL growth rates doubled approximately every three to four days. Furthermore, after 10 to 12 days, PL growth increased drastically. This same increase in growth after about 12 days was also noticed at the Bravito farm.

Stocking densities greater than 70 per liter were found to debilitate the raceway system, causing PL to become weak and, in some cases, reflect increased mortality.

Ponds stocked with juveniles from these raceways rather than PL10 have shown improvement of up to 16 percent increase in survival (Fig. 1). Table 1 summarizes the data obtained from Bravito's farm for ponds stocked with juveniles coming from nursery facilities, while Table 2 shows the effect of direct stocking on pond performance.

Samocha, Results from Bravito's farm in Ecuador show the beneficial effect of stocking grow-out ponds, Table 1

Pond Size (ha)	Stocking (PL/m²)	Cycle (days)	Survival (%)	Average Harvest Weight (g)	FCR	Yield (kg/ha)
13	6.6	125	44	13.7	0.9	408
13	6.6	126	40	12.7	1.2	343
9	6.6	121	39	14.3	1.1	377
9	6.6	122	51	11.5	1.0	400
10	6.6	122	42	14.9	1.0	421
10	6.6	124	44	15.5	0.8	462

Table 1. Results from Bravito's farm in Ecuador show the beneficial effect of stocking grow-out ponds with juvenile shrimp from a nursery.

Samocha, Results from Bravito's farm in Ecuador show the effect of direct stocking, Table 1

Pond Size (ha)	Stocking (PL/m²)	Cycle (days)	Survival (%)	Average Harvest Weight (g)	FCR	Yield (kg/ha)
11	5.8	141	28	13.4	0.7	220

Pond Size (ha)	Stocking (PL/m²)	Cycle (days)	Survival (%)	Average Harvest Weight (g)	FCR	Yield (kg/ha)
13	6.1	139	27	12.9	0.6	216
10	8.6	130	40	11.2	0.5	352
11	8.1	123	22	15.5	0.6	284
13	7.3	133	21	14.7	1.0	228
3	7.6	140	28	13.0	1.4	283

Table 2. Results from Bravito's farm in Ecuador show the effect of direct stocking on growth and survival in growout ponds.

Fig. 1: The effect on shrimp survival of stocking juvenile shrimp from nursery raceway vs. direct stocking in growout ponds.

Conclusion

Stocking grow-out ponds with juvenile shrimp from raceways or other nursery facilities has increased average pond survival rates and yields in WSSV-infected areas of Ecuador. Pond survival rates with raceway-produced juveniles averaged 21 percent in the cold season (WSSV virulence is heavier during this season), and are expected to be higher for the upcoming warm season.

Survival rates should increase further when raceway technology is accompanied by other WSSV management procedures (i.e., genetic selection, biosecurity, etc.). Ammonia and nitrite buildup in the raceways can be avoided when stocking densities are low (less than 10 PL per liter), but when the raceways are stocked at high densities (greater than 40 PL per liter), diatom blooms are difficult to control and ammonia/ nitrite levels can become unmanageable. Additional work is currently underway to achieve stable diatom blooms and better water quality conditions with high stocking densities in the raceways.

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