ENH1048

UF | UNIVERSITY of FLORIDA
IFAS Extension

Water-Conserving and Runoff-Reducing Production Systems for Containerized Plants[1]

Sharma, J.; Haman, D.Z.; and Beeson, Jr., R.C.[2]

Ornamental plant production is the fastest growing agricultural sector in the US, and Florida is the second largest producer of nursery plants in the country with an industry value of $15 billion in 2006 (personal communication, FNGLA) and about 4,500 registered wholesale nursery growers (NASS, Census of Agriculture, 2004). Approximately 74% of the value of Florida landscape and foliage crops is from container-produced material (Hodges and Haydu, 2002; Haydu et al., 2005; Hodges and Haydu, 2006). The area of container-grown nursery plants in Florida was approximately 15,000 ha in 1995 (USGS, 1999). Because the ornamentals produced in Florida are also shipped out of state, the production likely will continue to increase as the population in Florida and in other states increases. The US Census Bureau (2005) projects that population in Florida could increase to 28.7 million people in 2030, which would be an 80% increase from 2000. This will also result in rapid growth of residential construction and a growing need for landscape plants, stimulating growth of the ornamental industry in Florida.

Container production of marketable landscape ornamentals using overhead irrigation requires large amounts of water to overcome relatively small root volumes and deflection of water by plant canopies (Beeson and Yeager, 2003). In Florida, most of the container-grown ornamental plants are irrigated with overhead sprinkler systems. Of the 50 to 100 inches of water applied per acre per year for irrigation, as little as 25% of the water applied overhead can enter the containers, and crops utilize only up to 50% of applied fertilizer (Haman et al., 1998). When spacing is factored in, a high proportion of water applied through overhead irrigation falls between containers and thus is unavailable to the container substrate (Furuta, 1978; Beeson and Knox, 1991; Beeson and Yeager, 2003). Over the course of a production period, only 13% to 20% of the water applied overhead is retained for plant growth and the rest becomes runoff or evaporation (Weatherspoon and Harrell, 1980).

As population and industrial development increase, limited water supply will likely become a major constraint in the growth of the ornamental

1. This document is ENH1048, one of a series of the Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date December 1, 2006. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
2. Dr. Jyotsna Sharma, Assistant Professor, Environmental Horticulture, University of Florida, Quincy, Florida, 32351. Dr. Dorota Z. Haman, Professor, Agriculture and Biological Engineering, University of Florida, Gainesville, Florida 32611. Dr. Richard Beeson, Jr., Associate Professor, Environmental Horticulture, University of Florida, Apopka, Florida 32703.

industry. Consequently, water-conserving technologies for nurseries will be essential and perhaps mandatory. Further, because in some instances poor irrigation practices have resulted in environmental degradation due to the transport of nutrients, pesticides, salt, and trace elements to surface- and ground-water, irrigated agriculture is facing increasing public pressure and the threat of increased regulation. In light of this, there is an increasing interest in new, water-conserving production systems for containerized plant production in outdoor nurseries.

One early advance in water conservation technologies was the development of microirrigation (Figure 1a). This method, when designed and managed appropriately, significantly reduces water usage (Haman, 2000; Haman et al., 1998). There are many different types of microirrigation systems and these include frequent water application, in small flow rates, directly on or below the substrate surface. At container nurseries, where potting substrates are highly porous, the most common microirrigation systems consist of small spray stakes to distribute the water over a significant portion of the surface area to assure even moisture distribution (Figure 1b). Ideally, only enough volume of water is applied to the root zone in quantities that are approximately equal to the consumptive use of the plants. In addition, nutrients and other production related chemicals applied with water can be controlled with increased accuracy. However, microirrigation has been labor- and cost-prohibitive for production in smaller (1-gallon) containers because of higher cost of installation and maintenance when compared to the overhead irrigation system. Consequently, it has been mainly used to produce larger plants (5 gallons and larger). Overall, water requirements are much smaller in well-managed microirrigation systems, and the low pressure delivery requires less energy for pumping water than high pressure systems. Some disadvantages, however, can include lack of frost protection and clogging of emitters by substrate particles, organic matter, algae, or chemicals, for example.

Some other, newer irrigation methods and/or systems which reduce the overall usage of water, and thereby reduce runoff during plant production are described below.

1. Gro-Eco®

Gro-Eco® is a patented, raised bed, pot-in-socket nursery production system in which raised beds made with a press pan are covered with weed barrier fabric. Containers are then placed in the sockets, which also are lined with the fabric (Figure 2a). Drip tape is used to distribute water and nutrients directly to containers (Figure 2b). The raised beds are designed to improve drainage while the weed barrier and water distributed via drip tape within a bed help stabilize soil temperature around the containers. In the absence of overhead irrigation, occurrence of disease and use of pesticides is reduced. Potential benefits of this new production system include reduced water use, nutrient runoff, fertilizer use, and incidence of foliar disease. Another possible advantage is more uniform watering of crops.

2. A Multipot Box System

A Multipot Box System for use under overhead irrigation systems was designed by the University of Florida to capture the water falling between containers and make it available when needed by the plants (Figure 3). It consists of two sections: upper and lower. The lower section forms a water reservoir with three ridges covered with wicking material. The upper surface increases the effective surface area and captures most overhead irrigation water or natural rainfall. Boxes were designed to be placed end-to-end, creating a continuous surface area, the water that that would normally fall between the containers. Introducing multipot boxes under a sprinkler system significantly increases the efficiency of water use. During the rainy season, the boxes function as rain harvesting/storage devices and they often require very infrequent irrigation. Without the box, water storage capacity of a container is very low and allows for no more than 2 to 3 days between water applications. The amount of water saved in a specific nursery depends on box arrangement and width of the alleys. However, based on research (Haman et al., 1998), it can increase water application efficiency from a typical 15-20% of a system without boxes to above 70% with boxes.

Figure 1. Microirrigation is a water-conserving technique of supplying irrigation water and fertigation to plants in containers. (1a) A microirrigation system with drip tubes delivering water to containers. (1b) A close-up of spray stakes in pots.

Figure 2. Gro-Eco® production system. (2a) Newly installed beds with some planted pots in the background. (2b) A close-up of the pots showing the drip tape which delivers the water and nutrients to the plants.

Moreover, in wet climates the contribution of rainfall is the most significant. During the two seasons in which the system was tested, 30 to 50% of the total rainfall was harvested for plant use. The amount that can be harvested depends on the frequency and timing of the rain, and on the amount of rain in consecutive rainfall events.

3. Capillary Mat Systems

Capillary Mat Systems are plant demand driven systems in which capillary mats are placed on the nursery bed and plant containers then are placed on the capillary mats (Figure 4). Beeson and Haydu (2002) conducted a study at the UF Mid-Florida Research and Education Center to examine the efficiency and economic feasibility of two Soleno Textiles Inc. capillary mat prototype systems S-10 and S-1. Results indicated that the S-10 was economically feasible, and that initial investment cost could be recouped in a relatively short period. In the study the S-10 mat system required 60% less water than the typical overhead system (control) and resulted in a shorter production period. Since the study, the S-10 prototype has undergone several improvements, such as an impervious backing to the bottom and a better upper covering to prevent root growth into the mat. It also has drip tubes already installed to supply water. The capillary mat can still be used, however, with overhead irrigation or by

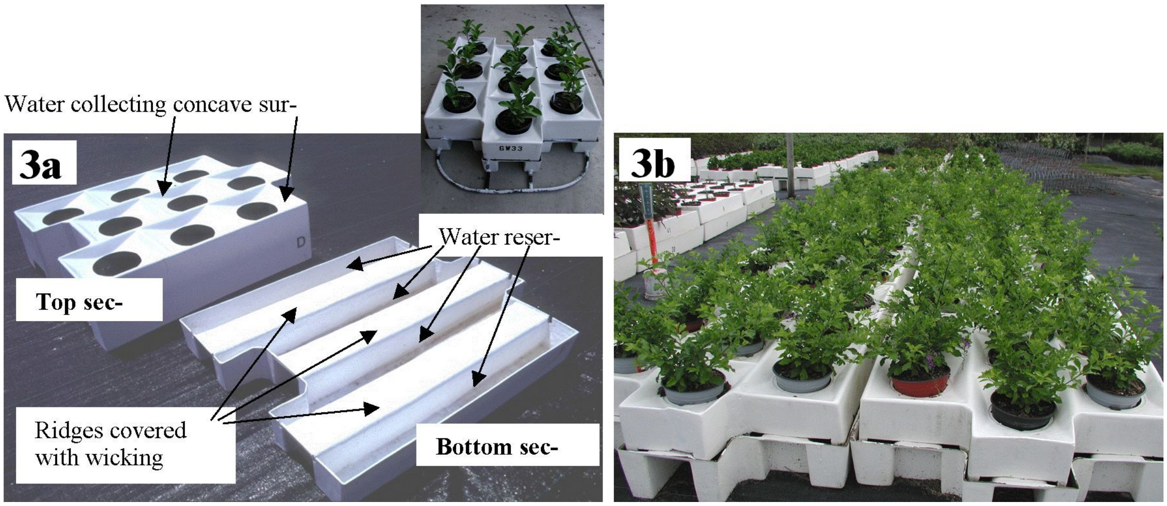

Figure 3. Components of a multipot box system (3a) and a photograph (3b) of plants growing in the multipot boxes.

using both mat-installed drip tubes and overhead sprinklers. Recently the Aquamat, as it is now called, won the 2005 Irrigation Association New Product Contest in agriculture.

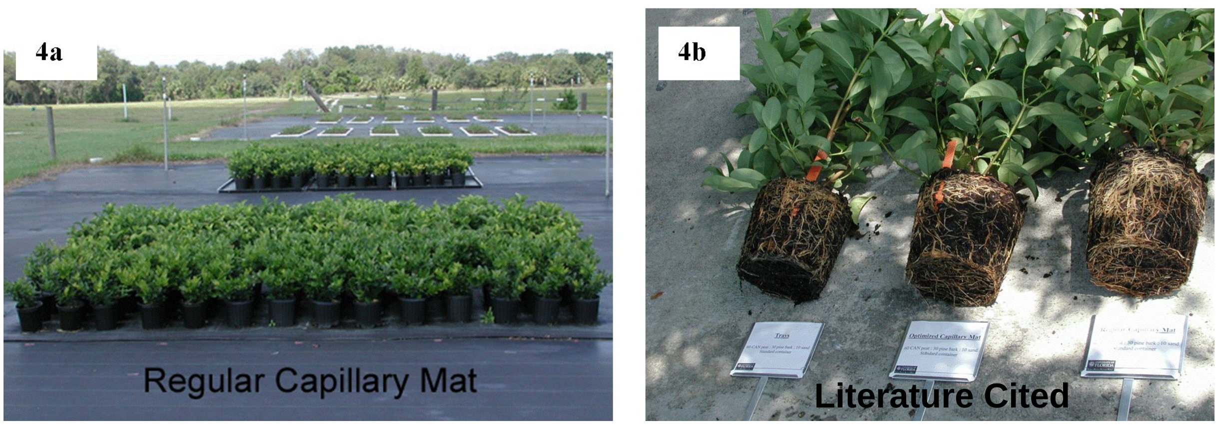

Figure 4. Capillary mat system. (4a) A photograph showing the capillary mat set-up. (4b) From left to right: roots of plants grown in large, flat trays; on optimized capillary mats (S10 prototype); and on regular capillary mats (S1 prototype).

4. The Holloway Irrigation System

The Holloway Irrigation System is an outdoor ebb and flow irrigation system that has not been previously used (except in preliminary tests at one location) for container production of woody ornamentals. In this system, plants are placed on an impermeable surface in graded basins (Figure 5a) that are periodically flooded for irrigation. Excess water is then returned to the retention reservoir (Figure 5b). Runoff resulting from rainfall is also collected in the reservoir for future irrigation use. Consequently, dissolved nutrients are retained in the pond, eliminating groundwater and minimizing surface water pollution from runoff. The only time nutrients may be released to the environment is during periods of exceptionally heavy rainfall, such as during a hurricane in Florida. In addition, the ebb and flow system allows un-utilized nutrients in the detention water to be reapplied for use by the crop. Based on monitoring (Haman et al., 2005) the amount of water released strongly depends on the size of the retention reservoir and on the management of water level in this reservoir.

Figure 5. Containerized plants growing in an ebb and flow basin lined with an impermeable surface (5a) to which water is supplied from a detention pond which collects rainfall and the recycled water (5b) in the Holloway Irrigation System.

Beeson, Jr. R.C. and G.W. Knox. 1991. Analysis of efficiency of overhead irrigation in container production. HortScience 26:848-850.

Beeson, Jr. R.C. and J.J. Haydu. 1995. Cyclic microirrigation in container grown landscape plants improves plant growth and water conservation. Journal of Environmental Horticulture 13(1):6-11.

Beeson, Jr. R.C. and J.J. Haydu. 2002. Comparison of Laval University capillary mats to other landscape nursery irrigation systems - Final report. Mid-Florida Research and Education Center, University of Florida, Apopka, Florida.

Beeson, Jr. R.C. and T.H. Yeager. 2003. Plant canopy affects sprinkler application efficiency of container-grown ornamentals. HortScience 38:1373-1377.

Furuta, T. 1974. Environmental plant production and marketing. Cox Publishing Co. Arcadia, CA.

Haman, D.Z. 2000. Irrigation 101. American Nurseryman 192(7):90-93.

Haman D.Z., L.C. Nogueira, R.H. Stamps, M.D. Dukes. 2005. Outdoor ebb and flow irrigation system for containerized ornamental plants in humid climate. 19-th ICID Congress, Beijing, China. Conference proceedings. Abstract: Q.52 P.1.08 :183-185.

Haman, D.Z., A.G. Smajstrla, and D.J. Pitts. 1998 . Efficiencies of irrigation systems used in Florida nurseries. EDIS Document BUL312, Agricultural and Biological Engineering Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville.

Haman, D.Z., T.H. Yeager, R.C. Beeson, and G. W. Knox. 1998. Multiple pot box for container plant production. Journal of Environmental Horticulture 16(1):60-63.

Haydu, J.J., L.N. Satterthwaite, and J.L. Cisar. 2005. An economic and agronomic profile of Florida s sod industry in 2003. Food & Resource Economics Department Agricultural Experiment Stations and Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida. http://hortbusiness.ifas.ufl.edu/ 2003%20FL%20Sod%20Survey%20Report.pdf

Hodges, A.W. and J.J. Haydu. 2002. Economic impacts of the Florida environmental horticulture industry, 2000. University of Florida/IFAS, Food & Resource Economics Department, Economic Information Report EI02-3. Available at http://economicimpact.ifas.ufl.edu

Hodges, A.W. and J.J. Haydu. 2006. Characteristics of the Florida nursery industry: 2003-04 National nursery survey results. University of Florida/IFAS, Food & Resource Economics Department, Extension Document FE 628. Available at: http://edis.ifas.ufl.edu/FE628

National Agricultural Statistics Service (NASS-USDA). 2004. Census of Agriculture, 2002. Florida State and County Data, vol.1, Geographic Area Series, Part 9, AC-02-A-9. Washington, D.C.

Weatherspoon, D.M. and C.C. Harrel. 1980. Evaluation of drip irrigation for container production of woody landscape plants. HortScience 15:488-489.

U.S. Census Bureau. 2005. Population division, interim state population predictions. Internet Release Date: April 21, 2005.

USGS, 1999. Water withdrawals, use, discharge, and trends in Florida. U.S. Geological Survey, Water Resources Investigations Report 99-4002. Tallahassee, Fla.