From Forest Nursery Notes, Winter 2012

37. © Effects of irrigation frequency and nitrogen fertilizer rate on water stress, nitrogen uptake, and plant growth of container-grown *Rhododendron*. Scagel, C. F., Bi, G., Fuchigami, L. H., and Regan, R. P. HortScience 46(12):1598-1603. 2011.

HortScience 46(12):1598–1603. 2011.

Effects of Irrigation Frequency and Nitrogen Fertilizer Rate on Water Stress, Nitrogen Uptake, and Plant Growth of Container-grown Rhododendron

Carolyn F. Scagel[1]
U.S. Department of Agriculture, Agricultural Research Service, Horticultural Crops Research Unit, 3420 NW Orchard Avenue, Corvallis, OR 97330

Guihong Bi
Truck Crops Branch Experiment Station, Mississippi State University, 2024 Experiment Station Road, Crystal Springs, MS 39059

Leslie H. Fuchigami and Richard P. Regan
Department of Horticulture, Oregon State University, Corvallis, OR 97330

Additional index words. nitrogen uptake, water use, *Rhododendron* 'P.J.M. Compact', *Rhododendron* 'English Roseum', *Rhododendron* 'Gibraltar', nursery production

***Abstract*. The influence of irrigation frequency (same amount of water per day given at different times) and nitrogen (N) fertilizer rate on water stress [stomatal conductance (g_S)], N uptake, and growth (biomass) of container-grown evergreen *Rhododendron* 'P.J.M. Compact' and 'English Roseum' and deciduous *Rhododendron* 'Gibraltar' was evaluated. Both N deficiency and high N rate increased water stress. Water stress was greatest in plants fertilized with the highest N rate and g_S of plants grown with the higher N rates changed more in response to water deficits resulting from irrigation treatments and seasonal climatic changes. Watering plants more frequently decreased water stress of plants fertilized with higher N rates and altering irrigation frequency had little impact on alleviating water stress of N-deficient plants. Increasing irrigation frequency decreased N uptake efficiency (N uptake per gram N applied), increased N use efficiency (growth per gram N uptake) and altered biomass allocation with little influence on total plant biomass. Response of biomass allocation to N rates was similar among cultivars and response of biomass allocation to irrigation frequency varied among cultivars. Altering irrigation frequency changed either the availability of N in the growing substrate or the ability of roots to absorb N. Our results indicate that transitory increases in plant water stress can alter N uptake, N use, and plant form without detectable changes in total plant biomass.**

The production of high-quality container-grown nursery plants requires adequate nutrients and water during production. Negative growth responses to excess N can occur from increased salinity, disruption of the balance between N and other nutrients, or increased water stress (Cabrera, 2004). Fertilizer application rates commonly used for container-grown crops are based on optimal water availability, a condition that rarely exists in commercial production systems. Fertilizer management effects on plant water use and drought stress during production for many crops has not been evaluated fully (Linder et al., 1987; Tan and Hogan, 1997). With some woody perennial plants it is possible that growth can be enhanced more by minimizing water stress than by increasing fertility (Rose et al., 1999).

The soilless substrate used during container production of nursery plants has a low nutrient and water-holding capacity and large irrigation quantities can result in nutrient losses from the container. Maintaining plant-available water near 100% field capacity in the growing substrate is believed to maximize plant growth (Beeson, 1992); however, this objective is impracticable in commercial practice. Reduced irrigation volume in combination with increased irrigation frequency can be used to decrease runoff of nutrients and water in nurseries (Fare et al., 1994). Increasing irrigation frequency can increase growth of container-grown plants or have no influence on growth (Beeson, 1992; Fare et al., 1994; Keever and Cobb, 1985). The growth responses of container-grown plants using deficit irrigation regimes have been investigated and acceptable growth was measured when the growing substrate was allowed to dry to 40% to 75% of container capacity before irrigation (Beeson, 2006; Welsh and Zajicek, 1993). Cumulative actual evapotranspiration was similar between control plants grown at 100% container capacity and plants grown at 40% container capacity (Beeson, 2006), suggesting this range of water stress has little influence on photosynthesis and carbon gain.

Nutrient uptake is a function of nutrient availability in the rhizosphere solution. Transpiration can cause large differences between the water content in the rhizosphere and that in the bulk growing substrate. Changes of a few percent in water content of a growing substrate can induce 4- to 5-fold decreases in the hydraulic conductivity of the substrate and can potentially limit nutrient acquisition by plants (Raviv et al., 1999). Increasing irrigation frequency may increase availability of nutrients and nutrient uptake efficiency and decrease the amount of fertilizer required for optimal growth. Several researchers suggest increasing irrigation frequency could compensate for certain nutrient deficiencies, and lower yields of plants irrigated less frequently may be a result of nutrient shortage rather than water shortage (Buljovcic and Engels, 2001; Silber et al., 2003; Xu et al., 2004).

Recently, we described the influence of N availability on growth and uptake and storage of N and other nutrients by container-grown evergreen and deciduous cultivars of *Rhododendron* spp. (Bi et al., 2007a; Scagel et al., 2007, 2008) and observed an apparent increase in water use with increasing rate of N fertilizer application. Improved knowledge of the combined influence of irrigation and nutrient management during nursery production of container-grown plants is needed to develop integrated nursery production practices that optimize nutrient and water use. The objective of this study was to investigate the influence of water stress (as induced by irrigation frequency) on growth and N uptake of one deciduous and two evergreen cultivars of *Rhododendron* grown with different rates of N fertilizer in containers.

Materials and Methods

Plant culture. Plants used in this experiment were two evergreen cultivars of *Rhododendron*, *Rhododendron* 'P.J.M. Compact', ARS#874 (PJM), and *Rhododendron* 'English Roseum', RHS#58 (ER), and one deciduous cultivar, *Rhododendron* 'Gibraltar', RHS#58 (AZ), obtained from a commercial nursery as 1-year-old liner (112-cm^3 rooting volume) stock of clonally propagated tissue-cultured plants. Plants were transplanted on 25 Apr. 2005 into 3.8-L (1-gal.) containers (GL-400; Nursery Supplies, Inc., McMinnville, OR) filled with a substrate of bark, sphagnum peatmoss, perlite, vermiculite, dolomitic lime, and gypsum (SB-300; Sun Gro Horticulture, Bellevue, WA)

Received for publication 27 July 2011. Accepted for publication 4 Oct. 2011.
This work was funded, in part, by the USDA-ARS-Northwest Center for Nursery Crop Research, the Oregon State University Agricultural Research Foundation, and the American Rhododendron Society. We gratefully acknowledge Jesse Mitchell, Suean Ott, Lisa Tribbet, and Rose Jepson for technical assistance and Monrovia Nursery, Dayton, OR, for plant materials.
Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture.
[1]To whom reprint requests should be addressed; e-mail Carolyn.Scagel@ars.usda.gov.