INNOVATION IN THE HORTICULTURE NURSERY INDUSTRY[1]

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INTRODUCTION

Over the years, growers of forest seedlings have adopted innovative technologies that were pioneered by producers of horticultural crops, and vice versa. This sharing of technology has improved the quality of crops and production efficiency in both sectors. Today, the major innovative ideas that are being developed by the horticultural nursery industry are in use by forest nurseries. These include the use of copper compounds to control root growth in containers; somatic embryogenesis; environmental-control computer systems; and the use of ergonomically designed equipment to reduce worker arm and back injuries.

In order to identify future technological advancements in the nursery industries, it is best to look at developments in the greenhouse sector. It has been said that the greenhouse sector is 10 years ahead of the nursery sector in the adoption of technology. If this is true, one future trend will be greater adoption of production practices that reduce or prevent the discharge of chemicals into the environment. These practices are commonly referred to as Best Management Practices (BMP), and include both structural systems and cultural practices.

WAYS TO REDUCE THE LEVEL OF CHEMICALS LEACHED FROM NURSERY STOCK

How does a nursery reduce the release of liquid wastes from their operation? The approaches available range from reducing the volume of irrigation and chemicals fed to the crop, to collecting and 'dealing with' the runoff. Some examples of BMP used to reduce irrigation inputs are drip or subirrigation systems, using information on the crop's water status and weather conditions to determine crop irrigation requirements, pulse irrigation, and collection and re-use of irrigation runoff.

Soilless media have a very low nutrient holding capacity, on a volume basis, and therefore leach fertilizer readily when irrigated. To reduce this risk, growers are replacing soluble fertilizers with slow and controlled-release fertilizers. Controlled-release fertilizers have tremendous potential to reduce nutrient leaching since their release profiles closely approximate a crop's fertilizer demand. This occurs because fertilizer release and plant growth are both correlated with temperature. There is also work being done to increase the nutrient holding capacity of soilless media. One direction this work is taking is the pre-loading of media with alumina or aluminum sulphate, which are responsible for forming insoluble complexes with phosphorus in soil. The results of this research have proven that the system does reduce phosphate leaching without negatively impacting crop production (Williams 1995). In fact, pre-loaded media produced equivalent crop growth despite using 65 percent less triple superphosphate (Williams 1995).

A step used to reduce pesticide inputs is Integrated Pest Management (IPM). IPM systems generally result in the use of less pesticides, and often use new, biorational pesticides. Biorational pesticides have relatively low toxicity levels and do not have long residual activity.

COLLECTION AND RE-USE OF NURSERY RUNOFF

To prevent raw wastewater from entering the environment, on-farm runoff collection systems are required. This technology is rapidly being adopted by the greenhouse industry to deal with the large volumes of nutrient-rich irrigation leachate they generate. For instance, greenhouse vegetable operations generate up to 45,000 L/ha/day of leachate (Prystay 1997). The Netherlands, a World leader in greenhouse crop production, had aimed to employ 100 percent nutrient collection and re-use by the year 2000. This target will not be met, but the greenhouse industry is still moving in this direction. In B.C., the greenhouse vegetable and floriculture industries are gradually adopting recirculation technology, too. Today, 13 percent of greenhouse vegetable operations collect and recycle all of their fertilizer leachate. B.C.'s nursery industry has not embraced this technology. However, Byland's Nurseries in Kelowna collects and recycles all of the runoff from their 40-acre container production site. The nursery industry in other regions of North America is adopting the technology. Oregon, which is the third largest producer of nursery stock in the U.S., is quickly seeing the implementation of recirculation systems.

There are several reasons why recirculation technology is being adopted.

- To conserve water in regions where fresh water supplies may be too expensive, or limited in quantity and/or quality during periods of peak demand. Byland's Nurseries has found their runoff collection system to reduce water consumption by 25 percent. With continued population growth, nurseries near high density urban areas may find it more difficult to secure a reliable source of good quality water. This is already occurring. In some regions along the west coast of Oregon, due to excessive withdrawal of water from wells, saltwater infiltration has polluted some freshwater aquifers.

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[1]Woodske, D. 1999. Innovation in the horticulture nursery industry. In: Landis, T.D.; Barnett, J.P., tech. coords. National proceedings: forest and conservation nursery associations—1998. Gen. Tech. Rep. SRS-25. Asheville, NC: U.S. Department of Agriculture. Forest Service, Southern Research Station: 144-146.
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- To reduce fertilizer use. Although fertilizer costs are only a small fraction of crop expenses, the potential savings can still be significant.

- Maintain the productivity and value of the land resource. The environmental quality of land is becoming a more important consideration in real estate transactions. Purchasers are beginning to perform environmental site assessments prior to property transfer, because the property owner must bare any costs for environmental remediation, which, depending on the wastes involved, can be significant. Some common contaminants are solid wastes in on-site disposal areas, and fertilizer, pesticide, and fossil fuel residues in the soil and water supply.

- To meet local regulations.

Most operations use collected irrigation runoff to irrigate their crops. The runoff can also be used to fertigate adjacent field-grown crops or it can be scrubbed in a manmade wetland prior to being discarded. Fertigating field-grown crops is permitted in B.C., however the "Code of Agriculture Practice for Waste Management" restricts when fertigation can occur. The Code states that the application rate must not exceed the amount required for crop growth; it must not be applied if runoff causes pollution of a watercourse or groundwater, or goes beyond the farm boundary; and it cannot be applied to frozen or saturated soils.

Several wetland designs were tested over a two-year period at Houweling Nurseries Ltd. in B.C. These manmade wetlands consumed up to 65 percent of phosphate, 74 percent of ammonia, and 54 percent of nitrate-N in greenhouse leachate (Prystay 1997). However, a very large land base would be required to generate sufficient carbon to denitrify all of the nitrate-N in the leachate: the ratio of wetland to greenhouse area would be in the order of 1:2 (Prystay 1997). Other drawbacks are self-contained wetlands are expensive to construct, require periodic vegetation thinning to maintain adequate flow, and do not remove phosphates quick enough (Prystay 1997). For these reasons, the wetland system has been abandoned as an option by the greenhouse vegetable industry.

Table 1—Fixed and operating costs of water disinfection systems used in The Netherlands (Runia 1994)

Disinfection system	Fixed cost	Operating cost (per m^3)	# in use
Heat pasteurization	\$30,700	\$1.44	~300
Ozone	\$35,000	\$1.54	~150
UV light	\$29,000	\$1.27	~50
Slow sand filtration	\$11,000	\$0.47	5-10

THREAT OF DISEASE SPREAD WITH RECIRCULATION

The major concern with recirculating runoff is the potential for the spread of pathogens. Lesser concerns include the accumulation of pesticides, growth regulators, and toxic levels of nutrients. Byland's Nurseries dilutes the irrigation runoff with fresh water before use, but does not treat it in any other way prior to re-use. In the 6 years the system has been in operation, no crop damage has occurred due to re-using runoff water. Every incident of root rot has been attributed to another cultural practice.

There are several possible explanations why root rot diseases have not been spread with recirculation at Byland's Nurseries. First, many of the crops grown are resistant to the common root rot organisms, namely *Pythium, Phytophthora, Fusarium,* and *Verticillium.* Second, the nursery has a large, one million gallon holding pond, which would provide a long retention period for chemical, physical, and biological processes to reduce pathogen levels. For instance, spores of *Fusarium* spp. and other fungi are known to settle-out in standing water within 24 hours (Anon. 1992). Third, there is a high background level of free chlorine in their water source. It has been found that a 5 minute exposure to at least 0.2 ppm free chlorine is adequate to completely eliminate *Phytophthora* zoospores in water (Reeser 1997). However, the actual dose required will depend on the quality of the water, since the effectiveness of chlorine is impacted by several impurities in water. Fourth, good cultural practices and a free-draining medium will play a major role in root rot prevention. Fifth, beneficial microbes, or the crop, may be releasing chemicals into the irrigation solution that are antagonists of the disease-causing organisms (McPherson 1994).

Both the greenhouse vegetable and floriculture industries have installed recirculation systems. Not all of these greenhouses use a disinfection system. Greenhouses that grow crops susceptible to water-borne pathogens, such as tomatoes or gerbera daisies, have incorporated a water disinfection system. There are numerous systems available, including heat pasteurization, ozonation, UV light, membrane filtration, iodination, and slow sand filtration. In The Netherlands, the preferred system is heat pasteurization (table 1). Not enough greenhouses are using a disinfection system in B.C. to determine a preference, although slow sand filtration is very popular due to economics. Slow sand filtration is the least expensive disinfection system to purchase and to operate (table 1). In addition, the system is effective against several fungi, including *Fusarium, Thieaviopsis, Verticillium,* and *Phytophthora* (Wohanka 1992).

SLOW SAND FILTRATION

Slow sand filters, as their name implies, contain a series of layers of sand, gravel, and drainage rock. The system removes microorganisms by physical and biological means. A layer of organic matter forms on and in the fine-textured layer of sand at the top of the filter. A unique collection of microorganisms colonize this zone and breakdown the organic layer, including any pathogens present. The effectiveness of the filter is determined by the flow rate of the solution, and the thickness and particle size of the sand layers. The system is very effective at eliminating water turbidity, which makes it an ideal pre-treatment for UV light. UV light is a very effective disinfectant, but its usefulness is limited due to water quality. Organic matter and other particulates shield microbes and lead to poor performance by UV systems. Combining slow sand filtration and UV light would be a very effective disinfection treatment. The slow sand filter developed by Wohanka (1992) is currently being tested and refined at the Pacific Agriculture Research Centre, Agassiz, B.C.

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