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ORIGINAL PAPER

# Irrigation scheduling and irrigation systems: optimising irrigation efficiency for container ornamental shrubs

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**Abstract** Water use and plant growth and quality were compared across different nursery stock beds, different methods of applying irrigation, and different methods of scheduling irrigation. With overhead irrigation, scheduling of irrigation according to plant demand, along with an irrigation system designed to maximise irrigation uniformity, resulted in substantial water savings, without reducing plant quality. This was the case in both wet and dry years. In the dry year, plant quality was particularly good when grown on a sub-irrigated sand bed; this system also used less water than any of the overhead irrigation systems. Two different systems were effective in scheduling overhead irrigation, one based on the volumetric moisture in the growing substrate, and the other based on plant evapotranspiration. The latter was determined with a small sensor with wet and dry artificial "leaves", the output of which correlated with that obtained following the Penman–Monteith method based on a full set of meteorological data.

## Introduction

Water scarcity and the increasing competition for water resources between agriculture and other sectors are forcing growers to consider more seriously the adoption of water saving strategies, especially in areas of intensive horticultural production and limited water resources (Costa et al. 2007). Water requirements of food crops are relatively well quantified in agronomic literature, but there has been little quantification of the irrigation requirement in order to maintain healthy growth and acceptable quality of ornamental plants (Henson et al. 2006). In several regions with container production, water is either limited, restricted, or both (Beeson 2006). Nursery production of woody landscape ornamentals has shifted in the past 40 years from in ground to container production for small to medium sized shrubs and trees. Whilst nurseries occupy relatively small land areas compared to agronomic crops, their consumption of water is quite high, ranging between 1.8 and 2.9 m depth over the crop annually in the southeastern US, for example (Beeson 2004). In areas such as Florida restrictions have been imposed on the quantity of irrigation that may be used (2.3 m depth in 1992, reduced to 1.8 m depth where there is a strong competition with urban centres for drinking water), meaning that nurseries need to increase their irrigation efficiency in order to remain in their current profitable locations (Beeson and Brooks 2007). In the UK, awareness that water supplies may be more limited in future has been heightened by recent water shortages during the summer, particularly in the south-east of England. Nonetheless, 90% of smaller nurseries are dependent on mains water, few recycle water, and many use inefficient irrigation systems (Briercliffe et al. 2000). In addition to the problems associated with depletion of water resources, losses of nutrients from hardy nursery stock systems can represent a considerable eutrophication potential (Harris et al. 1997).

To maximise growth, commercial nurseries generally strive to maintain plant available water to near 100% of container capacity (Beeson 2006). In large containers, this

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