From Forest Nursery Notes, Winter 2012

12. © CCROP -- simulation model for container-grown nursery plant production. Million, J. B., Ritchie, J. T., Yeager, T. H., and Larsen, C. A. Scientia Horticulturae 130:874-886. 2011.

Scientia Horticulturae 130 (2011) 874–886

Contents lists available at SciVerse ScienceDirect

Scientia Horticulturae

journal homepage: www.elsevier.com/locate/scihorti

CCROP—Simulation model for container-grown nursery plant production

J.B. Million[a,*], J.T. Ritchie[b], T.H. Yeager[a], C.A. Larsen[a], C.D. Warner[c], J.P. Albano[d]

[a] *Department of Environmental Horticulture, IFAS, University of Florida, Gainesville, FL 32611-0670, USA*
[b] *Department of Agricultural and Biological Engineering, IFAS, University of Florida, Gainesville, FL, USA*
[c] *Department of Astronomy, University of Florida, Gainesville, FL, USA*
[d] *U.S. Horticultural Research Laboratory, USDA-ARS, Ft. Pierce, FL, USA*

ARTICLE INFO

Article history:
Received 9 November 2010
Received in revised form 20 July 2011
Accepted 22 August 2011

Keywords:
Decision-support tool
Irrigation
Nitrogen
Ornamental
Runoff

ABSTRACT

Container Crop Resource Optimization Program (CCROP) is an integrative model which simulates the growth and water and nutrient requirements of a woody ornamental shrub grown in small (2.8–11.4 L) containers in a field environment with overhead sprinkler irrigation. The model was developed for producers, producer advisers and researchers to support best management practice decision-making in container nursery production. We describe the primary processes simulated by CCROP particularly how they differ from traditional crops grown in-ground and assess the ability of CCROP to simulate measured values for a range of irrigation and fertilizer trials and transplanting dates. Results of model testing with 11 trials indicate that CCROP provided reasonable outcomes for biomass and leaf area growth as well as evapotranspiration, runoff (container drainage plus un-intercepted irrigation and rainfall) and nitrogen loss.

1. Introduction

In 2009, the nursery industry in the U.S. was estimated to have sales of $3.85 billion with 66% of production in containers (National Agricultural Statistics Service; www.nass.usda.gov). Best management practices (BMPs) are needed in production of container grown nursery crops due to high plant densities, inherently inefficient overhead irrigation systems (Beeson and Knox, 1991), and high application rates of controlled-release fertilizer (Evans et al., 2007). Under these conditions, cumulative leaching losses of applied N and P were found to exceed 250 and 33 kg ha^{-1} yr^{-1}, respectively, from the moderate fertilizer application rates of 1100 and 150 kg ha^{-1} yr^{-1} of N and P, respectively (Million et al., 2007b). BMP guides such as Best Management Practices: Guide for Producing Nursery Crops (Yeager et al., 2007) recommend irrigation and nutrient strategies based on a limited amount of research (Heckman et al., 2003). Economic and environmental issues can change rapidly requiring critical information from research be rapidly available. However, it is quite difficult to evaluate BMPs under all conditions with trial-and-error research specific to weather, transplanting dates, site and irrigation and nutrient application strategies.

Agronomic crop production simulation models have gained wide acceptance as important tools in research, education, and management (Jones et al., 2003; Keating et al., 2003; Marcelis et al., 1998). In container production, efforts have been made to model individual processes such as evapotranspiration (Beeson, 2010; Pardossi et al., 2008), container temperature (Martin and Ingram, 1992), and fertilizer release (Birrenkott et al., 2005), but few simulation models integrate a wide range of factors affecting production of container-grown nursery crops (Smajstrla and Zazueta, 1987). The primary difference between traditional soil-based agricultural production and production in containers is the finite substrate volume imposed by containers. This finite volume has implications for relating canopy ET with water uptake. Temperatures in container substrates have the potential to exceed traditional soil temperatures due to adsorption of radiation by container walls and the surrounding environment (Martin and Ingram, 1993). Another major difference is the common use of controlled-release fertilizers (CRF) in container production. Numerical models used to estimate nutrient release from polymer-coated CRF are complex (Shaviv et al., 2003) and simplified release algorithms are needed. Another deviation from traditional crop models is the loss of overhead irrigation water and rain that falls between spaced containers. In this regard, the leaf canopy can affect the amount of overhead irrigation and rain captured by the container substrate (Beeson and Yeager, 2003).

Our objective was to develop an integrative simulation model for container-grown plants by adapting established principles from agronomic crop simulation models. *Viburnum odoratissimum* (L.) Ker-Gawl., common name sweet viburnum, grown in 2.8 L (trade #1) and 11.4 L (trade #3) containers was used as a test crop for developing and testing model functions. *V. odoratissimum* is a

* Corresponding author. Tel.: +1 352 538 1775; fax: +1 352 392 3870.
E-mail addresses: jmillion@ufl.edu (J.B. Million), ritchie@msu.edu (J.T. Ritchie), yeagert@ufl.edu (T.H. Yeager), calarsen@ufl.edu (C.A. Larsen), warner@astro.ufl.edu (C.D. Warner), joseph.albano@ars.usda.gov (J.P. Albano).

0304-4238/$ – see front matter
doi:10.1016/j.scienta.2011.08.030