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Reclaimed Water Start to Finish©

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INTRODUCTION

Limited water resources and increased demand for water have resulted in the need for water conservation. 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 other water sources. Fortunately, reclaimed water costs about one-half that of potable water, although additional connection and service fees may apply.

What is Reclaimed Water? Reclaimed water is processed from municipal sewage wastewater and should not be confused with capture and reuse of irrigation water, black water, or gray water. 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 it can be used in public areas. Several experiments have been conducted at University of Florida to determine response of container-grown plants to overhead sprinkler irrigation with reclaimed water.

MATERIALS AND METHODS

Three experiments were conducted to determine plant response to irrigation with reclaimed water that was processed according to criteria given in Part III of Chapter 62-610 F.A.C. Plants were grown outdoors in a pine bark, Canadian peat, and sand (2 : 1 : 1, by vol) substrate in trade 1-gal containers. Plants were positioned on black polypropylene that covered the surface of eight, 1.2 × 1.8 m (4 × 6 ft) platforms each with a single drainage outlet. Plants were watered as needed (usually daily) using a hose and water breaker. Average elemental compositions of reclaimed and municipal water are given in Tables 1 and 2, respectively.

Experiment 1. Liners of the following plants were potted June 2004: *Ixora coccinea* 'Maui' and 'Petite' (ixora), *Codiaeum variegatum* var. *pictum* 'Petra' (croton), *Hibiscus rosa-sinensis* 'Seminole Pink' (hibiscus), *Loropetalum chinense* f. *rubrum* 'Ruby' (loropetalum), and *Plumbago auriculata* 'Imperial Blue' (plumbago). There were four plants of each cultivar on each platform. Each container received a surface application of 15 g Osmocote® 18–6–12 (N–P–K) Classic 8–9 months formulation (The Scotts-Sierra Horticultural Products Co., Marysville, Ohio). Plants received either reclaimed water (three platforms), reclaimed water recycled from a previous irrigation (three platforms), or municipal water (two platforms).

Pour-through leachates were collected every other week from one *I*. 'Petite' plant per platform. After 5 months, plants from each water treatment were rated visually and shoot biomass (dry weights) determined.

Experiment 2. Liners of the following plants were potted August 2005: *I. coccinea* 'Petite', *L. chinense* f. *rubrum* 'Plum', *Rhododendron* 'Mrs. G.G. Gerbing' (azalea), *Euphorbia pulcherrima* 'Prestige' (poinsettia), and *Chrysanthemum* 'Beth' and 'Covington' (syn. *Dendranthema* ×*morifolium* 'Beth' and 'Covington'). There were four plants of each cultivar on each platform. Plants on four platforms were fertilized with 1.0N–0.4P_2O_5–0.6K_2O and plants on the other four platforms were fertilized with 1.0N–0.4P_2O_5-0.0K_2O (N–P), each applied as 2 g N per container. The fertilizers were formulated from Meister® controlled-release products: 40–0–0, 0–40–0, and 0–0–43 (Helena Chemical Co. Collierville, Tennessee). All plants were irrigated with reclaimed water and grown under two layers of 30% natural light exclusion black polypropylene. When plants reached marketable size, plants were rated visually and shoot biomass (dry weights) determined. Marketable size was reached 9.5 months after planting for *Loropetalum* and *Ixora*, 6 months after planting for azalea, 3.5 months after planting for mums, and 3.7 months after planting for poinsettia. Total potassium content of shoot tissues of mums and poinsettia was determined.

Experiment 3. Liners of the following plants were potted May 2006: *L. chinense* f. *rubrum* 'Plum' and 'Ruby', and *Ilex crenata* 'Helleri' (holly). There were eight plants of each cultivar on each platform. In July 2006, one-half of the plants on each platform were fertilized with 1.0N–0.4P_2O_5–0.6K_2O (1X) and one-half of the plants fertilized with 0.5N–0.2P_2O_5–0.3K_2O (0.5X). The 1X was each applied at 2 g N/container. Plants on four platforms were irrigated with reclaimed water and plants on the other four platforms were irrigated with municipal water. All plants were grown under two layers of 30% natural light exclusion black polypropylene. Ten months after fertilizing, marketable-sized plants were rated visually and shoot biomass (dry weights) determined.

RESULTS

Experiment 1. Shoot biomass (dry weight) after 5 months growth was similar regardless if plants were irrigated with municipal, reclaimed, or recycled reclaimed water. Visual ratings were also similar except for 'Maui' ixora and plumbago that received slightly lower ratings when irrigated with reclaimed water compared to municipal water. Substrate electrical conductivity for 'Petite' *Ixora* ranged from 0.5–0.6 $dS \cdot m^{-1}$.

Experiment 2. Shoot biomass was similar for all plants regardless of whether they received N–P–K or N–P fertilizer with the exception of 'Covington' mum that had 65% greater biomass when N–P–K was applied. Both mum cultivars as well as poinsettia contained more potassium in shoot tissue when fertilized with N–P–K compared to N–P. Except for azalea and 'Petite' *Ixora*, plants fertilized with N–P had lower visual ratings than plants fertilized with N–P–K.

Experiment 3. Shoot biomass was similar for all plants regardless of fertilizer rate if plants were irrigated with reclaimed or municipal water. However, irrigation with municipal water resulted in larger 'Ruby' loropetalum (57±10 g) shoot biomass (weight ± standard deviation), when fertilized with the 1X rate, compared to plants (39±7 g) that received reclaimed water. Visual ratings for 'Ruby' loropetalum were also higher for plants irrigated with municipal compared to reclaimed water, while ratings for 'Plum' loropetalum and 'Helleri' holly were similar within each fertilizer treatment regardless of water applied.

Table 1. Average values for analyses of reclaimed water from Kanapha Wastewater Treatment Facility, Gainesville, Florida.

		Experiment 1: June 2004 – November 2004 (n = 39)	Experiment 2: August 2005 – May 2006 (n = 66)	Experiment 3: May 2006 – May 2007 (n = 45)
Elec. Cond.	$Ds{\cdot}m^{-1}$	0.5	0.6	0.6
pH		8.4	7.9	7.9
Aluminum	$mg{\cdot}L^{-1}$	0.03	1.2	0.29
Ammonium	$mg{\cdot}L^{-1}$	0.14	0.14	0.15
Barium	$mg{\cdot}L^{-1}$	0.0	0.0	0.01
Boron	$mg{\cdot}L^{-1}$	0.47	0.25	0.25
Cadmium	$mg{\cdot}L^{-1}$	0.0	0.0	0.0
Calcium	$mg{\cdot}L^{-1}$	39.0	42.0	42.0
Chloride	$mg{\cdot}L^{-1}$	73.0	73.0	80.0
Copper	$mg{\cdot}L^{-1}$	0.0	0.01	0.01
Iron	$mg{\cdot}L^{-1}$	0.0	0.0	0.0
Lead	$mg{\cdot}L^{-1}$	0.01	0.0	0.0
Magnesium	$mg{\cdot}L^{-1}$	16.0	19.0	23.0
Manganese	$mg{\cdot}L^{-1}$	0.03	0.02	0.0
Molybdenum	$mg{\cdot}L^{-1}$	0.01	0.0	0.0
Nickel	$mg{\cdot}L^{-1}$	0.0	0.0	0.0
Nitrate Nitrogen	$mg{\cdot}L^{-1}$	2.1	2.6	2.7
Phosphorous (ortho)	$mg{\cdot}L^{-1}$	0.94	1.2	3.1
Phosphorous (total)	$mg{\cdot}L^{-1}$	2.0	1.3	3.4
Potassium	$mg{\cdot}L^{-1}$	13.0	15.0	16.0
Silicon	$mg{\cdot}L^{-1}$	12.0	13.0	14.0
Sodium	$mg{\cdot}L^{-1}$	56.0	55.0	55.0
Zinc	$mg{\cdot}L^{-1}$	0.03	0.0	0.01

DISCUSSION

Results of our experiments indicated that reclaimed water was a viable alternative water source for container-grown plants with the exception of 'Ruby' loropetalum. In one of two experiments, loropetalum 'Ruby' exhibited a slight reduction in shoot biomass when grown with reclaimed water compared to municipal water. However, it should be noted that without a municipal water control for comparison, it would be difficult to discern this slight reduction in biomass production because growth indexes (plant heights and widths) were similar (data not reported) in both experiments. However, plant quality may be adversely affected because plants that received the reclaimed water for 10 months (Experiment 3) had lower visual ratings than plants that received municipal water irrigation.

Table 2. Average values for analyses of municipal water at University of Florida, Gainesville, Florida.

		December 2005 (n = 3)	January – May 2007 (n = 6)
Elec. Cond.	$Ds \cdot m^{-1}$	0.4	0.6
pH		7.6	8.1
Ammonium	$mg \cdot L^{-1}$	0.1	0.05
Calcium	$mg \cdot L^{-1}$	42.0	34.0
Chloride	$mg \cdot L^{-1}$	32.0	27.0
Magnesium	$mg \cdot L^{-1}$	24.0	23.0
Nitrate Nitrogen	$mg \cdot L^{-1}$	0.0	---
Phosphorous (orhto)	$mg \cdot L^{-1}$	2.4	11.0
Phosphorous (total)	$mg \cdot L^{-1}$	0.0	0.0
Potassium	$mg \cdot L^{-1}$	1.3	3.0
Sodium	$mg \cdot L^{-1}$	10.0	10.0

In Experiment 2, 'Petite' ixora and 'Mrs. G.G. Gerbing' azalea irrigated with reclaimed water and fertilized with controlled-release fertilizer without potassium (N-P) had similar shoot biomass (40±6.3 and 40±4.6 g, respectively) and visual ratings compared to plants that received potassium (N–P–K) in the controlled-release fertilizer (36±7.2 and 37±3.7 g, respectively). This indicated that reclaimed water supplied sufficient potassium for these plants. However, reclaimed water did not supply sufficient potassium for 'Covington' mum. It was noted that visual 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. Thus, nursery operators should not assume without testing that nutrients in reclaimed water will substitute for nutrients that are usually supplied with controlled-release fertilizer.

In Experiment 3, loropetalum 'Plum' and 'Helleri' holly irrigated with reclaimed water and fertilized with one-half rate (0.5X) of controlled-release fertilizer tended to have less biomass (25±6 and 27±6 g, respectively) than plants irrigated with reclaimed water and fertilized with the full rate (1X) of controlled-release fertilizer (37±6 and 36±6 g, respectively); although, means were not different considering experimental variation. This suggests that reclaimed water is not a significant source of nutrients for plant growth.

Monitoring nutrients in irrigation water and nutrient status of the substrate is very important when irrigating with reclaimed water, just as it is when producing plants with municipal water or surface runoff water. By monitoring, one can determine if optimal ranges of nutrients are maintained in the substrate and ensure that nutrients in irrigation water are not excessive. Water and substrate nutritional levels for producing container-grown plants are given in *Water Quality/Quantity Best Management Practices for Florida Container Nurseries* (Yeager, 2007).

CONCLUSIONS

Reclaimed water has been used successfully to produce marketable container-grown plants in both commercial nurseries and experiments conducted at University of Florida. Elemental analyses should be conducted frequently or reports of analyses obtained from the supplier to ensure elemental constituents of the reclaimed water are not excessive. In addition, monitoring substrate nutrition is an important best management practice which will help the nursery gain confidence in the use of reclaimed water and provide a way of troubleshooting any nutritional problems that might arise. Reclaimed water managed properly can be an effective substitute for municipal, well, and surface water sources and its use may improve profitability and conserve natural resources.

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