Water Treatment Technologies for Specialty Crops

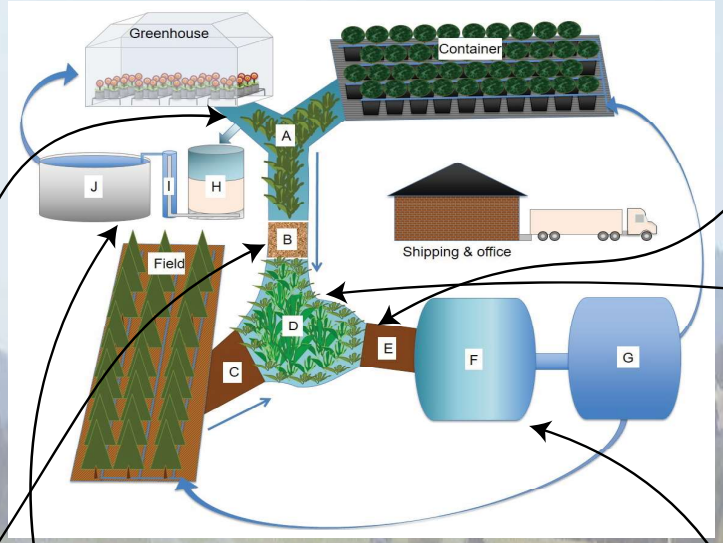
John Majsztrik[1*], Daniel Hitchcock[2], David Sample[3], Sarah White[1]

1 Clemson University Dept. Plant &Environmental Science, 2 Clemson University Belle W. Baruch Institute of Coastal Ecology and Forest Science, 3 Virginia Polytechnic Institute and State UniversityBiological Systems Engineering Hampton Roads Agricultural Research and Extension Center

SCRI - CLEAN WATER[3]
REDUCE, REMEDIATE, RECYCLE
CLEANWATER3.ORG

Introduction

- Irrigation runoff at ornamental production operations can range from 2,000 to 10,000 gallons per acre per day (Huett, 1997)
- Runoff water may include nutrients, pesticides, pathogens, growth regulators and other agrochemical inputs, which can cause harm both at the operation and in the surrounding environment
- Ideally runoff would be cleaned and reused, which would save growers money and reduce their environmental impact
- Growers would like cost and benefit information before making a decision
- There are a number of technologies that ornamental plant producers could implement



A-Vegetated Channel

Description: Aquatic and/or semiaquatic plants are placed in channels that lead to recyling ponds or off-site (Fig. 1&2). Plants slow water movement allowing sediment to be removed from the water column.

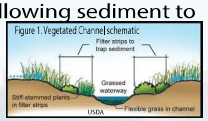



Figure 2. Installed vegetated buffers

Benefits
- Does not require additional area to be removed from production
- Inexpensive to install and maintain

Concerns
- Must be maintained for maximum effectiveness (sediment removed, debris cleaned out)
- Removed sediment may be difficult to dispose of

Target removal: Sediment, phosphorus, soil-bound agrichemicals

B-Carbon wall

Description: Water is plumbed to a trough with wood chips. Water flows through the wood chips, where microorganisms colonize pore spaces.

Benefits
- Does not require additional area to be removed from production
- Inexpensive to install and maintain
- Long lasting (10-20 years)


Figure 3. Installation of a woodchip bioreactor

Concerns
- Difficult to measure effectiveness over time

Target removal: Pathogens, nitrogen, sediment, agrichemicals

H, I, &J Slow Sand Filter (H), Flow control device (I), and Cistern (J)

Description: A thick layer of sand (1m) is topped by 1 meter of water (Fig 4). The water pushes through the sand where microorganisms and sand particles remove impurities from the water. Cleaned water is stored for use in a cistern or tank.

Benefits
- Can effectively remove a wide variety of contaminants
- Relatively maintenance free while running

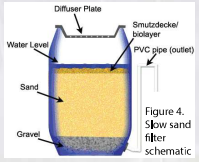


Figure 4. Slow sand filter schematic

Concerns
- Relatively slow rate of water movement
- Two parallel systems are required (after cleaning, it may take 1 month to reestablish microbial communities)
- Regenration (scraping and reestablishment) is required once pores become clogged

Target removal: Nutrients, pathogens, agrichemicals, sediment

C &E-Sediment basin and Sediment forebay

Description: Areas that allow water to collect before entering channel (sediment basin) or containment pond (sediment forebay) (Fig. 5). Ideally with a concrete base for ease of maintenance.


Figure 5. Sediment forebay feeding into a containment pond

Benefits
- Allows for easy removal of accumulated sediment
- Reduces sedimentation in channels and containment ponds

Concerns
- Must be maintained for maximum effectiveness (sediment removed, debris cleaned out)
- Removed sediment may be contaminated (e.g. diseased)
- Sizing is important for effective sediment removal

Target removal: Sediment, soil-bound agrichemicals

D-Constructed wetland

Description: An engineered system that uses plants and microorganisms to treat water for reuse or release into the environment (Fig 6). There are multiple types of wetlands that can be installed .


Figure 6. Established constructed wetland

Benefits
- Can be designed to remove operation-specific concerns (e.g. pathogens, nutrient loads, agrichemicals)

Concerns
- Must be maintained for maximum effectiveness (plant species, water movement)
- Sizing/water retention time is important for maximum effectiveness
- Less effective in colder climates/weather

Target removal: Nutrients (especially nitrogen), pathogens, some agrichemicals

F & G -Treatment pond (F) and Storage pond(G)

Description: Increasing hydraulic retention time (HRT), or the amount of time water stays in a system, increases the effectiveness of removal for many substances. Multi-pond systems are an effective way to increase HRT without necessarily increasing required area.

Benefits
- Can be designed to remove operation-specific issues (nutrient loads, pathogens, agrichemicals etc.)

Concerns
- Must be maintained for maximum effectiveness
- Sizing/hydraulic retention time is important
- Are less effective in colder climates/weather

Target removal: Nutrients (especially nitrogen), pathogens, agrichemicals

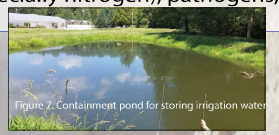


Figure 7. Containment pond for storing irrigation water

Conclusions

- Specialty crop producers have a number of options for sediment, agrichemical and pathogen remediation
- Recycling water would allow producers to either reduce irrigation costs, or increase production space
- Operations can choose treatment options that will work with their removal needs, budget, and land availability
- Growers would prefer unbiased, current information regarding water treatment options for their operation

Works Cited
Huett, D. O.; (1997) Fertiliser use efficiency by containerised nursery plants. 2. Nutrient leaching'; Australian Journal of Agricultural Research 48, 259-265.

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under award number 2014-51181-22372