Monitoring Irrigation at Container Nurseries

Donna C. Fare,
Charles H. Gilliam,
and Gary J. Keever

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Summary. Efficient usage of current water supplies is of great concern to container-nursery producers. Improving water management first requires knowledge of current commercial container production practices. In this study, irrigation distribution from overhead sprinklers was monitored at container nurseries to determine the distribution and the amount of irrigation applied during a typical irrigation cycle. Several nurseries surveyed had poorly designed irrigation systems; subsequently, irrigation distribution varied widely at sampling dates and within the growing-container block. Uniform distribution was achieved at some nurseries, but required careful monitoring of the irrigation system. Future water restrictions may force nurseries to improve water usage by changing irrigation delivery methods to minimize water use, resulting in reduced surface runoff and effluent from container nurseries.

The quality and quantity of water used, along with effluent leaving container nurseries, are great concerns to nurseries in the United States (McWilliams et al., 1991; Urbano, 1989; Whitcomb, 1991). Traditionally, water availability has not been a concern, thus it has generated little interest from growers or research to improve water-use efficiency. The developing awareness for proper water use within an ecologically managed environment has stimulated interest in the development of improved water-use techniques. This concept of improved water management is the first strategic step in improving water quality and reducing water usage and surface runoff from container nurseries.

Overhead irrigation is the primary irrigation method in container nurseries in the southeastern United States. Growers generally irrigate daily for 1 h during the growing season, assuming 1 inch of water / h (2.5 cm. h^{-1}) is applied. Bir (1988) showed that overhead irrigation may apply 40,000 gal (151,400 liter) of water per acre daily, with losses of 16,000 to 36,000 gal (60,560 to 136,260 liter) through evaporation during application and runoff. Beeson and Knox (1991) reported overhead-irrigation efficiency of 37% when plants were at close spacing and 25% at a spacing of 3.0 inches (7.6 cm) between containers. Container spacing, canopy shedding, and possibly some canopy retention of water eventually lost by evaporation were determined to be the main factors associated with the low efficiencies. In Alabama, total water used for irrigation was reported at 77,000 acre-ft per year (Solley et al., 1985), with the container-nursery industry using an estimated 30,000 to 40,000 acre-ft per year. Output and distribution of water from overhead systems depend on many variables, including system design (pipe size and spacing, nozzle size and type, and operating pressure), plant size and spacing, and wind. Sound water management requires consideration of these variables in designing an irrigation system, as well as frequent monitoring to ensure uniformity of distribution and adequate, but not excessive, application volumes. As a baseline, improving water-management practices requires an understanding of current irrigation procedures used in container nurseries. A 2-year survey was conducted to determine irrigation distribution at container nurseries in Alabama.

Six container nurseries were monitored in 1989 and 1990 to determine the amount and distribution of irrigation water applied to container-grown nursery crops using overhead impact nozzles. Irrigation systems were designed by the nurseries or by professional irrigation specialists. When asked, "How much irrigation is applied?," growers at these nurseries responded that they normally watered for about 1 h, applying about 1 inch (2.5 cmžh^{-1}). Four of the nurseries surveyed (nurseries 14) were located in central or southern Alabama. Production in these nurseries consisted mostly of trade and full-gallon plants potted in April or May, grown for one season, placed pot-to-pot during the winter months (November to March), and marketed during the following spring. In the two nurseries in northern Alabama (nurseries 5 and 6) and one nursery in southern Alabama (nursery 3), plants were placed pot-to-pot in polyethylene-covered overwintering houses during the winter months (November to March). All irrigation

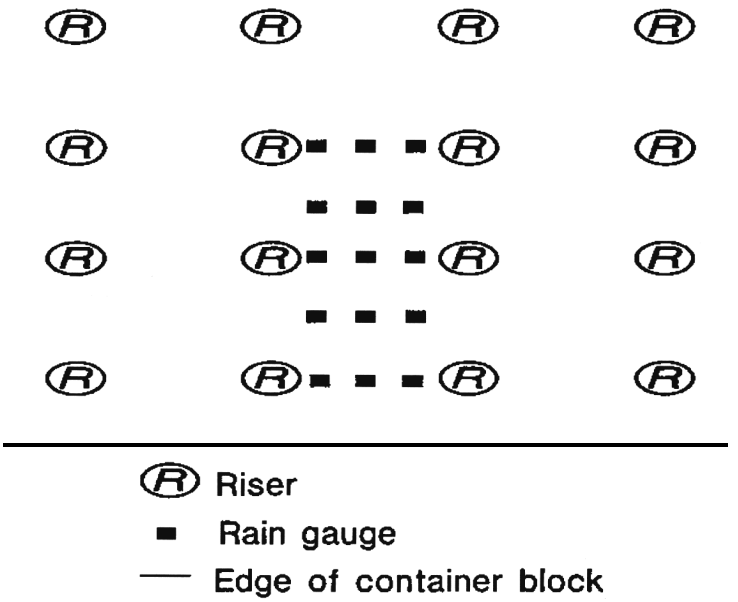

Fig. 1. ***Riser and rain gauge locations for irrigation sampling. See Table 1 for riser spacing in nurseries 1, 2, and 4.***

Department of Horticulture, Alabama Agricultural Experiment Station, Auburn University, Auburn, AL 36849.

nozzles at these nurseries were located within the overwintering structures. In the spring, the polyethylene was removed, and plants were spaced in the overwintering houses and adjacent areas. These plants were marketable after a growth flush.

Taylor rain gauges [8-inch (20-cm) height; Taylor Instruments, Arden, N.C.] were placed in plant containers to collect irrigation water over 1 h. The plant container gave stability to the gauge and ensured the gauge opening was slightly higher than the plant canopy. Fifteen gauges were located in a grid system between or around irrigation risers within a container block in each nursery (Figs. 1 and 2). When plants were spaced in

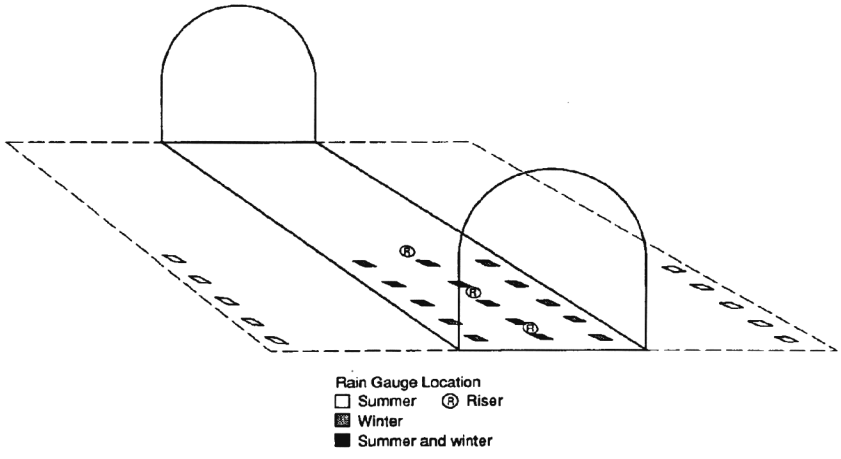

Fig. 2. ***Riser and rain gauge locations in winter and summer relative to over-wintering structures in nurseries 3, 5, and 6.***

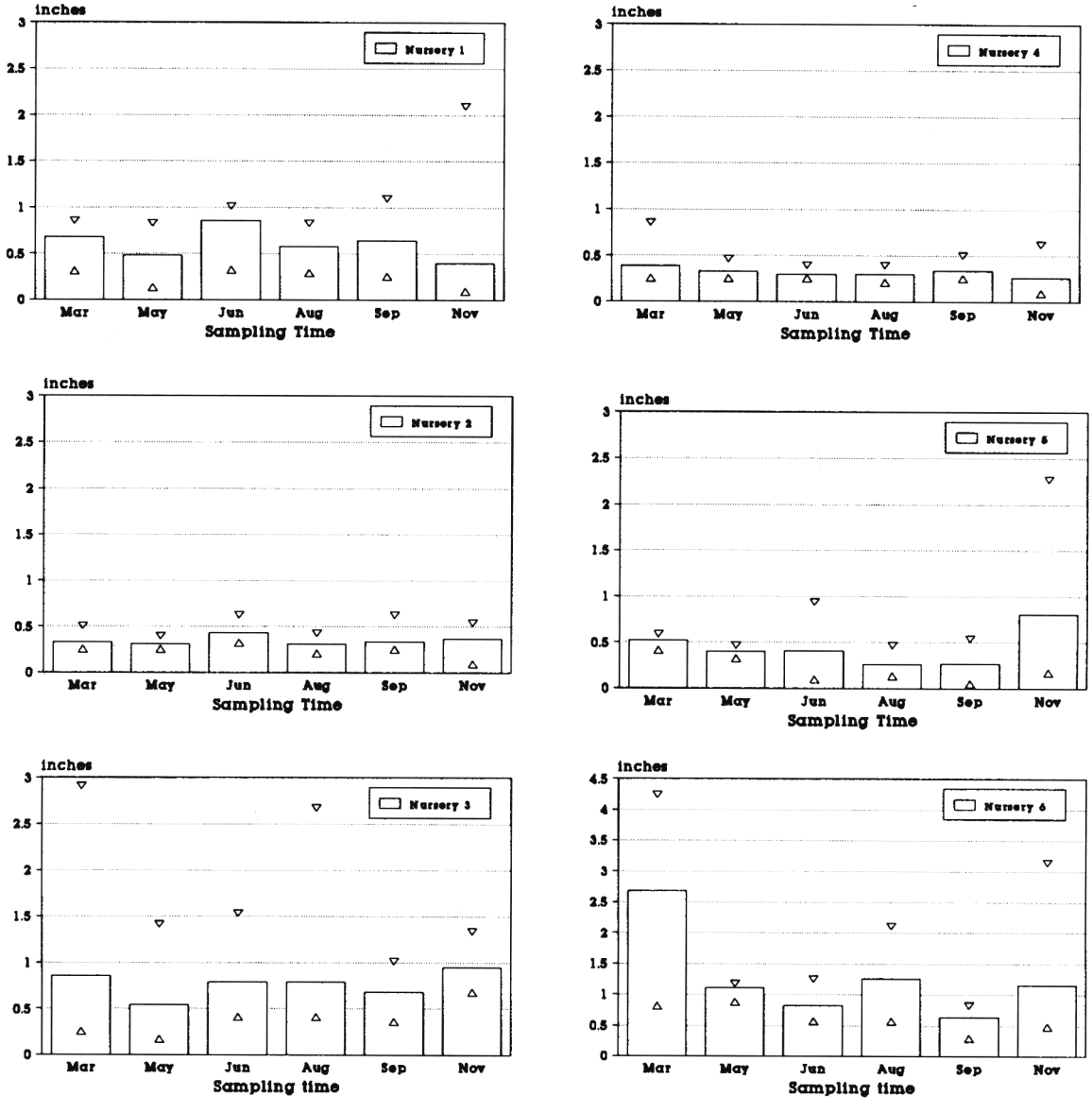

Fig. 3. ***Irrigation application distribution at six container nurseries in Alabama sampled monthly after 1 h of irrigation. Irrigation ranges are shown between A, and bars indicate means of 15 observations.***

Table 1. ***Characteristics of irrigation systems at six wholesale container nurseries in Alabama.***

Design/Equipment	Nursery (no.) 1	2	3	4	5	6
Nozzle type(s)[z]	Rain Bird 40 Rain Bird 35	Rain Bird 30	Rain Bird 25 Rain Bird 35 Nelson 631 A	NAAN 30	Rain Bird 30 NAAN 35	Rain Bird 25
Operating pressure	30–80 psi	30–80 psi	30–70 psi	25–65 psi	30–80 psi	30–70 psi
Riser spacing (ft)	40 × 40	48 × 48	10[y]	40 × 40	15[y]	15[y]
Riser height (ft)	6	5	5	3	4	3
Container size	2 gal[x]	Full gallon	Full gallon	3 gal[x]	2 gal[x]	Full gallon
Delivery pressure at pump	75 psi	60 psi	60 psi	45–65 psi	80 psi	85–90 psi

[z]*Manufacturer of Rain Bird nozzles is Rain Bird International, Glendora, Calif.; manufacturer of NAAN nozzles is NAAN Sprinklers and Irrigation Systems, Cerritos, Calif.; manufacturer of Nelson nozzles is R.L. Nelson, Orlando, Fla.*

[y]***Single-row spacing inside overwintering structure.***

[x]*Trade size.*

nurseries 3, 5, and 6, gauges were spaced farther apart (Fig. 2). Gauges were placed at the same locations at each sampling in nurseries 1, 2, and 4. At all nurseries, similar grid patterns for gauge location were used, even though each nursery had a different irrigation system design, including various riser heights, riser spacings, and nozzle types (Table 1). Calm conditions existed during sampling.

Annual average irrigation. Results were similar for the two years of the survey, hence only data from 1990 are reported. Average irrigation volumes applied varied widely from nursery to nursery (Fig. 3). For example, the average irrigation collected during a l-h period in nurseries for the six sampling times ranged from 0.3 inch (0.8 cm) in nursery 5 to 1.3 inch (3.2 cm) in nursery 6, a 4-fold difference. Excluding nursery 6, the average irrigation collected over the remaining five nurseries was 0.6 inch (1.6 cm), or slightly more than half of the 1 inch that most growers assumed they were applying during a l-h irrigation. An average of < 0.5 inch (1.3 cm) of water was applied during a 1 -h irrigation at three of the nurseries (nurseries 2, 4, and 5), while an average of 0.7 inch (1.8 cm) was applied in nurseries 1 and 3. Variation in irrigation among the sampled nurseries may relate to differences in nozzle type, delivery pressure, riser height, and spacing (Table 1).

Irrigation distribution by sampling times. Irrigation distribution varied widely over sampling times within some nurseries, while the irrigation volumes collected from other nurseries were relatively consistent. In nursery 1, 0.9 inch (2.2 cm) was collected in June, but only 0.4 inch (1 cm) was collected in November during a l-h irrigation. In nursery 3, the average irrigation collected ranged from 0.6 inch (1.4 cm) in May to 0.8 inch (2.3 cm) in November. In contrast, with nurseries 2 and 4, the hourly irrigation averages were between 0.3 and 0.4 inch (0.7 and 1.0 cm) for all of the sampling times (Fig. 3). These data demonstrate that uniform irrigation distribution can be achieved and that there is a need for careful monitoring of the irrigation system to ensure efficient water usage and minimize potential water runoff.

Overwintering structures. Temporary covering of winter-protection structures altered irrigation volumes measured. Nursery 6 used polyethylene-covered overwintering structures that confined irrigation to a smaller area and resulted in almost three times the irrigation applied in March as in the other five months of sampling, 2.7 vs. 1.0 inch (6.8 vs. 2.5 cm). A similar situation occurred in nursery 5, where irrigation from the November sampling (overwintering structures were covered) averaged 0.8 inch (2 cm), while the other five sampling dates averaged 0.4 inch (0.9 cm).

Irrigation distribution varied widely in the overwintering structures. For example, at nursery 6 during March (covered structure), irrigation ranged from 0.8 inch (2.0 cm) to 4.3 inches (10.8 cm). During the growing season (May to September), when the polyethylene was removed and plants were spaced, the irrigation distribution range was less, ranging from 0.5 to 2.1 inches (1.4 to 5.3 cm) among the 15 gauges. Most of these systems were designed to accommodate the expanded growing areas. In most parts of the United States, overwintering structures (hoop houses) are a critical component of nursery production. Our data indicate that poor irrigation distribution and usage may occur when the houses are covered, if the system is designed for irrigating adjacent areas.

Irrigation distribution within sampling area. Uneven water distribution within a block of plants occurred in all nurseries on at least one sampling date. Variations in irrigation volumes were not confined to overwintering structures, but were due to other unidentified factors. Within-block variations were relatively low in nurseries 2 and 4 during May through September, but in August at nursery 3, irrigation ranged from 0.5 inch to 2.6 inches (1.3 to 6.6 cm).

Despite differences in irrigation output, plants grown in the six nurseries were of consistently uniform marketable quality. These data emphasize the need for uniform initial design, careful monitoring and adjustment of irrigation systems throughout the year to ensure minimal variation within the container block, and adjustments for overwintering structures. Most of the irrigation systems were not checked for properwater output or distribution, but the growers assumed the system was delivering 1 inch of water per hour. Poor water distribution could have been improved with a properly designed and managed irrigation system.

This irrigation survey reflects current production irrigation application volumes in Alabama and is probably indicative of the southern United States. The amount of irrigation applied varied

with each nursery sampled, but averaged 0.6 inch / h (1.6 cm), or ≈ 40% less than most nurseries assumed was being applied during 1 h of irrigation.

Significance to the industry. Based on this survey, potential ways for improving irrigation delivery include monitoring irrigation output throughout the year and adjusting systems to ensure uniform delivery. Nurseries should be aware of poor water distribution in overwintering structures when the irrigation system is designed to water adjacent areas. Future water restrictions may dictate changes in current overwintering irrigation practices, which may include either changing the nozzles for uniform irrigation distribution within the structure or designing the irrigation system to irrigate uniformly only the area within the structure.

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