Effects of Substrate and Stocking Density on Pacific White Shrimp in High Tunnel based Biofloc Systems

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USDA

United States Department of Agriculture
National Institute of Food and Agriculture

Greenhouse Biofloc Systems

-No Artificial Heat Input
-Algal production benefits shrimp
-Improved biosecurity
-Lengthen growing season
-Higher animal density
-Reduced feed inputs
-Can be built near consumer markets

High Tunnel Facility

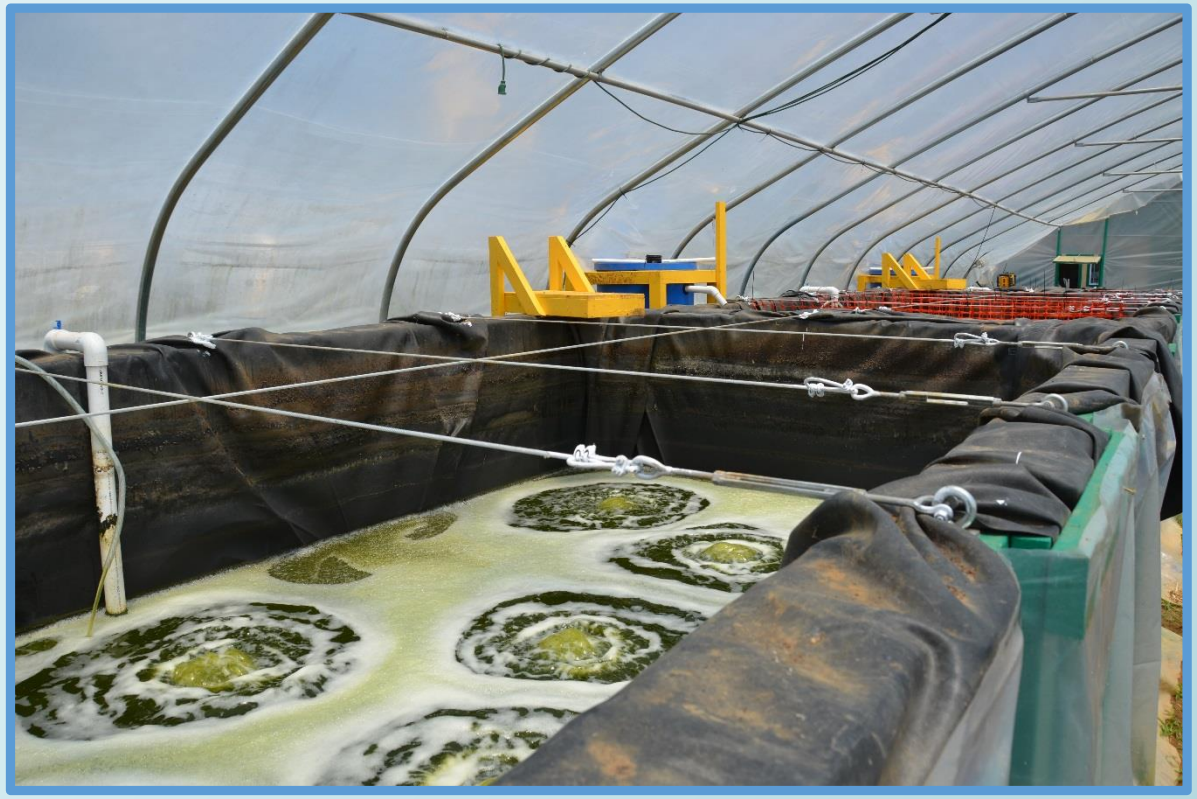
-Frankfort, KY, USA
  -38.2009° N, 84.8733° W
  -Temperate climate
-Four high tunnels
-Temperature controlled by roll up sides, windows, doors
-USDA Organic Certified
  -Half of tunnel used for plants
-Powered partially by solar panels

System Design

-Greenwater Biofloc system
-Chemoautotrophic based bacterial community
-Water previously used in tilapia study
-High amounts of biomass present in water at start of study

System Design

- Sixteen 11m^3 Tanks
- Wood framed, rubber lined
- 0.5m^3 Settling chambers
- 10 air diffusers per tank
- Settling Chambers drained weekly
- Topped off with rain water



System Design

Experiment

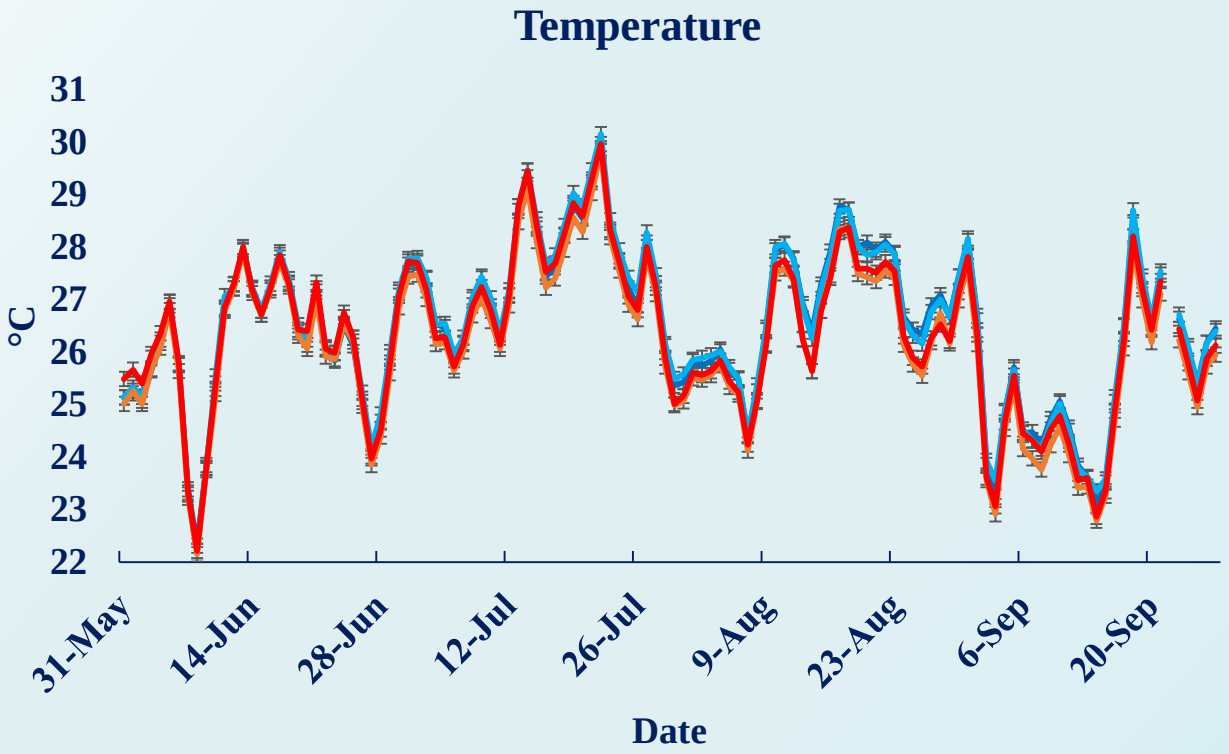
-4 Treatments
- With/Without substrate
-9.7m^2 surface area (30.6% increase)
- High/Low density
-200/100 shrimp per m^3
- HD-S, HD-NS, LD-S, LD-NS
- 120 day experiment

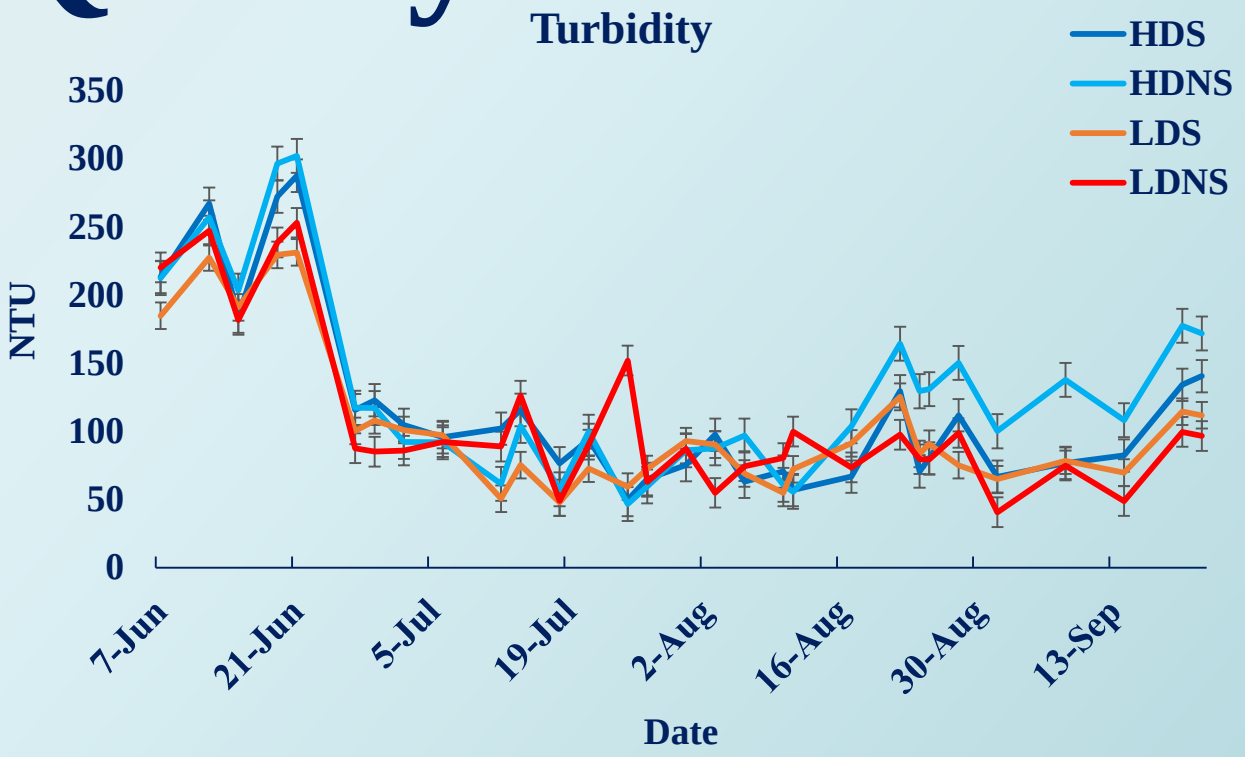
- 4 Replicates
- 7.15g average stocking

Experiment

-Shrimp fed twice daily, strict feed management
-Tanks fed according to density
-Tank parameters measured twice daily
-Temperature, pH, dissolved oxygen, salinity
-Water quality measured once every week
-Total Ammonia Nitrogen, Nitrite, Nitrate, Turbidity
-Randomized block design, Linear Mixed Effects Models
-Results considered significant when $p<0.05$

Water Quality

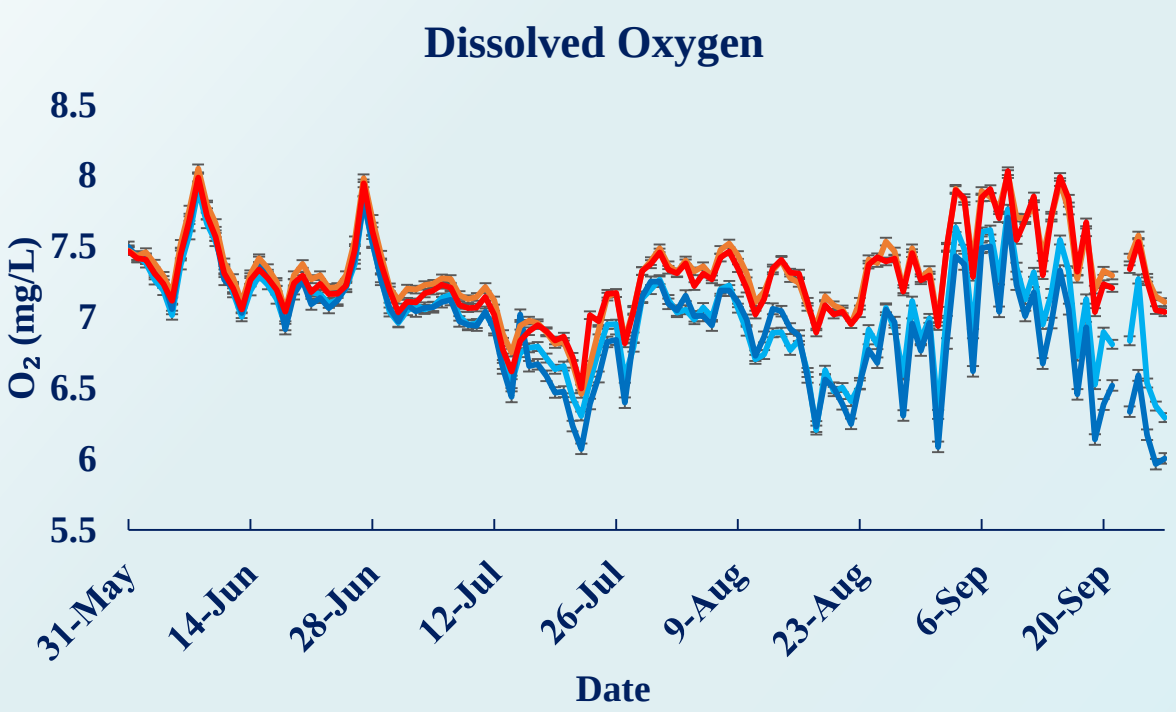


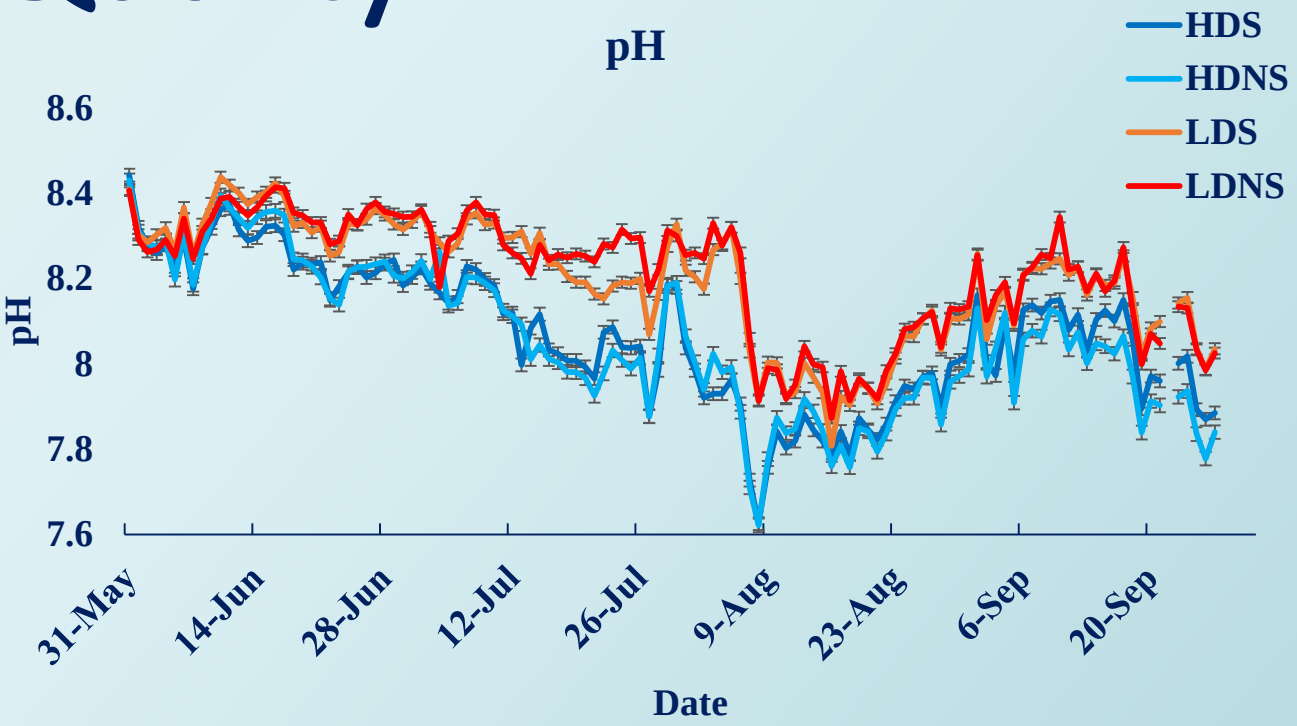


-No significant differences between treatments in Temperature, Average Temp: 26.4

-HD-NS turbidity significantly higher than LD-S and LD-NS

Water Quality





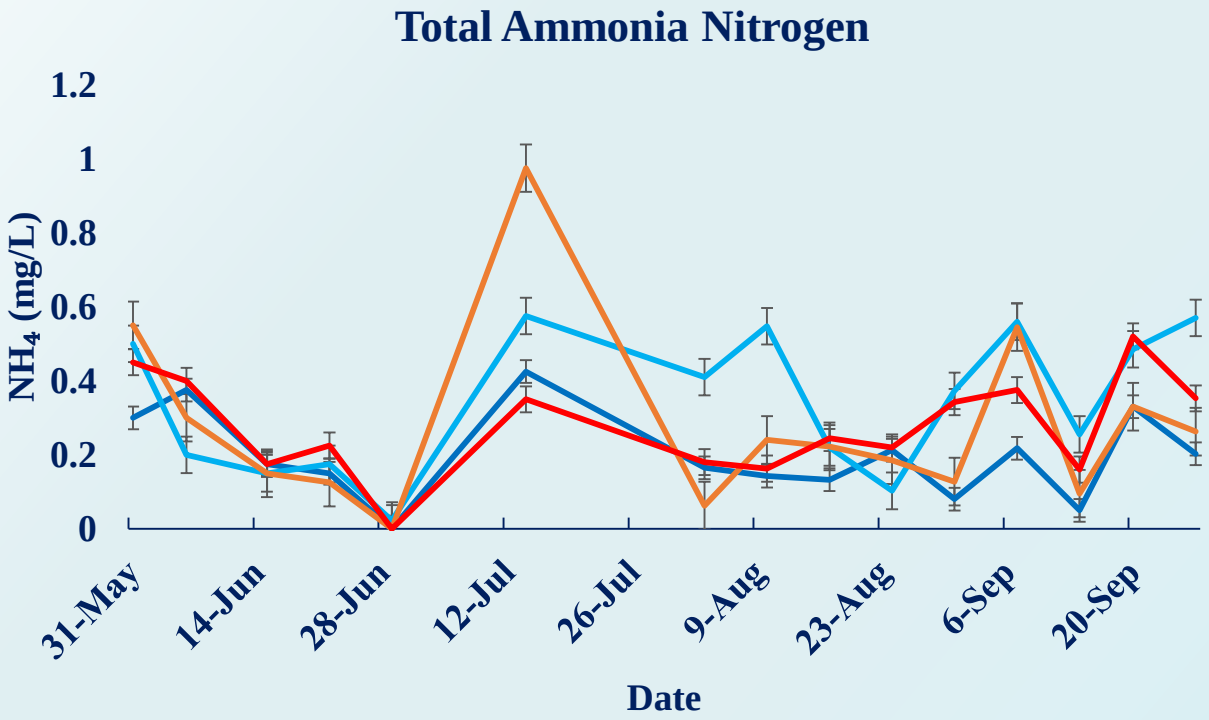
-Average Salinity: 17.7 PPT

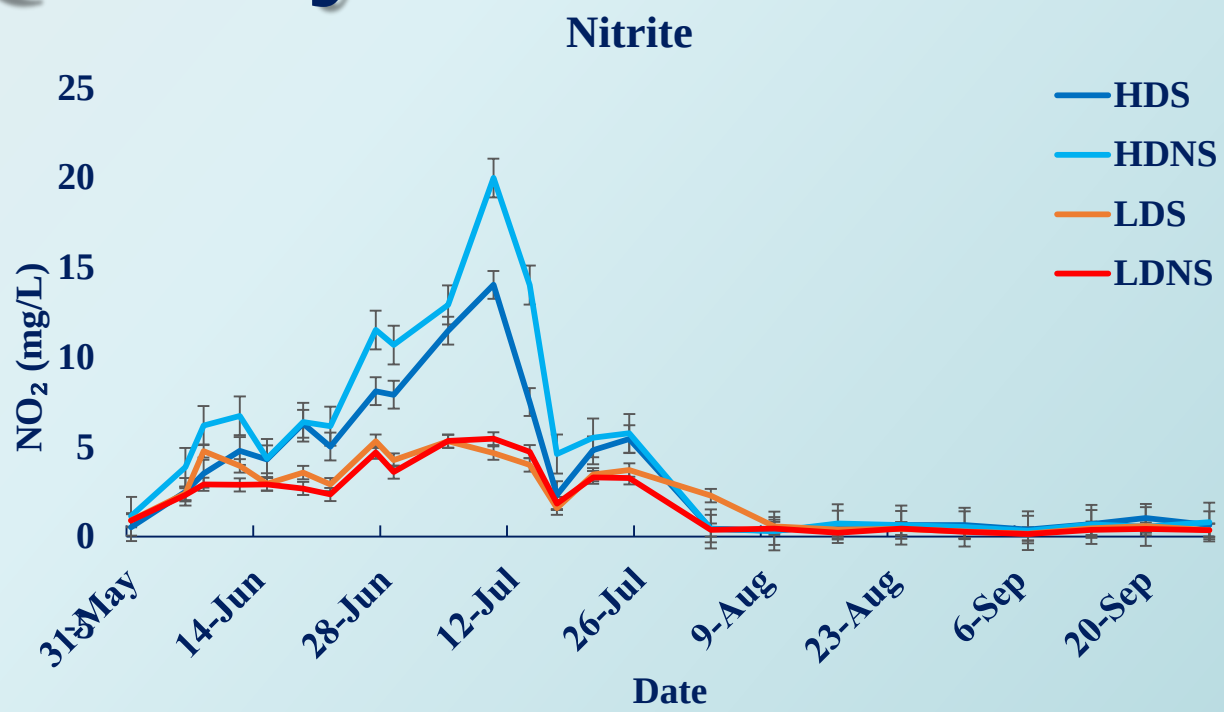
-No significant differences in DO, pH, Salinity

-Last 60 days; significant differences in DO and pH

-High Density tanks required higher amounts of Sodium bicarbonate to maintain pH

Water Quality





-Significant differences between HD-NS and HD-S, HD-S and LD-NS

-Nitrite significantly higher in high density tanks compared to low density tanks

-Nitrate significantly higher in high density tanks

Production Results

Treatment	Individual wt. (g)	Total Harvest (kg)	kg/m^3	FCR	Survival
HDS	24.5^a	44.7	4.04	1.14^a	90.6
HDNS	25.0^a	43.4	3.92	1.18^a	91.9
LDS	26.7^b	25.0	2.26	1.02^b	91.8
LDNS	25.9^b	24.3	2.21	1.05^b	97.2

***Different superscripts denotes a significant difference between treatments**

-Significant differences between densities

-Lower FCR in low density

-Higher individual weight in low density

-No effect from substrate in high or low density

-No difference in survival due to density or substrate

Summary

- Shrimp production possible in simple, unheated High Tunnels
- Low density tanks outperformed high density tanks in individual shrimp weights
- Low FCRs likely due to high amounts of biomass present at start and strict feed management
- High density showed impacts on water quality
- No shrimp production effects due to substrate
- Possible water quality effects from substrate
- Further research:
    - Higher amounts of substrate and higher densities
    - Stable isotope analysis to examine biofloc uptake
    - Rotating tanks to cool water fish production

High Tunnel Production

- High tunnel area: 280m^2
- Eight 11m^3 tanks
- Density at 200 shrimp/m^3
- Potential output of 363kg total
- 5246.5 kg/acre
- 12.3kW to run blowers and pumps
  - Offset by solar during the day
- Construction using USDA Organic approved materials

Thank You!

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KSU Aquaculture Webpage: http://www.ksuaquaculture.org/