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Water recycling study evaluates changes in chemical characteristics

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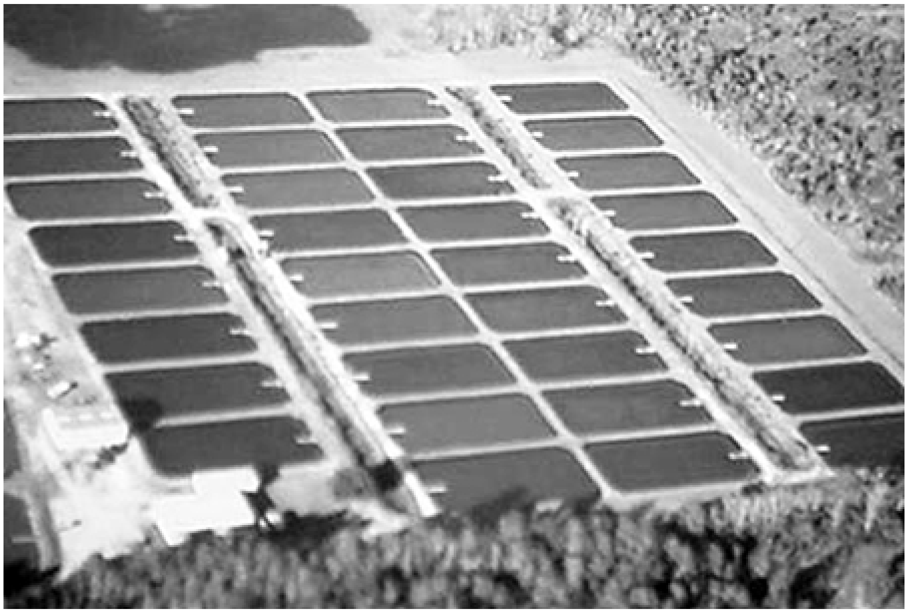
Little advantage in recirculation between production, oxidation ponds

A conventional practice to resolve degraded water quality in shrimp aquaculture ponds is to exchange water. During water exchange, pond water with high nutrient and algal concentrations is discharged from a pond, and replaced by water with lower nutrient and algal concentrations and greater dissolved-oxygen concentration. Water exchange as a pond-management tool must be used judiciously, however, because of the potential negative impact effluents can have on receiving waters.



Research ponds were located in Alabama, USA.

Alabama study

A variety of water-recycling schemes has been proposed. Research at the Claude Peteet Mariculture Center in Gulf Shores, Alabama, USA evaluated changes in the chemical characteristics of production pond water, soils, and shrimp yields in response to water recycling through an oxidation pond. Effects on water quality and shrimp production were minimal using this approach.

Treatments

Three 0.1-ha ponds were stocked with *Litopenaeus vannamei* at 50 postlarvae per square meter with no water recirculation, while another three received the same stocking but included water recirculation through an adjacent pond of equal volume not stocked with shrimp. Another set of ponds was stocked at 25 postlarvae per square meter with no water recirculation.

Water movement and aeration

Water movement between the ponds using the recirculation set-up was accomplished with one 0.5-hp submersible pump at the deep end of the culture pond, and another at the shallow end of the oxidation pond. Pumps were operated simultaneously 20 hours per day.

All ponds were equipped with oxygen-sensing systems, and a 1.5-kw propeller aspirator aerator. The automatic aerator-activation system in each pond was programmed to maintain a dissolved oxygen concentration of 3.5 milligrams per liter in the pond water.

Shrimp densities and yields

The density of shrimp in the low- and high-density with recycling treatments was equal when based on the total water area of production and recycling ponds. Mean shrimp yields for the low-density, high-density, and high-density recycling ponds were 1,706 kilograms per hectare; 4,648 kilograms per hectare; and 4,534 kilograms per hectare, respectively.

There was no significant difference in yields between the high-density treatments, or between the low-density and high-density treatment with recirculation, when based on total water surface area. Mean harvest weights for shrimp in all ponds ranged 22 to 25 grams.

Nitrogen and water quality

Recycling water through oxidation ponds resulted in significant reductions in the mean mass weight of total nitrogen and total ammonia nitrogen when compared with the high-density ponds without recycling, because the recirculating ponds used twice the water volume (Table 1).

Table 1. Mean mass weight for water-quality variables in treatment ponds.

Treatment	Total Suspended Solids (kg)	Soluble Reactive Phosphorus (kg)	Total Phosphorus (kg)	Total Nitrogen (kg)	Total Ammonia Nitrogen (kg)	Nitrate Nitrogen (kg)	Nitrite Nitrogen (kg)	BOD_5 (kg)	Chlorophyll *a* (g)
LD	80.3	0.25	0.81	4.36	0.82	0.05	0.02	16.31	159.92
HD	86.9	0.16	0.77	4.56	1.55	0.10	0.03	17.93	184.16
HDR	81.9	0.30	0.86	4.16	0.65	0.10	0.02	16.29	156.73
R	72.6	0.45	0.84	3.38	0.38	0.06	0.04	12.42	85.64
HDR + R	154.53	0.75	1.70	7.54	1.03	0.16	0.06	28.71	242.37

LD = Low-density ponds HDR = High-density ponds with recirculation to oxidation ponds
HD = High-density ponds R = Oxidation ponds only

The sum of the mean mass weight for water-quality variables found in the high-density/oxidation pond systems was significantly greater than the mean mass weight in the free-standing high-density ponds, except for nitrate-nitrogen, nitrite-nitrogen and total ammonia nitrogen. No differences were noted for water quality between the ponds without recirculation.

Water exchange alternative

Only limited research has been done on the effectiveness of recycling systems in reducing nutrient loads, and yields are commonly expressed in terms of the culture unit without including the recycling area. It is important to note the recycling system discussed here is different from indoor recirculation systems or those that use settling basins. In settling basins, water is normally held after the production cycle ends and their effectiveness in water-quality improvement has been plainly proven.

Conclusion

In this study, the recycling of water from production ponds through oxidation ponds of equal volume had minimal effect on water quality and shrimp yields. No differences were observed among treatments for soil pH, concentrations of carbon, sulfur, nitrogen, soil respiration and phosphorus absorption capacity.

The major operational disadvantages of recycling water are that pond space is put into non-productive use as oxidation ponds, and 3.3 times more energy is used for aeration and water circulation. A better strategy would be to stock two ponds at half the rate, instead of doubling the volume of water per pond by recycling through an oxidation pond.

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