# Small Steps to Improving Your Irrigation System, Reducing Labor and Increasing Your Bottom Line©

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## INTRODUCTION

Irrigation is one of our most critical cultural practices in production of nursery crops. Whenever an individual asks about getting into the container nursery business, my first advice is always — you must have large quantities of high quality water. Whenever you hear an irrigation lecture, the point most frequently emphasized is that you assign your most competent, knowledgeable person to oversee the irrigation. Yet, in reality, irrigation is a cultural practice that we offer the least attention to at most nurseries and in our research studies. There are so many variables that it is extremely difficult to perfect an irrigation system that will maximize growth of all the varied species at a nursery. However, like golf, while we cannot master it, we can continue to work toward improvement. This article looks at where we have been, where we are, and what small steps we can take to improve irrigation management systems.

## HISTORICAL PERSPECTIVE

Twenty years ago I worked at Taylor's Nursery in Raleigh, North Carolina. It was a highly respected mid- to large-sized nursery at the time (and still is). The Taylor family had Ray, the production manager (although I remember no titles at that time). Ray was the only one who knew where everything was. If you needed to find a less popular item like an *Osmanthus*, you would ask Ray and he would guide you to the containers behind the north pines beside the greenhouse. On your way, among the more popular plants, you might have seen a 5-year-old weeping willow in a 1-gal container that was 3.7 m (12 ft) tall, or you may have passed a bonsai enthusiast going through your junipers looking for an over-grown, pot-bound specimen to work into a piece of art.

The Taylors had beautiful plants, but nurseries back then did not have the urgency of efficiency. Plants that were not sold would "hang around". It was the way things were. Irrigation was treated similarly. It was important but it was done when it was convenient to turn water on and off. A good thing about the water-plant relationships is that plants have evolved to tolerate extremes in water availability to account for nature's fickle schedule of irrigation. So, while plants survived and grew, we certainly could have done it more efficiently.

## TODAY'S NURSERY INDUSTRY

In today's nursery **BUSINESS**, we no longer just strive to keep plants alive and growing until we can sell them. Rather, our goal is to produce quality plants in the shortest time, using the minimal space, having the least negative impact on the environment, while reducing costs with efficient and effective use of resources. Nurseries are businesses and the objective is to not keep plants around the nursery any longer than necessary. Nurseries now operate in terms of units sold, turnover, costs or returns per unit area, and maximizing product mix and crop scheduling. We are not doing our jobs if we keep plants "past their time". Irrigation management plays a big part in shortening production time. But there is plenty of room for improvement.

## WHAT ARE THE VARIABLES THAT MAKE IRRIGATION AND IRRIGATION SCHEDULING SO DIFFICULT?

**Different Media.** Pine bark, peat moss, coir, sand, perlite and other container amendments offer different potentials for water-holding capacity and water availability to plants.

**Containers of Varied Sizes, Shapes, and Material Makeup.** Height and volume of containers as well as the location and size of holes and other physical factors determine water availability and loss.

**Different Sized Containerized Plants.** Growth rate and size of plants influence water loss.

**Plant Species with Different Water Requirements.** In my early nursery production classes, we were taught that we should group plants by their water requirements, which is still true. Deciduous plants use more water than broadleaf evergreens which used more water than conifers. Recently, research by Richard Beeson and others show that there are not only different water requirements among plant species, but differences among cultivars of the same species. (Yeager, 1997) You must know your plants!

**Temperature, Humidity, Wind, Rain, Light, Time of Day.** All these abiotic factors influence the amount of water loss and quality of the plants produced.

**Irrigation Uniformity.** Uniformity entails utilizing, calibrated irrigation equipment and consistent media, fertility, and other cultural factors. If you do not similarly treat all plants within a group, uniformity of growth or diagnose problems can not be achieved.

## WHAT ARE OUR OPTIONS FOR SCHEDULING IRRIGATION AND DEALING WITH THESE VARIABLES? (REED, 1996)

**Be at One with Plants and Observe Their Stress.** It is the most common method used and can be done with moderate success with experienced people. This method involves using your experience to mentally weigh all the environmental factors, lift the pots, use you finger to test for container moisture, and observing physical signs of plant stress — this method is labor intensive and not always reliable.

**Weigh the Pots.** Determine the moisture applied deficit (MAD). Weigh pots at container capacity (the maximum water-holding capacity after drainage) and reweigh the same plants 24 h later. The difference in the two weights is the amount of water lost through evapotranspiration under the environmental conditions during this time period. This is a good method to learn how much to daily water plants, but it is cumbersome to do, with all the varied plants in nursery production, i.e., it's an impractical, cumbersome technique.

**Timed Irrigation.** This requires less labor but still requires much "tweaking" by the irrigation manager. It is too rigid to account for all the irrigation variables.

**In-pot Sensors.** Irrometers or tensiometers can be modified to accurately measure moisture loss in containers. In our research at Auburn, we wanted to replace daily water loss with minimal leaching. We found that the irrometers were not very accurate. So, we cooperated with our electrical engineers to write a complicated fuzzy logic computer program so the computer could monitor and "learn" the variability of the irrometer instruments and make corrections (Zhang et al., 1997).

We grew a crop of geraniums in the greenhouse to test the technology. It was very successful. We grew an entire crop of 40 geraniums as well or better than other irrigation scheduling methods without ever manually turning on the water. However, we needed a bundle of wires going to sensors in a number of pots and our own electrical engineer to make frequent adjustments to the program. Application of this technology can be done and I am sure it will be in the future. But for now, it is a big jump from one greenhouse to a large nursery with 100's of crops with different water needs, i.e., this method has potential, but is currently not practical.

**Model-based Irrigation Control.** This method uses sensors to monitor the environmental factors causing water loss and sends data to a computer to calculate the amount of water to apply to the crops. This method has the greatest potential to provide the right amount of water on demand, but is very expensive and complicated.

## SUGGESTED SCHEDULING STRATEGY FOR TODAY

As with golf, you are not going to be perfect, but you can take small steps to continuously improve and do a better job. Since all the above options have some merit, a hybrid of these options may offer a better system than we are currently using — and allow more constant improvement. Combining options may take the guess-work out of irrigation scheduling. It will take money and time to convert, but in our changing world with diminishing resources and greater environmental restrictions, we will be ahead of what will likely be mandatory in the future.

Improvements can be made by knowing the approximate volume of water to apply (MAD), using environmental sensors to model water loss, using a computer to help gather data, scheduling cyclic irrigation and keeping records — and using personal expertise to make adjustments. There is a margin for error in irrigation scheduling (Beeson, 1991). They found no difference in plant growth measured on some plants as long as they were replacing MAD between 20% and 40% of container capacity.

## CYCLIC IRRIGATION

Consider using cyclic irrigation, since research supports the benefits of micro-irrigation and more efficient utilization of overhead irrigation systems. You will need a controller or a computerized monitoring system. Controllers and timers are cost effective, ranging from $200 to over $2000, and allow scheduling of irrigation events with options for schedule adjustments. However, there are so many drastically different irrigation jobs on a nursery including propagation, monitoring various sizes of containers, and inherent variability among and between species. Many plants are also at varying stages of growth. The flexibility of a computer system may be the more economic and sound business choice to manage it all. Computer irrigation management systems range from $5,000 to $10,000 or more, depending on the size of nursery. Two companies that offer this equipment are Q-COM in Santa Ana, California and World Wide Water, Inc., Apex, North Carolina.

These management systems allow you to better control and manage irrigation. Computer systems can be a big capital expenditure, but no more costly than many media mixers and other production equipment used on the nursery. Irrigation systems are just as critical, if not more so, than other cultural systems.

## MONITORING AND CALCULATING IRRIGATION REQUIREMENTS

The next step is to begin to monitor and calculate the amount of water required for irrigating various crops and keep records for future scheduling. As water restrictions continue, we will be required to track our water usage. Flow meters are added to the system to help you do this, as well as monitor and adjust duration and volume of irrigation.

Begin your conversion to the new system by learning your plants water use. Measure the MAD of a number of your plants at different sizes and stages of growth. Do this on a hot, clear, low humidity day so that you will learn the maximum moisture loss of the plant over a 24-h period. Use this information to schedule the maximum amount of water you would apply using cyclic irrigation to minimize runoff and maximize your fertility program.

You can apply the water in three equal increments throughout the day or apply more of the calculated amount during the hottest part of the day. Research suggests that the greatest value from cyclic irrigation comes from increasing from one to three irrigation events with possible improvement by increasing 6 or 8 event increments. But, plant growth difference is diminished as irrigation events increase. Name these irrigation schedules as “azalea 1 gallon month one”, or some other descriptive term.

Next, use your experience to electronically calibrate temperature, rain, humidity, light, or a combination of sensors to reduce or eliminate irrigation events. It can be as simple as adding a Mini Clik or an Electronic Rain Gauge ($100) to turn off the water when a critical amount of rain occurs. It certainly makes sense to add one of these devices rather than irrigating automatically during a blinding rainstorm or running back and forth to the valve to manually shut off the irrigation. Sensors can be monitoring the environment night and day and taking your place at the on/off switch. If your rain sensor measures 0.4 cm (⅛ inch) of rain, you may program the computer to skip one or two irrigation events during the day.

Throughout the seasons and years, you will develop and fine tune a play book of irrigation options for your nursery and propagation areas that are utilized to monitor environment and adjust irrigation for each crop and their respective growth stage. The computer will also keep a record of when and how much water was applied to each crop. You will need to reweigh the pots on a regular basis throughout the season to adjust for plant growth, plant water demand, and seasonality.

Another adjustment method is to use cyclic irrigation and monitor the amount of leaching after irrigating. Put a pie pan under several containers with a spacer of some sort to lift the container and drain holes above the bottom of the pie pan. Measure the volume of leachate after drainage has stopped. You would like to minimize the total leachate to less than 10% to 15% of the total water applied. Some of the cycles in the heat of the day may not have any leaching. If you are getting no leaching during the day, you may want to adjust the irrigation volume up, or adjust down if you are getting excessive leaching.

## CURRENT RESEARCH

Our current research is evaluating the value of these sensors, individually and in concert to determine an economic, practical system to partially automate irrigation while increasing growth, or at least reducing labor and run-off into groundwater systems. The system does not totally replace you, but it saves miles of running each week and a few premature gray hairs from worrying whether plants were irrigated and if it was too much or too little. With computerized systems you can train your electronic eyes and finger in the field to keep track of what is going on and to alert you if things are not going as you instructed. A deviation in the flow to the containers at a set percentage, too much or too little, signals the computer to sound the alarm or call one or several people to let them know a problem exists. Or the computer can be instructed to call every day at a specified time to let you know all stations were irrigated. This is not a system just for large nurseries. It also offers peace of mind and possibly a free day or two away from the smaller nursery for the manager.

## CONCLUSION

When it comes to irrigation, almost all growers believe we can do better and still make it cost-effective to take the small steps to improve. There will be a learning curve in the beginning to fine tune your electronic finger and eyes to manage your new irrigation system. But, after you get your system up and running, you will find much more freedom, peace of mind, and still be able to reach the ultimate objective of producing uniform quality plants heading out the nursery gate. Many universities in nursery states are working on these irrigation opportunities. Experiment along with them. Stay alert as new information develops for improving your irrigation effectiveness and begin to take small steps to improve your irrigation management program. We CAN do a better job.

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