Proper irrigation management requires attention to three fundamental questions: When, how much and how to deliver? The answers to these questions are interrelated. Knowing when to irrigate is one of the most important skills in greenhouse production, and it is the first question to address in discussing irrigation management.

Crops should be irrigated so they do not suffer from excessive water stress. For many crops, excessive irrigation is undesirable. With too much water, crops become lush and soft, and if the growing medium is too wet, conditions will be favorable for root rots. On the other hand, excessive water stress is also undesirable, as the crop will be stunted and unattractive.

The exact degree of tolerable stress is highly specific; some crops can wilt and recover readily, while others may be permanently damaged by a single wilting episode. The degree of stress also depends on the crop’s market; snapdragons grown for bedding plants could stand more stress than snapdragons grown for cut flowers.

Crop demand will vary depending on several factors, such as plant type and size, characteristic water use and stress tolerance, and crop environment, including light, temperature and humidity. On the supply side, the availability of water will depend on the growing medium’s volume and amount of water it can supply for root uptake.

Understanding Irrigation Zones

Irrigation can be delivered several ways, but they all have one thing in common: Valves control water flow. An irrigation zone consists of a group of containers that are irrigated, either simultaneously or sequentially, when a valve is open. The smaller tensiometer on the right is equipped with a pressure transducer for electronic output. (Photos: George Elliot)
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Furthermore, even if the same amount of water is supplied to every container, they won’t all take up the same amount. The consequence of all this is that some containers will be underwatered and some will be overwatered. In this situation, the best general practice is to allow some stress in the plants that have the highest demand.

Automating Irrigation

The simplest form of automation is a time clock that determines how often and how long the irrigation system is on. This type of control is often used for propagation mist systems. The grower can change the interval and duration: For example, more frequent misting during the early stages of rooting cuttings and less frequent misting to harden off cuttings before transplant. Mist systems may use a clock setting or a solar sensor to reduce mist frequency at night. Outdoor timer systems used for crops like garden mums may have a rain sensor that overrides the time clock.

Irrigation management systems based on environmental measurements offer much improved control of supply in relation to demand. In the aerial environment, light accumulation and vapor pressure deficit (VPD) are all related to water demand, and both are used for irrigation control systems. Of these, VPD is more sophisticated, as temperature and relative humidity measurements are integrated over time to determine the evapo-transpiration potential.

Either light or VPD accumulation measurements are used to develop predictive crop models. Based on experience, the grower determines a relationship between measurements and crop demand. The irrigation controller is programmed so irrigation will occur when the measured value reaches a certain level.

In systems using aerial environment measurements, one sensor or group of sensors can be used to control multiple irrigation zones as long as they share the same environment. The sensors are generally reliable and useful for other aspects of environmental management. If the greenhouse has an environmental computer to manage heating and cooling, it should already have light and humidity sensors that could be used to control irrigation based on VPD or solar accumulation.

Irrigation management systems may also use soil moisture measurements to estimate the supply of water. When the growing medium is irrigated to its effective water-holding capacity, the subsequent change in the weight of the planted container is largely due to the loss of water from the medium. Some growers use portable balances to weigh representative pots. This process can be automated by using equipment...
tronic strain gauges to measure weight continuously.

**Monitoring With Sensors**

Another option for managing water based on soil moisture is to use sensors that measure either the relative availability of water in the growing medium or the water content of the growing medium as a percentage of its total volume.

The most widely used device for measuring water in potting mixes is the tensiometer. Basically, a sealed tube filled with water with a porous tip on one end is inserted in the growing medium. As water is withdrawn from the medium, it pulls water through the porous tip, creating negative pressure, or tension, in the tube. Soil moisture tension is related to soil moisture content, but the exact relationship is different in different growing media. However, the soil moisture tension at which water availability becomes limiting is generally similar for most growing media.

The EC2O probe, from Decagon Devices, Inc., is a more recently developed instrument that measures the volumetric water content in growing media, that is, the amount of water in the medium as a percentage of its volume.

The design has evolved rapidly, and the newest versions are small enough to use in 4-inch containers. The response is similar for a range of growing media, although it may be necessary to calibrate the sensor for a specific medium. Although EC2O probes have been used for irrigation control in research trials, I am not aware of a commercial controller specifically designed to use them.

Soil moisture sensors have some advantages for irrigation control. Since the sensor is measuring supply, the control system doesn’t need to be reset as plants get larger. For normal irrigation control, the same lower limit set point can be used for a variety of crops, since water availability is a function of the growing medium.

One major advantage of soil moisture sensors is both lower and upper limits can be set; that is, the irrigation system can be turned on when the water tension or content reaches a lower limit and turned off when it returns to a higher tension.
an irrigation zone, where should it be placed? If several sensors are used, how many measurements are needed to determine a reliable average?

Compare The Options

There are advantages and disadvantages to each irrigation management option and opportunities to combine different approaches. Manual control of irrigation is the most exacting. It requires frequent attention to the crop and environment, which is not a bad thing in itself, but it’s nice to be able to take a day off. Even with manual control, growers can use environmental measurements, including aerial conditions and soil moisture, to make better-informed and more consistent decisions.

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system uses measurements of the aerial environment and a crop model, the grower has to estimate a relationship between environmental parameters and water demand. If a system uses soil moisture measurements, the grower has to determine the limits for water availability or water content. Single-purpose irrigation controllers typically use a single control parameter, either solar accumulation, VPD or soil moisture. Environmental control computers can combine multiple parameters, for example, solar radiation and time or soil moisture and solar accumulation.

An approach that some growers take is to use their own judgment to manage irrigation on a day-to-day basis and use an automated system to manage irrigation on their day(s) off. The grower can program the controller based on the relationship between the system measurements and their own observations.

Conclusion
In summary, automating irrigation control can be very useful, but grower judgment is still required to determine the set points, based on observation and experience. A good grower can use any irrigation management system effectively by understanding its limitations.

In the next installment of this 2-part series, I’ll compare different irrigation systems in terms of how they deliver water to the growing medium and how they can be used with different management approaches.

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