

Grower 101:

Quenching Your Thirst For Irrigation

Last month, this 2-part series discussed principles of irrigation management and looked at irrigation management systems. This article discusses irrigation delivery systems in terms of functional characteristics and management potential.

By George Elliot

In the most basic terms, an irrigation system has three key components: a water source, a means of distribution and a means of regulating the water flow. The goal for any irrigation system is to deliver water to the growing medium as uniformly, effectively and efficiently as possible.

Irrigation delivery may be manual or automated. Automated irrigation technology has advanced

tremendously in response to the need for efficient water management and precise water delivery. Different types of irrigation systems have evolved to meet different needs.

Irrigation systems can be divided into two basic categories depending on how water is delivered to the growing medium. Overhead systems deliver water to the surface of the growing medium. Subirrigation systems deliver water to the bottom of the container. Overhead systems can be divided into two subcategories: sprinklers or booms, which deliver water as a spray covering a relatively large area, and drip or trickle systems, which deliver water to individual pots. Subirrigation systems include capillary mats, troughs, flood and drain trays, and flood floors.

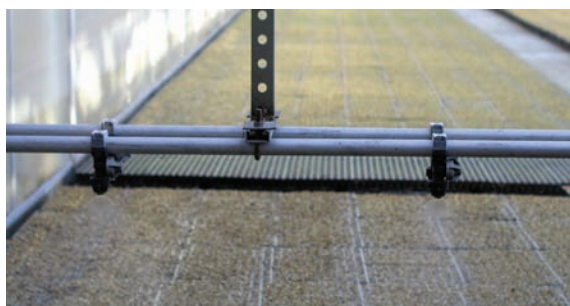
Retaining Water

The upper limit for water retention in a growing medium is the effective water holding capacity (EWHC). This is normally the target for irrigation. However, it may be desirable to maintain the medium's moisture content below the EWHC in order to regulate plant growth. Regardless of whether the target for irrigation is EWHC or some lower value, it is important to irrigate thoroughly. That is, the amount of water applied must be sufficient to rewet the entire volume of growing medium. If the medium is dry and too little water is applied, only part of the mix will be rewetted.

The amount of water needed to irrigate thoroughly will depend on the delivery method. If water is delivered overhead, the force of gravity will pull it down. As it moves downward, some water will be held by the growing medium. Some water usually will escape from the pot bottom before the medium is thoroughly wet. At the same time, water collects at the pot bottom and then moves back upward.

This can easily be seen if a saucer is placed under a pot with a very dry growing medium. When water is applied to the surface, it will quickly flow through to the saucer but then move back up into the medium. The relationship between the amount and rate of water application and the amount retained can be rather complex, but in general, the slower the application, the higher the proportion that is retained.

When water is delivered by subirrigation, it contacts the growing medium at the pot bottom and is drawn up by capillary action. The amount of water taken up will depend on the height of the



Clockwise from top right: Boom systems are very useful for plug trays and flats; drip tape can be used for containers, which must be placed according to emitter location; a recent innovation in capillary mat design places a layer of fluffy material between the mat and the surface cover; If the medium is dry and too little water is applied, only part of the mix will be rewetted. (Photos: George Elliott)



Trays are flat and the bottoms are configured with channels so the tray fills and drains uniformly and every container has the same contact time and water table height.

water table (i.e., the height of free water in contact with the medium), the size and placement of the drainage holes on the pot bottom, the pot height, the duration of the contact time between the growing medium and the water, and the growing medium porosity.

Hand Watering

The simplest irrigation system is hand watering. Most greenhouses have hoses with watering wands and breakers. Of course, hand watering is too costly for routine irrigation, but there will always be situations where hand watering is useful. Growers need to know how to hand water efficiently and effectively.

Water should be applied as gently as possible to avoid compacting the potting mix or washing it out of containers. Using an appropriate breaker is helpful. Several types of breaker are available. The number and size of holes on the breaker face determine the flow rate and pressure. Direct the stream of water from the breaker in an upward arc so the line pressure is dissipated. It is better to deliver the required amount of water in pulses rather than continuously. Instead of consecutively watering single pots until the headspace (freeboard) is overflowing, it's better to apply a smaller amount of water successively to several pots and then repeat the application. That way, the water has more time to soak in and less will end up leaching out the bottom.

Hand-watering efficiency in terms of water use and labor depends on the crop type. Hand watering is most efficient for plugs trays and flats where small containers are tightly spaced because a large area can be irrigated quickly with minimal waste. Hand watering is least efficient for potted plants when they are at final spacing and the canopy is closed because it is harder to get the water to the growing medium, it takes longer to deliver

water to each container and more water is wasted from runoff.

Even with careful application by experienced workers, as much as 50 percent of the water that comes out of the hose ends up on the floor. Efficiency and uniformity can be greatly improved by using water-saver saucers or trays that catch much

of the water that would otherwise miss the pot and retain it so that it can be absorbed from the bottom up.

Sprinkler Systems And Booms

Sprinkler systems and booms can deliver water fairly uniformly to the growing medium's exposed

surface, resulting in uniform wetting and good water retention. The spray drops are under relatively low pressure, so compaction and washout is minimized. Boom systems are very useful for plug trays and flats. They also can be used for larger containers, especially when the pots are still tightly spaced. ▶



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Both sprinkler and boom systems can be used for pulsed irrigation; that is, applying relatively small amounts of water at variable intervals depending on environmental conditions. Boom systems may have quick-change nozzles for different spray patterns, allowing them to be used for

misting during propagation and for higher-volume delivery for irrigation. Booms can be programmed to make repeated passes over the same area or to shut on and off while passing over different areas. Shutting off some of the nozzles on a boom allows for selective irrigation within a block.

Drip Systems

Drip systems deliver water as a point source. In drip tape, the emitters are incorporated at regular intervals in the tape. Drip tape is widely used for irrigating cut flower crops in soil beds. Drip tape can be used for containers, which



In trough systems, the trough is pitched slightly from the inlet to the outlet end so water will flow by gravity.

must be placed according to emitter location. Drip tape is pressure compensated; that is, water does not come out of the emitters until the tube is uniformly pressurized. This ensures a uniform flow rate from all emitters. A regulator that maintains water pressure at about 25 lbs. per sq. inch is used to avoid excess pressure that could burst the tape.

A "spaghetti tube" drip system consists of a rigid or semi-rigid pipe about one-half-inch inside diameter and flexible micro tubing that connects to the pipe and delivers water to the container. The tubing's delivery end has a weight or barb to hold the tubing in the pot. Pot weights designed to allow the tube to be shut off when it is not in use can be handy. Dribble rings made of perforated tubing that forms circles on the surface of the medium provide more uniform water distribution than single-point drippers. In large containers, individual spray stakes are an effective way to spread water over the surface.

A pressure-compensating outlet ensures uniform flow rates from each emitter. Multiple outlets can be connected to the same pressure compensator. If the length and diameter of the tubing from each outlet is the same, the flow rates will be uniform. If a multiple-outlet system has tubes of varying lengths, a flow restriction device at the end of each tube is needed to obtain uniform flow rates.

Pressure-compensated drip systems can also be used for pulsed irrigation. For example, if the normal irrigation run time would be 30 minutes, the system can run for six cycles of five minutes on and 10 minutes off. Irrigation systems controlled by soil moisture sensors can be programmed to pause long enough for soil moisture to equilibrate after each pulse.

Capillary Mats

Capillary mats are the simplest form of subirrigation. In these systems, water is delivered to a porous

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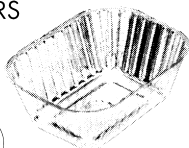
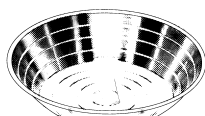
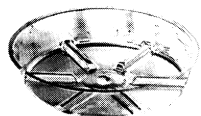
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Boom irrigation can also be used for larger containers, especially when the pots are still tightly spaced.

mat that is in contact with the bottom of the container, allowing for movement of water from the mat to the growing medium. The mat is placed on a plastic sheet to retain water and is covered with a perforated plastic sheet to retard the growth of algae.

A recent innovation in capillary mat design places a layer of fluffy material between the mat and the surface cover. When a pot is placed on the cover, it sinks down to the mat, but the cover is otherwise separated from the mat. Water is usually delivered to the mat by a drip tube, but sprinklers or even hand watering can be used.

With a capillary mat, the water table in contact with the growing medium is very shallow. Furthermore, the mat can be difficult to rewet when dry. Therefore, the mat

is generally kept at least partially moist all the time.

Capillary mat systems are often used for small containers and crops that must be kept uniformly moist. Some growers find capillary mats useful with plug trays that are irrigated by hand or with sprinklers. They find the capillary mat provides more uniform irrigation. Capillary mats can also be used with larger, spaced containers irrigated from overhead sprinklers. In this case, the mat can catch the water that falls between containers, improving both efficiency and uniformity.

Flood And Drain

Flood and drain irrigation systems, such as ebb and flow trays, flood floors and troughs, deliver water directly to containers by



Drip tape is widely used for irrigation of cut flower crops in soil beds.

flowing water around the base. Subirrigation systems are not capable of pulsed irrigation. Rather, the system is turned on just long enough for the growing medium to rewet to the desired level. The irrigation cycle is timed depending on the area being irrigated, the height of the water table and the contact time required to obtain thorough irrigation. This may range from less than 10 minutes total contact for a system that fills and drains rapidly to more than 30 minutes for a slower system.

Trays are generally capable of faster cycles than floors, although flood floor systems are being developed to provide faster flood and drain. Trays are flat and the bottoms are configured with channels so the tray fills and drains uniformly and every container has the same contact time and water table height. Trays are suitable for both pots and flats.

Floors have to be pitched slightly upward from center to edge for drainage and usually fill up from and drain back to the center, so containers in the center of the floor have both longer contact time and a slightly higher water table than those at the edge. This makes it difficult to obtain uniform irrigation with small containers.

In trough systems, the trough is pitched slightly from the inlet to the outlet end so water will flow by gravity. The water table is very shallow, so relatively long contact times are required for thorough irrigation. However, trough systems require lower volume than trays or floors because the water table is shallower and the flooded area is smaller. Trough systems are usually used for potted plants, because the troughs can efficiently accommodate only a narrow range of container sizes.

Combining Systems

Many growers find it useful to have more than one type of irrigation system. A boom system above a flood floor is one example. Although costly to install, the two systems complement each other in delivering water effectively and efficiently to crops in different stages of development. Many operations use drip tube systems for hanging baskets and large containers, while trays or troughs are used for conventional smaller containers.

Growers have many alternatives for irrigation systems. Choosing among these alterna-

tives requires careful consideration of the capabilities of each system, the intended use, and installation and operating costs. **GPN**

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