# PD/A CRSP Seventeenth Annual Technical Report

## Water Exchange to Rectify Low Dissolved Oxygen

*Eighth Work Plan, Honduras Research 4 (8HR4)*
*Final Report*

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### Abstract

In Central America semi-intensive shrimp production technology is used by many producers. Semi-intensive production technology is characterized by final stocking rates of 5 to 11 shrimp $m^{-2}$, daily water exchange at ≤ 10% of pond volume, and use of 20 to 25%-protein feeds. The role of water exchange in semi-intensive shrimp culture is being evaluated in Honduras. A recent study "Influence of daily water exchange volume on water quality and shrimp production" (HR3) indicated that daily or emergency water exchange did not affect significantly shrimp production, but that water quality was better in ponds that received daily water exchange. However, differences in water quality generally did not become pronounced until the latter half of the 12 to 16-wk production cycle. Producers may find unacceptable the risk associated with utilizing an emergency-only water exchange policy. However, it appears that the current standard practice of initiating water exchange beginning the fourth week post-stocking is not the most efficient was exchange strategy. This experiment builds on the previous experiment by investigating the effects of time of initiation of water exchange on early morning dissolved oxygen, water quality, and shrimp production in ponds. The objectives of this experiment are to evaluate the effect of time of initiation of water exchange on pond dissolved oxygen, water quality, and shrimp production. Nine 0.93-ha ponds located on a commercial shrimp farm in southern Honduras were used for this completely randomized design study to test time of initiation of water exchange. Water was exchanged at 10% of pond volume per day, six days per week beginning four, seven, or ten weeks after stocking. The rainy-season experiment was initiated and was to be repeated during the dry season. Ponds for the rainy-season experiment were stocked with hatchery-spawned post-larval (PL) *P. vannamei* at 145,000 PL $ha^{-1}$ (14.5 PL $m^{-2}$) on 15 August 1998. Shrimp were fed six days per week beginning three weeks after stocking. On 30–31 October 1998 the torrential rains of tropical storm Mitch resulted in massive flooding of farms and enormous losses to shrimp farmers in southern Honduras. Data were collected up until the ponds were flooded. Treatment effects on pond water quality appeared to begin to manifest themselves in those treatments where water exchange had been initiated (the four- and seven-week treatments). Shrimp growth appeared to be affected by treatment as shown by the divergence of growth curves in Figure 1, but because there are no harvest data available it is impossible to draw conclusions regarding effects of treatment on shrimp growth and yield. Shrimp farms suffered infrastructural damage and very large economic loss as a result of the flooding caused by tropical storm Mitch. Given this situation it was not possible to repeat the rainy season experiment nor conduct the dry-season experiment.

### Introduction

Results of previous research on water exchange in shrimp production in Honduras indicated that daily or emergency water exchange did not affect significantly shrimp production, but that water quality was better in ponds that received daily water exchange (Green et al., 1999). However, differences in water quality generally did not become pronounced until the latter half of the 12 to 16-week production cycle. Producers may find unacceptable the risk associated with utilizing an emergency-only water exchange policy. However, it appears that the current standard practice of initiating water exchange beginning the fourth week post-stocking is not the most efficient water exchange strategy. This experiment was designed to build on the previous experiment "Influence of daily water exchange volume on water quality and shrimp production" (Green et al., 1999) by investigating the effects of time of initiation of water exchange on pond early morning dissolved oxygen, water quality, and shrimp production.

### Methods and Materials

Nine 0.93-ha (± 0.04 ha SD) ponds located on a commercial shrimp farm on a riverine estuary of the Gulf of Fonseca, Honduras, were used for this completely randomized design study to test three water exchange regimes. Water was exchanged at 10% of pond volume per day, six days per week beginning four, seven, or ten weeks after stocking. No water exchange occurred during the first three weeks of culture. In all water exchanges, water first was discharged and then added to refill ponds.

Ponds for the rainy season experiment were stocked with hatchery spawned post-larval (PL) *P. vannamei* at 145,000 PL $ha^{-1}$

(14.5 PL m$^{-2}$) on 15 August 1998. Stocking of ponds for the dry-season experiment was scheduled for December 1998. A survival rate of 50% was assumed because of Taura Syndrome effects on hatchery-produced larvae. Most of the mortality was assumed during the first month following stocking. Shrimp in the rainy-season experiment were scheduled to be harvested in late November 1998. Dry-season experiment ponds were scheduled to be harvested in March 1999. However, on 30–31 October 1998 the torrential rains of tropical storm Mitch resulted in massive flooding of farms and enormous losses to shrimp farmers in southern Honduras (Green, 1999). Thus, it was impossible to complete this experiment.

Shrimp were fed a 20% protein commercially formulated ration. Shrimp were fed six days per week beginning three weeks after stocking for the rainy-season experiment. Feed rate for all ponds was based on the theoretical feeding curve for *P. vannamei*:

$$\text{Log}_{10}Y = -0.899 - 0.56\text{Log}_{10}X$$

where

Y = feed rate as a percent of biomass and
X = mean shrimp weight in grams.

Daily feed rate was calculated for individual ponds and then averaged so that all ponds received the same quantity of feed on a daily basis. Feed was offered once daily. Shrimp growth was monitored weekly by cast net samples of each pond's population. Feed rate was adjusted weekly based on shrimp samples.

Water quality variables in each pond were measured weekly in pond and intake water. Intake water was sampled from supply canals, while pond water was sampled by pooling a minimum of six column samples collected at random within the pond. Pond water and replacement water samples were obtained with a column sampler. Water samples were analyzed for pH measured potentiometrically, nitrate-nitrogen by cadmium reduction (Parsons et al., 1992), total ammonia-nitrogen (Parsons et al., 1992), soluble reactive phosphorus (SRP) (Grasshoff et al., 1983), chlorophyll *a* (Parsons et al., 1992), total alkalinity by titration to pH 4.5 endpoint, salinity, 2-d biochemical oxygen demand ($BOD_2$) at 20°C (APHA, 1985), and reactive silicate (Strickland and Parsons, 1977). Total nitrogen and total phosphorus were determined by nitrate and phosphate analysis, respectively, after simultaneous persulfate oxidation (Grasshoff et al., 1983). Dissolved oxygen (DO) concentration and temperature were measured in ponds twice daily (0400 and 1600 h) at 25 cm below the water surface.

## RESULTS

Data were collected up until the ponds were flooded. The data are presented in this report, but the reader is reminded that it is impossible to draw conclusions as the experiment was never harvested. Water exchange had begun in the four- and seven-week treatments and was about to begin in the ten-week treatment when the hurricane struck. Shrimp growth through week 10 averaged 0.65 g wk$^{-1}$ (Figure 1). Total nitrogen (Figure 2), total phosphorus (Figure 3), chlorophyll *a* (Figure 4), and $BOD_2$ (Figure 5) concentrations in ponds began to increase several weeks after ponds were stocked but then declined in treatments where water exchange had been initiated. Mean water quality variable concentrations for the ten-wk period are shown in Table 1.

## DISCUSSION

Treatment effects on pond water quality seemed to manifest themselves in those treatments where water exchange had been initiated (the four- and seven-week treatments). Water exchange reduced water quality variable concentrations in ponds because inlet water had lower nutrient concentrations and diluted pond water (Table 1). Shrimp growth appeared to be affected by treatment as shown by the divergence of growth curves in Figure 1, but because there are no harvest data

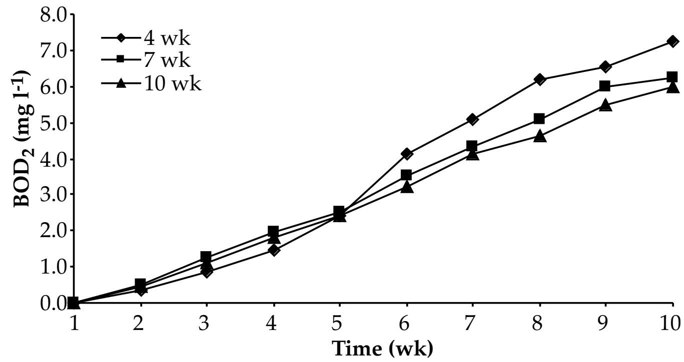


Figure 1. Growth of shrimp in 1-ha earthen ponds during the first ten weeks of the rainy-season experiment in Honduras to test the effects of beginning water exchange four, seven, or ten weeks after stocking.

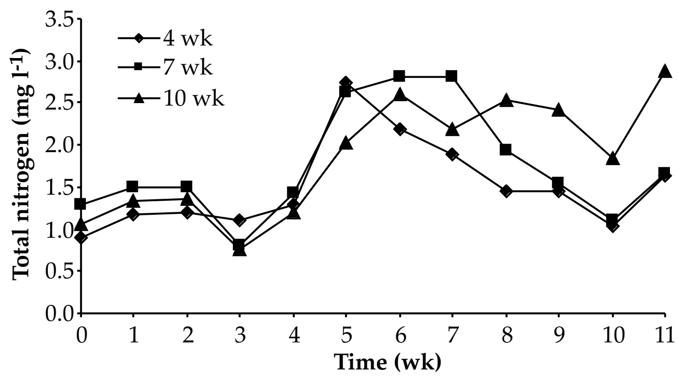


Figure 2. Mean total nitrogen concentrations in ponds during the first ten weeks of the rainy-season experiment in Honduras to test the effects of beginning water exchange four, seven, or ten weeks after stocking.

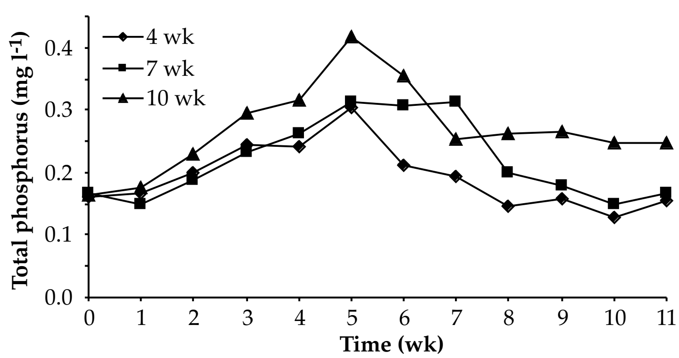


Figure 3. Mean total phosphorus concentrations in ponds during the first ten weeks of the rainy-season experiment in Honduras to test the effects of beginning water exchange four, seven, or ten weeks after stocking.

available it is impossible to draw conclusions regarding effects of treatment on shrimp growth and yield.

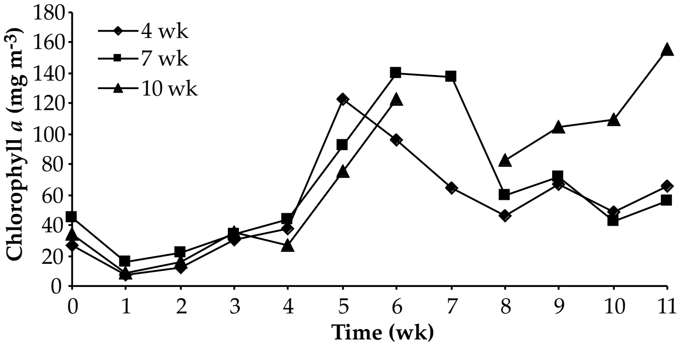


Figure 4. Mean chlorophyll *a* concentrations in ponds during the first ten weeks of the rainy-season experiment in Honduras to test the effects of beginning water exchange four, seven, or ten weeks after stocking.

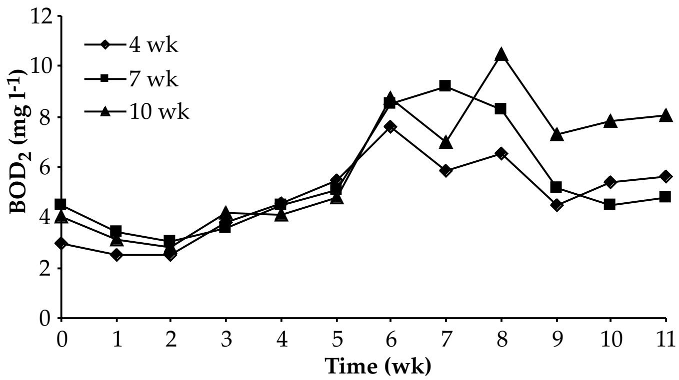


Figure 5. Mean two-day biochemical oxygen demand in ponds during the first ten weeks of the rainy-season experiment in Honduras to test the effects of beginning water exchange four, seven, or ten weeks after stocking.

Shrimp farms suffered infrastructural damage and very large economic loss as a result of the flooding caused by hurricane Mitch. Given this situation it was not possible to repeat the rainy-season experiment nor conduct the dry-season experiment.

## ANTICIPATED BENEFITS

Results of this research would have continued to contribute to the refinement of techniques for exchanging water efficiently in shrimp ponds managed semi-intensively.

## ACKNOWLEDGMENTS

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Table 1. Mean water quality variable concentrations in ponds and inlet water during the ten-week period before ponds were flooded because of tropical storm Mitch. Water exchange (10% pond volume $d^{-1}$) in 0.1-ha earthen ponds stocked with 14.5 *P. vannamei* $m^{-2}$ began four, seven or ten weeks after ponds were stocked.

| Variable | Inlet Water | Water Exchange Regime | | |
|---|---|---|---|---|
| | | *4 Weeks* | *7 Weeks* | *10 Weeks* |
| Salinity (g $l^{-1}$) | 9.79 | 11.45 | 11.37 | 12.25 |
| Total Ammonia N (mg $l^{-1}$) | 0.04 | 0.04 | 0.05 | 0.04 |
| Total Nitrogen (mg $l^{-1}$) | 1.15 | 1.50 | 1.75 | 1.85 |
| Total Phosphorus (mg $l^{-1}$) | 0.14 | 0.19 | 0.22 | 0.27 |
| Soluble Reactive P (mg $l^{-1}$) | 0.02 | 0.04 | 0.02 | 0.06 |
| Total Alkalinity (mg $l^{-1}$ as $CaCO_3$) | 79.54 | 99.12 | 114.38 | 111.28 |
| Chlorophyll *a* (mg $m^{-3}$) | 53.38 | 52.08 | 63.40 | 70.73 |
| $BOD_2$ (mg $l^{-1}$) | 3.61 | 4.78 | 5.37 | 6.03 |
| Reactive Silicate (mg $l^{-1}$) | 3.81 | 3.83 | 3.43 | 3.73 |

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