SOLUTIONS FOR POND WATER QUALITY

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CONCERN

Irrigation pond water for horticultural operations has potential poor water quality issues due to:

- Elevated nutrient content – environmental risk
- Filamentous algal scums, particulates and turbidity – irrigation system impacts (e.g., clogging, reduced performance)
- Filamentous algae and cyanobacterial blooms (Fig. 1) – aesthetics and potential toxicity (cyanobacteria, reduced O_2)

BACKGROUND

Nutrient content (entering or existing) increases eutrophic nature of surface water[1]. Phosphorus (P) and nitrogen (N) are two key nutrients that are limiting to many phytoplankton that can adversely affect water quality[2]

Organisms (phytoplankton) that can negatively affect water quality include algae and cyanobacteria ("blue-greens"). These organisms can survive/thrive with very low levels of nutrients in the water or sediment. Some cyanobacteria have the capability to access N and P from the sediment[3].

Many commercial technologies for mitigating high nutrient levels exist: aeration, covers, bacterial blends that digest organic matter in the sediment, floating islands of plants (PhytoLinks), geo-tubes, etc. These technologies have been tested and utilized in highly eutrophic waters, even sewage treatment facilities. Question 1: can we utilize these technologies effectively in retention (stormwater and runoff capture) ponds?

A preferred option may be to treat the water before it reaches the pond using Hybrid Treatment Systems (HTS). These have been shown to remove significant amounts of nitrate, phosphorus, pathogens, and some crop protection products[4]. Edge-of-field woodchip bioreactors have been used to improve water quality of field runoff[5]. Question 2: can the HTS concept be modified to treat outdoor production runoff?

OBJECTIVE

To test several in-pond technologies and a pre-pond management practice (a hybrid swale or shallow HTS) for effectiveness in improving pond water quality in capture ponds.

METHODS

Water quality was evaluated every 2-4 weeks for 2 full growing seasons by:

a) compete water analysis (both surface and column grab samples)
b) in-situ testing using a handheld YSI ProDSS multimeter fitted with turbidity, chlorophyll *a*, phycocyanin, and optical dissolved oxygen probes
c) sediment sampling (grab samples, Ekman and core sampler)
d) phytoplankton identification

Both in-pond treatments and a pre-pond hybrid swale were examined.

IN-POND TREATMENTS

- Traditional Aeration (stone bubbler)*
- Macrophyte (*Chara* spp.) Plantings*
- Duckweed (*Lemna* spp.) covering*
- Physical Covering (shade or solid)*
- Clariphos (P-binding coagulant)*
- Bacterius C or P, and a combination of C and P*
- PhytoLinks**
- Nanobubbler (MOLEAER 150)/Ultrasonic Transducers/Water Hyacinth***

* within mesocosm (Fig. 2) **in channel (Fig. 3) ***main pond (Fig. 4)

SUMMARY OF RESULTS

Figure 1. Cyanobacteria/Algal Bloom

Figure 2. Mesocosm Installation: Setup, Site C, Site B

Figure 3. PhytoLinks in Channel

Figure 4. Nanobubbler/Ultrasonic/Hyacinths

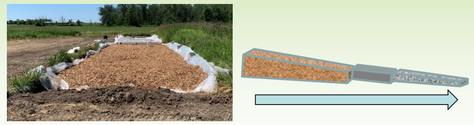


Figure 5. Hybrid Swale: Installed (L); 3 cells: woodchips, slag, gravel (R)

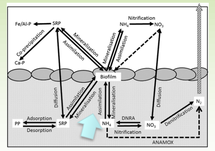


Figure 6. Pond Nutrient Cycling[6]

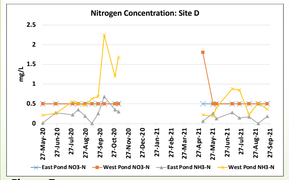
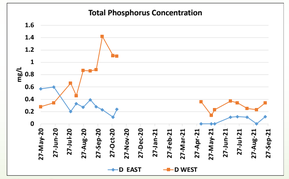


Figure 7.



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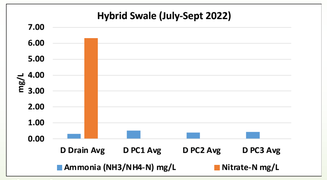

Figure 9.

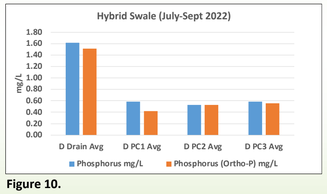

Figure 10.

Figure 11.

General

- Baseline nutrient levels in ponds using standard water test protocols were extremely low
- Often see a Nitrate-N peak in spring – related to initial fertilization (Fig. 7)
- Significant phosphorus is entering some ponds from production runoff (Fig. 8)

Pre-Pond Treatment

- The Hybrid Swale removed a significant portion of N and P in the runoff (Figs. 9, 10)

In-Pond Treatments

- Aeration supports organic matter breakdown (decrease in ODO, Fig. 11)
- Shading (solid and shade cloth) decreased phytoplankton populations and ODO (Fig. 11)
- Whole pond coverage (hyacinths, in combination with nanobubbler/ultrasonic) was effective in altering the bloom in 2021 (Fig. 12) . A serious *Microcystis* bloom reappeared in 2022 (no shade).

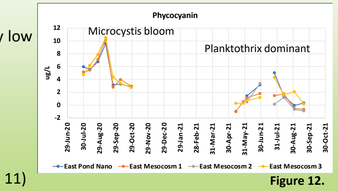

Figure 12.

CONCLUSIONS

In ponds with existing sediment buildup, in-pond treatments were marginally effective during the 3-year project. It is critical - and easier - to keep nutrients (N, P) out of the ponds in the first place.

The Hybrid Swale concept appears to be an effective tool for decreasing nutrients before they reach the pond.

Some treatments (e.g., increased macrophyte populations, PhytoLinks, aeration) have potential as long term management strategies.

Low nutrient levels do NOT necessarily mean the pond has a high water quality – monitoring the phytoplankton and ODO levels are more useful measures of quality. Since very low nutrient levels can still support algal and cyanobacterial growth[6], looking at these populations can be more revealing.

Mesocosms were likely too small to adequately represent whole pond dynamics, nutrient levels were possibly too low to be significantly impacted by these treatments.

GROWER TAKEAWAY

It takes very little N/P and very little time to cause an issue in a pond, but a long time and a lot of effort and money to remediate it.

How can you manage nutrients before they reach surface water?

- Fertilizer choices (WSF/CRF combos, low P formulations)
- Fertilizer application options (subsurface CRF, dibbling)
- Berms and infiltration, impermeable surfaces so limited infiltration but with capture of runoff, hybrid swales
- Reduce irrigation volumes (pulse/cyclic irrigation)

How can you effectively test the water quality of their ponds without purchasing a YSI? Consider monitoring the water that goes into the pond instead!

REFERENCES

1. Schindler, DW. 1978. *Limnol. Oceanogr.* 23:478-486.
2. Smith, VH. 1982.. *Limnol. Oceanogr.* 27:1101-1112.
3. Cottingham, K.L. et al. 2015. *Ecosphere*. 6(1): 1-19.
4. Huber A. 2022. HTS3 COHA8 Video. www.cohaconnections.com
5. Bell, N. et al. 2015. J. Environ. Qual. 44:1647-1656.
6. Weigelhofer, et al. 2018. Riverine Ecosystem Management: Part of the Aquatic Ecology Series book series (AQEC, volume 8): 187-202.

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