# Environmental Resource Management Systems for Nurseries, Greenhouses, and Landscapes: 2005 Update

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**Significance to Industry:** Collaborative studies at two USDA-ARS units and four universities in the Southeast have developed strategies to more efficiently use and protect the environmental resources that nurseries, greenhouses, and landscapers rely on to produce their crops or products. The methods being developed will help make nursery and greenhouse production facilities and landscaped developments more efficient, self-contained, and self-remediating with respect to bed space, irrigation, nutrients, and pollutants in runoff water. They will have more options when designing management systems to meet stricter water quality standards that may be adopted in the future by federal, state, and local governments. Other methods being developed will increase the efficiency of water and nutrient use for container-grown crops, and will create new markets for landscape species that remediate pesticide and nutrient pollution.

**Nature of Work:** Commercial production of containerized nursery and floriculture crops results in the use of significant quantities of water, fertilizers, and pesticides. Additionally, container nurseries use plastics, fabric, or gravel to facilitate placement and handling of containers and to minimize weed growth; yet these materials may allow greater surface runoff than bare ground because they prevent infiltration and create sheet flow. Today many larger production facilities retain their runoff water in holding ponds or lagoons. A few have constructed wetlands to treat nutrient and pesticide enriched runoff water. Upon consideration of these commercial practices, the overall objective of this project was to develop and demonstrate methods to efficiently produce high quality woody and herbaceous nursery crops while minimizing inputs of nutrients and irrigation water while maintaining environmental water quality. Specific objectives of the project were: 1) to maximize nutrient and water use efficiency; 2) to mitigate nutrient and pesticide contaminants in off-site drainage; and 3) to develop strategies for using landscape plant species to improve water quality in the urban landscape.

*Objective 1: Maximization of nutrient and water use efficiency.* Scientists at USDA-ARS, McMinnville TN, North Carolina State University, University of Florida at Gainesville and Tennessee State University are studying the effects of various methods to maximize efficiency of nutrient and irrigation inputs on a range of plant materials that include *Magnolia virginiana Quercus phellos Oxydendrum arboreum Cotoneaster dammeri* 'Skogholm', *Dendranthema* x grandiflorum and *Euphorbia pulcherrima*. Irrigation type and rate, fertilizer formulation, rate and placement, container spacing, and substrate amendment type, rate, and particle size have been evaluated to determine their effects on plant performance, nutrient uptake, nutrient loading, and water use. The substrate amendment studied most extensively is calcined clay.

*Objective 2: Mitigation of nutrient and pesticide contaminants in off-site drainage.* Researchers at Clemson University are investigating the dynamics of constructed wetlands located at Wight Nurseries of Monrovia Growers in Cairo, GA. This 450 ha nursery has 230 ha of irrigated beds and recaptures about 85% of its irrigation water. Researchers have collected monitoring data for 38 months from a 3.77 ha constructed wetland, which receives drainage from a 48.6 ha catchment. They are developing an understanding of the hydraulic and nutrient and pesticide loading from runoff into a constructed wetland system by measuring the remediation efficiency of the various system parts, and how downstream water quality is affected by system discharges.

Scientists at the University of Florida and USDA-ARS in Ft. Pierce are studying bioremediation with filtration technology, currently used by the aquaculture industry. This type of managed biofiltration system uses substrate materials with extremely high surface area for microbial and periphyton colonization to provide the denitrification potential. The system may be particularly useful for smaller nurseries or as a more economical alternative to constructed wetlands when runoff flow volumes are not excessive.

*Objective 3 Use of ornamentals to improve water quality in the urban landscape.* Researchers at Clemson University are screening a large number of landscape plant species to determine their potential for phytoremediating pesticides, nitrogen, and phosphorus. Results are being compared with those from systems using bare soil and turfgrass filter strips.

**Results and Discussion:** Among the findings of this ongoing cooperative project thus far are: 1) *Cotoneaster* grew as well with a 0.5X rate of phosphorus (19-2-8) as with a 1X rate (19-4-8); 2) leaching of phosphorus from container-grown crops was reduced with cyclic microirrigation and peat- and clay-amended substrates; 3) calcined clays reduced the amounts of water required to grow several woody and herbaceous crops; 4) supplying irrigation at 2 cm/day versus 1 cm/day did not change growth but increased runoff volume and nutrient loads; 5) however, evapotranspiration-based irrigation decreased irrigation inputs and runoff volume in comparison with arbitrary irrigation amounts; 6) early spacing of the landscape species tested on a container pad reduced plant growth and increased runoff of irrigation water and the nutrients applied; 7) CW systems were highly efficient (>95%) at removing nitrogen from runoff at water temperatures >15 ºC, but remediation of orthophosphate-P was highly variable and not correlated with water temperatures; and 8) greater than 90% of nitrate nitrogen was removed in a matter of hours from runoff in a closed, relatively small-scale biofiltration media system.

Based on these results and those of previous studies conducted in connection with this project, the application of phosphorus at low rates is recommended. Fertilizer formulations with high ratios of nitrogen and potassium relative to phosphorus should be used whenever possible. Reducing the volume of water used for each irrigation event is recommended as this will increase both water and nutrient use efficiency, but water availability should not become limiting as it results in reduced plant growth. Irrigation methods based on water loss are more efficient than those that apply irrigation water on an arbitrary schedule. Controlling the amount of leachate conserves nutrients stored in the container substrate. Calcined clays conserve both water and nutrients in the substrate when added to soilless substrates at rates around 10%. However, all practices related to irrigation and fertilization must be considered collectively to most efficiently manage these resources.

With regard to the storage, treatment, and reuse of irrigation water, both small- and large-scale bioremediation strategies can be effectively implemented to reduce nitrogen levels. These systems are dynamic with regard to load, flow, substrate, and biofiltering organisms, and must be monitored and managed based on the unique combination of variables present. Today nursery and greenhouse operators have more strategies and methods than ever before to proactively maximize nutrient and water use and to remediate runoff water.

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