ENH1119

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Use of Reclaimed Water for Irrigation in Container Nurseries[1]

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Introduction

About 60 percent of Florida's freshwater supply comes from wells (Marella, 2000), and demand for this resource continues to increase. The state's growing population as well as inadequate amounts and distribution of rainfall have resulted in the need for water conservation throughout the state. As a result, in most areas of Florida, restrictions limit the quantity of water that can be used by commercial nurseries for the purpose of irrigation. In some regions of the state, restrictions also limit the time periods during which irrigation can be applied.

Alternative water sources, such as reclaimed water, offer some relief from the limitations of inadequate water resources. Reclaimed water may serve as the sole source of irrigation water or may supplement the amount of water permitted by local water management districts. The districts can permit for irrigation purposes the lowest quality water that is economical, as well as technologically, and environmentally feasible to use. In some locales, reclaimed water may be the only water source available for irrigation. Fortunately, reclaimed water costs about one half of the cost of potable water although additional connection and service fees may apply for use of reclaimed water.

What is reclaimed water?

Reclaimed water is processed from municipal sewage wastewater and should not be confused with black water or gray water, which has not been processed in any sewage facility.

In Florida, the operation of a processing facility is outlined in Chapter 62-600 F.A.C. (Florida Administrative Code, 1996). Part III of Chapter 62-610 F.A.C. (Florida Administrative Code, 2007) outlines the criteria that result in high-quality reclaimed water for land application. In addition to filtration, reclaimed water processed according to guidelines for Part III must have a high level of disinfection, so the reclaimed water can be used in public areas.

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Evaluations of Reclaimed Water for Overhead Sprinkler Irrigation of Container-Grown Plants

The suitability of reclaimed water (Part III) for overhead sprinkler irrigation of container-grown plants has been the subject of evaluations conducted from 2001 - 2007 at the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS). As a part of the evaluations, a survey was conducted documenting seven container nurseries that used reclaimed water (Part III). Table 1 identifies plants grown in these nurseries and irrigated with reclaimed water (Part III). The average nutrient concentrations of reclaimed water used at those nurseries is provided in Table 2.

The study indicated that chloride, sodium, and pH of reclaimed water exceeded the desired levels for irrigation water (less than 100 and 70 ppm and less than 7, respectively). Calcium concentrations in reclaimed water exceeded the desirable range of 20-40 ppm for the container substrate while potassium and magnesium were within the desirable range of 10-20 and 15-20 ppm, respectively, for the substrate (Yeager, 2007). Electrical conductivity (EC) of the reclaimed water was (0.96 dS/m) within the desirable range for the substrate (0.5-1.0 dS/m). A noteworthy concern is that nitrate and phosphorus in the reclaimed water might contribute to nutrient runoff problems even though the concentrations were low.

In addition to the plants grown by the survey respondents, researchers at UF/IFAS in Gainesville have used reclaimed water (Part III) for overhead irrigation of the following plants:

'Petite' and 'Maui' *Ixora (Ixora coccinea),* 'Petra' croton *(Codiaeum variegatum),* 'Seminole Pink' Hibiscus *(Hibiscus rosa-sinensis),* 'Ruby' and 'Plum' loropetalum *(Loropetalum chinensis),* 'Imperial Blue' Plumbago *(Plumbago ericulata),* 'Mrs. G. G. Gerbing' azalea (*Rhododendron japonica),* 'Prestige' poinsettia (Euphorbia pulcherrima), 'Beth' and 'Covington' chrysanthemum *(Dendranthema x morifolium),* and 'Helleri' holly *(Ilex crenata).*

In one evaluation at UF in Gainesville, 'Plum' and 'Ruby' *Loropetalum* exhibited a slight reduction in growth (dry weight) when grown with reclaimed water compared to the same kind of plants grown with municipal tap water from Gainesville. However, it should be noted that without a municipal tap water control for comparison, it is unlikely this slight reduction in growth in a production nursery would be discernible because growth indexes (height and spreads) of these *Loropetalum* cultivars were similar.

Nutrient concentrations of the municipal tap water used to irrigate plants during January – May, 2007 of this evaluation are given in Table 3. Nutrient concentrations of the reclaimed water used in the evaluation in Gainesville were similar to average concentrations in reclaimed water used at the nurseries surveyed (Table 2) with the exception of sodium and chloride. Concentrations of sodium and chloride were about 50 percent less in the reclaimed water used in the trials in Gainesville than in the reclaimed water used in the nurseries responding to the survey.

In another evaluation at UF in Gainesville, 'Petite' Ixora (Ixora coccinea) and 'Mrs. G. G. Gerbing' azalea irrigated with reclaimed water and fertilized with controlled-release fertilizer without potassium were similar in size (dry weights) and quality to plants that received the potassium in the controlled-release fertilizer. This similarity in plant size and quality indicated that reclaimed water supplied adequate potassium for these plants. However, the same study revealed that reclaimed water did not supply sufficient potassium for the growth of 'Covington' mum. The study results also indicated that for plants irrigated with reclaimed water, the quality of 'Plum' *Loropetalum,* 'Prestige' poinsettia, and 'Beth' and Covington mums declined because of leaf marginal necrosis, necrotic spots, or interveinal chlorosis when potassium was withheld from the controlled-release fertilizer. The study indicated that nursery operators should not assume without testing or conducting evaluations that nutrients in reclaimed water will substitute for nutrients that are usually supplied with controlled-release fertilizer.

In a related evaluation, also conducted at U.F. in Gainesville, 'Plum' *Loropetalum* and 'Helleri' holly irrigated with reclaimed water and fertilized with one half rate of controlled-release fertilizer (N-P-K) tended to be smaller (less dry weight) than plants irrigated with reclaimed water and fertilized with the full rate of controlled-release fertilizer. However, average-growth indexes were not different considering experimental variation. These results suggest that reclaimed water is not a significant source of nutrients for nursery plant growth.

Monitoring

Monitoring nutrients in irrigation water and monitoring the nutrient status of the substrate is important when irrigating with reclaimed water, just as when producing plants with municipal, well, or surface runoff water. By monitoring, one can determine whether optimal ranges of nutrients are maintained in the substrate and ensure that nutrients applied in fertilizer and in irrigation water are not excessive. Water and substrate nutritional levels for optimal plant growth are provided in *Water Quality/Quantity Best Management Practices for Container Nurseries* (Yeager, 2007).

Where do I get reclaimed water?

A list of sewage processing facilities that produce reclaimed water is located in the *Reuse Inventory Report* (see Reuse Inventory Web site, below). Reclaimed water is distributed through a network of pipes, storage tanks (Figure 1), and pumping stations. (Purple pipes identify reclaimed-water transmission.)

Nursery operators should contact the local processing facility, municipality, or local government for protocols regarding access to reclaimed water supplies. For container-plant production, obtain the highest quality water with high-level disinfection (HI or HB in Appendix B of *Reuse Inventory Report)* as achieved under the guidelines for Part III in Chapter 62-610 F.A.C.

Suppliers and users should execute a written contract. Some topics to discuss with the contractor or supplier for consideration in the contract are included in Table 4.

Figure 1. Purple pipes identify reclaimed-water transmission. Credits: Tom Yeager

Distributing Reclaimed Water within the Nursery

Reclaimed-water supply pipes entering the nursery may be connected to the existing nursery water-distribution system for overhead sprinkler irrigation and microirrigation or may be connected to pipes that deposit water into reservoirs or other storage structures. Cross-connection prevention must be in place if reclaimed water supply pipes connect to nursery pipes that could allow backflow or intermingling of reclaimed and potable water.

It is preferable to pressurize the existing piping system in the nursery by pumping reclaimed water from a storage structure or reservoir. In this way, comparable pressure can be achieved with reclaimed and non-reclaimed irrigation applications. Otherwise, pressure-relief valves or pressure regulation (e.g. a booster pump) maybe needed. Reclaimed water needs filtration (as does non-reclaimed water) if used for microirrigation.

Special Application Procedures and Cautions for Use of Reclaimed Water

The nursery should retain the capacity to return to the use of non-reclaimed water for irrigation in the event of shortages in reclaimed water supply or aberrations in reclaimed water quality.

The EC of reclaimed water should be checked and recorded weekly to ensure consistency. Such monitoring can help if it becomes necessary to investigate the cause for any significant changes in EC. Additionally, an analysis of all nutrients in reclaimed water should be determined monthly.

Check to see if nutrient analyses may be obtained directly from the processing facility or supplier.

Plants grown in native soils should be more tolerant of aberrances in water quality than plants grown in soilless substrates. However, aberrances due to reclaimed water and interactions with controlled-release fertilizer are unlikely if Best Management Practices (BMPs) are followed (Yeager, 2007). Using BMPs is particularly important if reclaimed water is recycled in the nursery.

Signs denoting the use of non-potable reclaimed water must be posted according to Chapter 62-610 F.A.C. (Figure 2). The reclaimed water application wet zone is set back 75 feet from existing wells and 100 feet from open eating and other personnel areas unless some measure is taken to alleviate mist moved by wind.

Figure 2. Signs denoting the use of non-potable reclaimed water must be posted according to Chapter 62-610 F.A.C. Credits: Tom Yeager

Tables 5 and 6 provide survey responses with regards to use of reclaimed water (Part III) for irrigation of container ornamental plants. Nursery operators should discuss with their employees the information in tables 5 and 6, as well as other information in this fact sheet to help employees develop an understanding of the benefits and diligence needed for successful use of reclaimed water in the nursery.

Conclusion

In seven commercial nurseries at various locations in Florida and in experiments conducted at UF in Gainesville, reclaimed water has been used successfully to produce marketable container-grown plants.

The EC of reclaimed water should be monitored and recorded weekly to ensure consistency. Elemental analyses should be conducted monthly or reports of analyses obtained from the supplier to ensure that elemental constituents of the reclaimed water are not excessive. In addition, monitoring substrate nutrition is an important BMP that will help the nursery gain confidence in the use of reclaimed water and will also provide a means to troubleshoot plant nutritional problems that might arise.

When properly managed, reclaimed water can be an effective substitute for municipal, well, and surface water sources, and use of reclaimed water may improve nursery profitability and conserve natural resources.

Summery of Important Points on Use of Reclaimed Water

1. Follow statutory guidelines for signage, setbacks, storage, cross connection, etc. (Chapter 62-610 F.A.C.).
2. Irrigation scheduling should be based upon plant need and container water-holding capacity.
3. Monitor reclaimed water and substrate nutrient concentrations to achieve optimal levels.
4. Nursery owner should contract with the reclaimed water processing facility or supplier. Property owner should approve use of reclaimed water if not the owner of nursery.
5. Require the processing facility or supplier to notify the nursery if changes or aberrances in wastewater treatment occur.
6. Become informed about the steps and/or processes that may curtail or restrict reclaimed water delivery to the nursery.

References and Web Sites

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Glossary

Black water is sewage water.

Electrical conductivity (EC) is the capacity of water to conduct electricity due to ions in the water. Units for measuring EC are dS/m, mS/cm, or mmhos/cm.

Gray water is water from sinks and baths.

Reclaimed water is from a wastewater treatment facility that cleans the wastewater using processes of secondary treatment.

Reuse is beneficial use of reclaimed water in accordance with regulations.

Table 1. Ornamental plants ranked from greatest to least quantity grown with reclaimed water at seven nurseries participating in the survey. 1= greatest; 5= least. (Container size is noted when included in response.)

1.	All plants in nursery; *Gardenia* spp., 1 - 10 gal.; *Ixora* spp.; *Jasminum* spp. (Jasmine); *Ligustrum* spp.; *Phoenix roebeleni*; *Quercus virginiana* (Live Oak), 15 gal.; *Rhaphiolepis indica,* 3 gal.; *Schefflera arbicola* 'Trinette', 3 gal.
2.	*Codiaeum* spp. (Croton); *Hibiscus* spp.; *Loropetalum chinensis,* 3 gal.; *Quercus virginiana* (Live Oak), 25 gal.; *Rhaphieolepis* 'Alba', 3 gal.; *Rosa* spp., 3 gal.; *Schefflera arbicola*; *Syagrus romanzoffiana* (Queen Palm)
3.	*Ixora* spp.; *Jasminum* spp.; *Juniperus chinensis* 'Parsonii', 3 gal.; *Philodendron selloum*; *Quercus* spp., 10 gal.; *Syagrus romanzoffiana* (Queen Palm), 15 gal.; *Viburnum* spp.; *Viburnum odoratissimum,* 3 gal.
4.	*Juniperus chinensis* 'Shore', 3 gal.; *Nerium* spp.; *Philodendron* 'Xanadu'; *Pittosporum* spp.; *Quercus laurifolia* (Laurel Oak), 15 gal.; *Viburnum suspensum,* 3 gal.
5.	*Ilex* spp. (Holly); *Ligustrum japonica,* 3 gal.; *Quercus laurifolia* (Laurel Oak), 25 gal.; *Rhododendron* spp. (Azalea); *Viburnum odoratissimum,* 3 gal.

Table 2. Low, average, and high values for analyses of reclaimed water from seven nurseries participating in survey.

	Low	Average	High
Elec. Cond. (dS/m)	0.28	0.96	1.48
pH	6.9	7.9	9.1
Aluminum (mg/l)	0.00	0.78	1.42
Ammonium (mg/l)	0.05	2.69	15.24
Barium (mg/l)	0.00	0.00	0.00
Boron (mg/l)	0.02	0.34	1.03
Cadmium (mg/l)	0.00	0.00	0.00
Calcium (mg/l)	46	65	99
Chloride (mg/l)	17	136	261
Copper (mg/l)	0.00	0.00	0.00
Iron (mg/l)	0.00	0.00	0.00
Lead (mg/l)	0.00	0.01	0.03
Magnesium (mg/l)	7.4	13.6	20.4
Manganese (mg/l)	0.00	0.00	0.00
Molybdenum (mg/l)	0.00	0.02	0.07
Nickel (mg/l)	0.00	0.00	0.00
Nitrate Nitrogen (mg/l)	0.08	2.86	6.99
Phosphorus (ortho) (mg/l)	0.11	1.80	4.47
Phosphorus (total) (mg/l)	0.10	1.60	4.92
Potassium (mg/l)	1.2	17.0	32.2
Silicon (mg/l)	5.6	8.2	12.0
Sodium (mg/l)	19	122	217
Zinc (mg/l)	0.00	0.00	0.00

Table 3. Average values for analyses of three municipal tap water samples per collection date.

Date	Elec. Cond.	pH	Ammonium	Calcium	Chloride	Magnesium	Nitrate Nitrogen	Phosphorus (ortho)	Phosphorus (total)	Potassium	Sodium
	dS/m		mg/l	mg/l	mg/l	mg/l	mg/l	µg/l	mg/l	mg/l	mg/l
Dec. 05	0.4	7.6	0.1	42	32	24	0	2.4	0	1.3	10
Jan-May 07	0.6	8.1	0.05	34	27	23	0	11	0	3.0	0

Table 4. Non-exhaustive list of topics considered in reclaimed-water contract between supplier and nursery.

Description of property and irrigation system
Water costs, connection fees, rebates, tax incentives
Water supply exceeds or is less than contracted quantity
Water quality and pressure specifications and consistency
Availability of nutrient compositional analyses from supplier
Plant aberrances resulting from water quality
Nursery access to processing facility personnel or easements
Cross connection or backflow prevention
Duration of contract and provision for exchange of ownership
Quantity changes due to adverse weather
Transfer of water delivery to another property or change in land use
Change in suppliers or contractor

Table 5. A survey was conducted in Florida of seven container nurseries that used reclaimed water (Part III). Survey participants were asked to indicate which statements applied to their nursery as a result of reclaimed-water use.

Survey question	**Percent responding yes**
Need for filtration	43
Very high pressure	43
Fluctuating pressure	29
Health or safety concerns	29
Emitter or nozzle clogging	29
Need for acidification	14
Pipes or valves breaking due to pressure	14
Lack of reliable supply	14
Irrigation system down time	14
Loss of plant sales	14
Disgruntled employees	14
Water treatment because of emitter or nozzle clogging	14
Forced to take more water than needed	0
Toxic reaction with fertilizer or chemicals	0
Water treatment because of pathogens	0
Increased pesticide use	0

Table 6. A survey was conducted in Florida of seven container nurseries that used reclaimed water (Part III). Survey participants were asked to indicate if they were strongly satisfied with reclaimed-water use.

Survey question	**Percent strongly satisfied**
How satisfied are you with reclaimed water?	100
How satisfied are you with your current arrangement with the reclaimed water supplier regarding water quality?	86
How satisfied are you with your current arrangement with the reclaimed water supplier regarding water quantity?	86