From Forest Nursery Notes, Winter 2012

86. © Recycled liquid cattle manure as a sole fertilizer source for growing container nursery stock in a closed system. Alam, M. Z. and Chong, C. HortScience 45(1):157-160. 2010.

HortScience 45(1):157–160. 2010.

Recycled Liquid Cattle Manure as a Sole Fertilizer Source for Growing Container Nursery Stock in a Closed System

Mohammed Z. Alam[1]
Agriculture and Agri-Food Canada, Crop Science, 32 Main Street, Kentville, Nova Scotia, Canada B4N 1J5

Calvin Chong
Department of Plant Agriculture, University of Guelph, Guelph, Ontario, Canada N1G 2W1

Additional index words. nutrient recirculation, liquid manure recycling, container culture, ornamentals, deciduous woody species

There is increasing environmental concerns about irrigation runoff, leachates, and other effluents from farms, composting sites, and other operations (Hong et al., 2009; Lea-Cox et al., 2004; Yeager et al., 1993). Waste effluents may cause surface and groundwater contamination (Million et al., 2007; Owen et al., 2008). Effluents are often rich in certain nutrients and can potentially be recycled for fertilizing plants (Alam and Chong, 2006; Owen et al., 2008; Qian et al., 2005).

Wastewaters from diverse sources, including municipal effluent (Beltrao et al., 1999; Kızıloglu et al., 2007; Manios et al., 2006; Qian et al., 2005), compost leachates (Shrive et al., 1994; Welke, 2004), and liquid byproduct from anaerobic digestion (Little and Grant, 2002; Michitsch et al., 2008) have been used in various crop production systems.

In North America, captured irrigation runoff has long ago been advocated for reuse in the fertigation of container nursery crops (Harrison, 1976; Skimina, 1986) and is increasingly being researched/used today (Beeson et al., 2004; Moore et al., 2008; Mosley and Fleming, 2009). However, it is labor-intensive to recycle wastewater and difficult to achieve a proper nutrient balance without proper equipment.

With the aid of an experimental-sized, computer-controlled multifertigation injector system, initially patented for use in growing greenhouse vegetable crops (Climate Control Systems, 2000; Papadopoulos and Liburdi, 1989), the ornamental nursery research program at the University of Guelph began to recycle container leachates for growing nursery plants in a closed system (Chong et al., 2004; Purvis et al., 2000). In this context, Chong et al. (2008) reported use of mushroom farm and anaerobic digestion wastewater as supplementary fertilizer sources for container culture of selected nursery plants. The aim of this related investigation was to ascertain if liquid cattle manure (LCM) could be used as the sole nutrient source under similar cultural conditions.

The computer-controlled multifertigation injector was described by Purvis et al. (1998). The system basically consisted of 10 electrically driven, individually controlled dosimetric injection pumps, various electrical conductivity (EC), pH, and flow sensors and two nutrient blending tubes connected in series. To fertigate, the computer can be programmed to deliver a set amount of any type of nutrient (individual, mixed, or acid) from its own individual stock container, i.e., a total of 10 types simultaneously, one per dosimetric pump. A series of 2% sloped crisscrossing, interconnecting aluminium troughs (25 cm wide × 3 cm deep × 5 m) directed leachates from containers into three large (1300 L) in-ground storage mixing tanks, each also equipped with its own EC sensor, and continuously aerated. The injector and mixing tanks were connected to a computer through an interface panel. This fourth-generation configuration of the system allowed recirculation of up to three different nutrient solutions, fresh water, or both; automatic or manual recharging of the solutions; and treatment randomization (Chong et al., 2008).

On 12 June 2007, plug-rooted liners of cotoneaster (*Cotoneaster dammeri* C.K. Schneid. 'Coral Beauty'), silverleaf dogwood (*Cornus alba* L. 'Argenteo-marginata'), and forsythia (*Forsythia ×intermedia* Zab. 'Spring Glory') were potted in #2 containers (6 L; 21 cm diameter × 21 cm deep) filled with a growing medium consisting by volume of 65% pine bark, 25% peatmoss, and 10% compost [Grow-Bark (Ontario) Ltd., Milton, Ontario, Canada]. On 21 June, plants were placed 45 cm apart on the aluminum troughs and grown under four separate fertilizer treatment strategies: 1) control fertilizer solution based on a nutrient formula described in Table 1 with a targeted EC of 2.0 $dS\cdot m^{-1}$ delivered and recirculated through the computerized injector; 2) recirculated, unamended liquid cattle manure [uLCM; raw liquid from an on-site collection tank at the dairy cattle barn, Elora Research Station, University of Guelph, Ontario, Canada, diluted fourfold with tap water to reduce (adjust) its EC to a value of 2.0 $dS\cdot m^{-1}$ (chemical composition shown in Table 1)]; 3) recirculated, amended liquid cattle manure [aLCM; fortified with 50 $mg\cdot L^{-1}$ of NO_3-N twice (at start and in mid-July), EC = 2.0 $dS\cdot m^{-1}$; Table 1]; and 4) Nutricote 18-6-8 (18N–6P–8K) T100 controlled-release fertilizer (CRF) with micronutrients (Plants Products Co. Ltd., Brampton, Ontario, Canada) topdressed at a rate of 4.32 g nitrogen per container as recommended by the manufacturer; nutrients were not recycled. The fertigation solutions in Treatments 1 to 3 as well as water only to Treatment 4 were dispensed by the injector through drip emitters at a rate of 1 L per container per day throughout the experiment [12 June (start) to 31 Aug. (harvest)]. The experiment was laid out in a split-plot design with the four fertilizer treatments as main plots and the three species as subplots. There were four main plot replications and three plants of each species per subplot unit.

The control fertilizer solution (Treatment 1, Table 1) was formulated by the computer from the following individual nutrient stock and concentration (bracket): $Ca(NO_3)_2.4H_2O$ (200 $g\cdot L^{-1}$), KH_2PO_4 (150 $g\cdot L^{-1}$), KNO_3 (150 $g\cdot L^{-1}$), K_2SO_4 (100 $g\cdot L^{-1}$), $MgSO_4.7H_2O$ (150 $g\cdot L^{-1}$), $Mg(NO3)_2.6H_2O$ (150 $g\cdot L^{-1}$), NH_4NO_3 (200 $g\cdot L^{-1}$), iron chelate (ethylene diamine tetra-acetic acid 13.2%, 5 $g\cdot L^{-1}$), and micronutrient mixture (manganese 24%, zinc 35%, boron 15% copper 25%, and molybdenum 46%; 1.5 $g\cdot L^{-1}$).

Samples of the dispensed control solution were collected at the emitter at the start and at 15-d intervals and analyzed for pH, EC, and the 15 nutrients shown in Table 1. The laboratory-based values were programmed into the computer to facilitate maintenance of target values. Solutions in the LCM tanks were recharged manually at weekly intervals (i.e., when storage tank volumes were depleted 300 L or less and EC reduced 1.5 $dS\cdot m^{-1}$ or less). The recharge procedure was facilitated using a predictive equation modified from Gils et al. (2005): $Y = (Vi \times ECi) \times (Vi - Vd)/[(Vr \times ECd) + (Vi - Vr)] \times ECr$, where Y = top-up volume of raw LCM; Vi = initial tank volume (1200 L); ECi = initial EC of 4 × diluted LCM; Vd = depleted volume; ECd = EC of depleted volume; and ECr = EC of the raw LCM.

On 31 Aug. (harvest), samples of fully matured leaves were collected from plants of each subplot, dried at 60 °C for one week,

Received for publication 1 Oct. 2009. Accepted for publication 30 Oct. 2009.
Financial and infrastructure support was provided by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and by the OMAFRA Tier 1 Research Support Program.
We thank Eric Labatte for design and technical support of the fertigation system.
[1]To whom reprint requests should be addressed; e-mail zalam@uoguelph.ca.