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An Initial On-site Analysis of Irrigation Management Practices at Four Alabama Container Nurseries©

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SUMMARY

The ornamental container nursery industry is large contributor to Alabama's green industry. However, it relies on intensive irrigation and fertilization to achieve high economic yields. In this study, observational data including application rate, distribution uniformity, and leaching fraction were collected from four Alabama container nurseries in July 2018 to assess current irrigation management practices. All four nurseries fell short of the recommended distribution uniformity (DU) value of greater than 80%. One nursery exceeded the recommended maximum leaching fraction value of 15%. Improvements can be implemented to improve efficiency, reduce inputs, and decrease environmental impact. Effort should be put forth to increase education and training for irrigation management in container nurseries.

INTRODUCTION

The use of containers in ornamental production has increased over the past 50 years because plants can be produced more efficiently than in-field cultivation (Majsztrik et al., 2011). In the state of Alabama in 2014, container nursery stock generated $91.9 million in sales (USDA, 2014). However, container-cultivated ornamentals rely on intensive irrigation and fertilization practices to produce high yield and economic returns.

Many container-grown nursery crops are irrigated with overhead sprinkler systems (Bilderback, 2002). These systems are a common choice of nursery growers because they have low installation and maintenance needs and cover large areas. The downside is that overhead sprinklers can be inefficient if installed improperly, and the uniformity of a system may be impacted by environmental factors of wind and evaporation (Whitcomb, 1984). To compensate for uneven distribution, nursery growers often run irrigation until the driest areas are sufficiently irrigated, causing excess water to be applied in other areas (Biernbaum, 1992). Due to the large amount of applied water, growing media in nursery production must be porous to allow proper drainage and avoid pest problems caused by overwatering. Nurseries in Alabama typically use porous pine bark-based growing media which has low nutrient-holding capacity. Due to the large amounts of irrigation necessary to prevent containers from drying out, loss of nutrients occurs readily (Rathier and Frink, 1989). Hence, high fertilizer application rates are used to offset leaching due to current irrigation practices. Consequently, because of high fertility rates, frequent irrigation is deemed necessary to prevent the buildup of soluble salts. Despite being effective for producing container-grown nursery crops, these cultural practices waste expensive resources and contribute to environmental problems.

Inefficient irrigation systems at container nurseries create a significant amount of runoff water which can transport dissolved substances into the surrounding area (Briggs et al., 1998). Leachates from nursery plants are primarily nitrate fertilizers, but also include soluble phosphates and traces of heavy metals (Biernbaum, 1992). Unutilized nitrates can lead to contamination of surface and groundwater - and have detrimental environmental effects such as excessive growth of algae and death of aquatic species (Howarth 1988; Kabashima, 1993; Rauschkolb and Hornsby, 1994). Inefficient distribution within irrigation systems may cause plants to be over- or under-watered, causing disease, plant stress, and death. In addition, leaching of nutrients means loss of expensive inputs from the production cycle. Degradation of crops combined with the high inputs needed to produce container ornamentals can lead to economic losses for nursery growers. By implementing better irrigation management practices, growers can prevent leaching of applied nutrients and other chemicals and decrease production costs.

Container nurseries can improve irrigation efficiency by implementing Best Management Practices (BMPs), strategies intended to mitigate environmental impacts of nursery crop production (Southern Nursery Association, 2013). Implementing BMPs can reduce water use and leaching of fertilizers, thereby reducing inputs and environmental impacts.

Inefficient irrigation management practices increase the cost of production and contribute to environmental problems. To begin improving irrigation management practices in Alabama, current practices must be assessed. There has not been an assessment of irrigation practices at container nurseries in Alabama in the last 20 years (Fain et al., 2000). The objective of this study is to collect observational data about irrigation management practices in Alabama container nurseries.

MATERIALS AND METHODS

Visits to four participating nurseries in Alabama began in July 2018. Two nurseries are located in central Alabama, and two are located in southern Alabama on the Gulf Coast. Application rate, distribution uniformity and leaching fraction were assessed on blocks of dwarf yaupon holly (*Ilex vomitoria* ‘Nana’) in #3 containers under overhead irrigation at each nursery.

The area of the block, number of plants, container dimensions, orientation of risers, and sprinkler head type were recorded. Growers were asked to run a typical irrigation cycle for data collection.

Distribution uniformity (DU) is a measure of how uniformly water is applied to an irrigation area. To determine DU, cups were placed in a uniform grid pattern within an irrigation zone. After an irrigation cycle, the volume of water collected in the cups were measured with a graduated cylinder. The average of the lowest quartile of application volumes were divided by the overall average application volume and multiplied by 100.

$$DU = \frac{\text{average application of lower quartile}}{\text{average overall application}} \times 100$$

According to BMPs, DU values should be greater than 80%, with a percentage lower than 60% indicating a more thorough audit is required to determine design or hardware malfunctions in the system.

Leaching fraction (LF) is the proportion of applied water that leaches from a container. To calculate LF, 8-12 plants (depending on the number of plants within a block) were randomly selected (Fig. 1). Each plant was fitted tightly into a 5-liter bucket and “skirted” with a plastic bag so that no irrigation water could enter the bucket between the container and the buckets (Fig. 2). A section of six-inch PVC pipe was placed under the container to ensure adequate space between the bottom of the container and the bottom of the bucket for leachate to collect. The plant with the bucket and plastic bag skirt was then weighed to determine its pre-irrigation weight and placed back in its original location within the block. After running a typical irrigation cycle, the samples were allowed to drain for 30 minutes and weighed again. Total applied irrigation per plant was calculated by subtracting the pre-irrigation weight from the post-irrigation weight. The plants were then removed from the 5-liter buckets, and leachate that had collected in the bottom of the bucket was measured with a graduated cylinder. To determine the LF, the leachate recovered is divided by total applied irrigation and multiplied by 100.

$$LF = \frac{leacheate\ recovered}{total\ applied\ irrigation} \times 100$$

BMPs state that LF should be 15% or less to avoid excessive irrigation. If the percent LF is over 20%, irrigation run time should be reduced.

Size index of the same plants used to measure LF was recorded as the average of the height, widest width, and width perpendicular to the widest width. Media pH and electrical conductivity (EC) were measured on the same plants using the pour-through nutrient extraction method (Wright, 1986). Leachate pH and EC were measured using a HACH Pocket Pro+ Multi 2 Tester (Hach Co., Loveland, CO).

RESULTS AND DISCUSSION

Results were collected on 20 July at Nursery A and Nursery B, 19 July at Nursery C, and 30 July at Nursery D. Cultural irrigation practices are different for each nursery and vary between irrigation run time, sprinkler arrangement, and sprinkler head type. The average irrigation amount was around 1.3 cm (0.5 in.) for all nurseries. However, DU for all nurseries was below the recommended value of 80%, ranging from 61% to 74% (Table 1). Sprinkler orientation (corner, side, or center) and spray pattern (90^0, 180^0 and 360^0) affect DU. The hollies at Nursery A was irrigated with four 180º sprinklers and six 360º sprinklers and had a DU of 67%. Nursery B was irrigated under sprinklers with a 360º spray pattern and had the highest DU (74%). Nursery C's block was irrigated by two 90º and six 180^0 sprinklers and had the lowest DU of 61%. Nursery D's block was irrigated with two 180º sprinklers and two 360º sprinklers and had a DU of 66%. None of the nurseries had installed matched precipitation sprinklers, therefore sprinklers applied the same volume of water per minute despite spray pattern. Matched precipitation sprinklers match the flow rate of the nozzle to the spray pattern and can improve the DU. For example, a corner sprinkler spraying a 90^0 spray pattern would apply half the volume compared to a sprinkler with a 180^0 spray pattern since it is covering half the area (Bilderback, 2002).

Average LF for nurseries A, B, and C are within the BMP guideline of ≤15%, however poor DU led to a large range of LF values. Nursery B LF ranged from 1.7% to 35.2%, while Nursery C LF ranged from 0.2% to 41.5%. Average LF at nursery D exceeded the recommended LF with an average of 36.4% and ranged from 5.0% to 67.2%. Nursery A had the lowest average LF at 7.4% and ranged from 1.8% to 15.5%. Splitting irrigation into multiple applications throughout the day, a recommended BMP known as cyclic irrigation, can reduce the LF.

Distribution uniformity is the biggest limitation to efficient overhead irrigation systems (Southern Nursery Association, 2013; Fare et al., 1994). If DU were improved and irrigation was applied more evenly throughout the area, irrigation duration and therefore volume can be reduced. Additionally, LF range and LF averages would improve as well. Decreasing LF reduces the amount of nutrients lost to leaching and decreases environmental impact. Using matched precipitation sprinklers can significantly improve DU. Regular inspection and maintenance of irrigation systems is also an important step to identify and resolve DU issues.

The initial results of this study are encouraging for Alabama growers, but small changes could be implemented to improve irrigation management practices, reduce inputs, and decrease the impact in the environment. Effort should be put forth to increase education and training for irrigation management in container nurseries. Irrigation assessments at several Alabama nurseries will continue through 2019, and results will be used to develop irrigation BMP training workshops for nursery growers through the Alabama Extension Service.

LITERATURE CITED

Biernbaum, J.A. (1992). Root-zone management of greenhouse container-grown crops to control water and fertilizer. HortTech.. 2:127–312.

Bilderback, T.E.(200)2. Water management is key in reducing nutrient runoff from container nurseries. HortTech. 12:541–544.

Briggs, J.A., Riley , M.B., Whitwell, T. (1998). Quantification and remediation of pesticides in runoff water from containerized plant production. J. Environ. Qual. 27:814–820.

Fain, G.B., Gilliam, C. H., Tilt, K.M., Olive, J.W. and Wallace, B. (2000). Survey of best management practices in container production nurseries. J. Environ. Hort. 18:142–144.

Fare, D.C., Gilliam, C.H., Keever, G.J. (1992). Monitoring irrigation at container nurseries. HortTech. 2:75–78.

Fare, D.C., Gilliam, C.H., Keever, G.J., Olive, J.W. (1994). Cyclic irrigation reduces container leachate nitrate-nitrogen concentration. HortScience. 29:1514–1517.

Howarth, R.W. (1988). Nutrient limitation of net primary production in marine ecosystems. Ann. Rev. Ecol. 19:89–110.

Kabashima, J.N. (1993). Innovative irrigation techniques in nursery production to reduce water usage. HortScience. 28:291–293.

Majsztrik, J.C., Ristvey, A.G., and Lea-Cox, J.D. (2011). Water and nutrient management in the production of container-grown ornamentals. Hort. Rev. (Am. Soc. Hort. Sci.). 38:253-97.

Rathier, T.M. and Frink, C.R. (1989). Nitrate in runoff water from container grown juniper and Alberta spruce under different irrigation and N fertilization. J. Environ. Hort. 7:32–35.

Rauschkolb, R.S. and Hornsby, A.G. (1994). Nitrogen management in irrigated agriculture. Oxford Univ. Press, New York.

Southern Nursery Association. (2013). Best management practices guide: Guide for producing nursery crops. 3rd ed. Southern Nursery Association. Acworth, Georgia.

U.S. Department of Agriculture. (2014). Census of horticultural specialties. Table 17: Nursery stock sold: 2014. U.S. Dept. Agr., Washington, D.C.

Whitcomb, C.E. (1984). Plant production in containers. Lacebark Pub. Stillwater, OK.

Wright, R.D. (1986). The pour-through nutrient extraction procedure. HortScience 21:227-229.

Table 1. On-site irrigation data collected from four nurseries located in Macon, Mobile, and Montgomery county in Alabama in July of 2018.

Nursery	Irrigation duration (min)	Average irrigation depth (in)	Irrigation depth range (in)	Distribution uniformity[z]	Average leaching fraction[y]	Leaching fraction range
A	30	0.52	0.22–0.95	67%	7.4%	1.8%–15.5%
B	60	0.48	0.33–1.05	74%	14.4%	1.7%–35.2%
C	90	0.53	0.27–1.01	61%	8.5%	0.2%–41.5%
D	120	0.54	0.3–1.05	66%	36.4%	5.0%–67.2%

[z]Distribution uniformity = (average application of lower quartile)/ (average overall application) × 100

[y]Leaching fraction = (leachate recovered/total applied irrigation) × 100

Figure 1. Leaching fraction samples (pink flags) within a block.

Figure 2: "Skirted" sample for irrigation efficiency analysis