C-Irrig Concepts

Container nurseries irrigate in order to resupply water loss through evapotranspiration (ET), the combined processes of plant transpiration and substrate evaporation. If a sprinkler irrigation system is used, we need to also consider the plant's irrigation capturing ability. The C-Irrigation Tool, or C-Irrig, estimates the amount of water lost through ET and adjusts irrigation rates according to the plant's irrigation capturing ability and rain. We have the best opportunity to apply water efficiently in the nursery if we consider all of these factors in making irrigation decisions. These and a few 'adjustment' considerations are discussed briefly below.

3 Factors Used to Determine Irrigation Requirement

Evapotranspiration (ET) is the amount of water lost due to plant transpiration and substrate evaporation and represents the amount of water that needs to be resupplied through irrigation (or rain). ET is affected by weather and thus changes daily. ET is calculated on a 24-hr period.

Capture Factor (CF) is a measure of the plant canopy's capacity to channel irrigation water into the container that would otherwise fall between containers. As a plant's CF increases, irrigation rates can be reduced proportionately. CF is affected by plant species, plant size, and container spacing.

Rain has the potential to reduce or eliminate irrigation on any given day. C-Irrig determines when the rain fell and calculates its contribution in reducing the water deficit in the container substrate.

Evapotranspiration (ET)

Evapotranspiration is water evaporated from leaf (transpiration) and substrate (evaporation) surfaces. The potential rate of ET is primarily affected by weather (solar radiation and temperature). The actual rate of ET is affected by plant cover (leaf area), container size and container spacing. Assuming water is not limiting, actual ET is less than potential ET when plant cover does not intercept all incoming radiation. A plant's leaf area index (LAI) is a measure of the plant canopy's capacity to intercept incoming solar radiation. LAI is the ratio of leaf area to ground area. As LAI increases, a greater percentage of incoming solar radiation is absorbed resulting in higher plant transpiration but lower substrate evaporation. Once an LAI of 3 (think of 3 layers of leaves over the ground) is reached, essentially all of the incoming solar radiation is captured by typical plant canopies and actual ET approaches potential ET. Because the determination of LAI is a difficult and time-consuming process, C-Irrig uses percent canopy cover to estimate light interception for ET calculations.

Fig. 1. Spirea plants (left) only partially covering the production area exhibit lower ET values than azalea plants (right) with high percent canopy cover and high ET rates.

Evapotranspiration is typically calculated as depth of water (inch) lost over the production area. Unlike field-grown plants with wide root distribution, container-grown plants are limited to receiving irrigation through the container top area. The end result is that ET (inch) is multiplied by the ratio of total area allotted each container to the top area of the container in order to calculate an equivalent container ET rate (inch/container). Container ET is directly related to the depth of irrigation required.

$$\textbf{Container ET (inch/container)} = \text{ET (inch)} \times \frac{\text{total area alloted container (in}^2\text{)}}{\text{container top area (in}^2\text{)}}$$

Example

ET = 0.2 inch

Total area allotted each container = 150 in^2

Container top area = 75 in^2

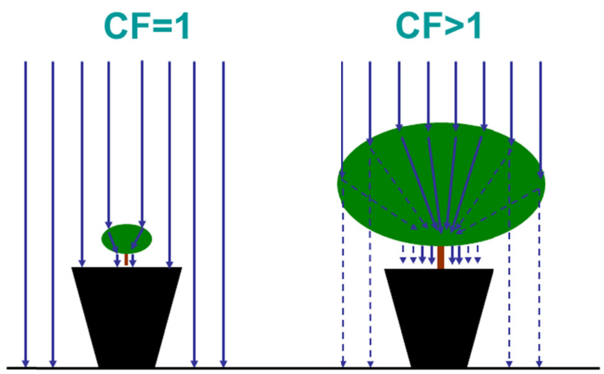
Container ET = 0.4 inch/container

This means you would need to apply 0.4 inch of irrigation water to the container to apply the equivalent of 0.2 inch of ET were the plant grown in the ground.

Irrigation capture factor (CF)

We need to consider the ability of plant canopy to affect the amount of irrigation water that enters the container. The capture factor is the ratio of water entering the container with a plant in it compared to the amount of water that would enter the same container without a plant. CF values >1 indicate the plant is channeling water into the container that would otherwise have fallen un-captured between containers. Conversely, CF<1 indicates that the plant canopy is channeling water away from the container and irrigation rates would need to be increased according. As an example, a CF=2 indicates that twice as much water will enter the container than indicated by irrigation depth alone and thus one-half as much irrigation water needs to be applied. In general, plant species with tall, upright-spreading growth habit exhibit greater CF values then low, broad-spreading growth habits. As you might expect, CF values typically increase as plant size increases. C-Irrig estimates CF based upon plant species, plant size, container diameter and container spacing

Capture factor (CF) describes a plant's capacity to channel water into the container that would otherwise fall between containers. CF is related to canopy size, plant species, and container size and spacing.



Rain

We need to consider not only the amount of rain but also the time of day the rain fell in order to determine if the rain was effective in reducing the water deficit in the substrate. Rain falling after irrigation but before significant ET will not be effective, while rain falling at the end of the day after significant ET will. C-Irrigation accounts for rain by doing an hourly balance between ET (loss) and rain (gain), taking into account CF. Because ET is calculated on a 24-hr basis, we partition total daily ET into 24 hourly amounts based on the proportion of solar radiation observed for each hour of the 24-hour period. If rain occurs, C-Irrig calculates and outputs the percent of the rain that effectively reduced irrigation.

Other adjustments to consider

Irrigation uniformity (DU) The uniformity of irrigation water distribution within the irrigation zone can be measured by placing irrigation collection cups (approx. 30 cups per 1000 sq ft) through the zone and measuring the volume of water collected after an irrigation event. The distribution uniformity (DU) is calculated as the average of the 25% lowest cup volumes divided by the overall average cup volume. It is desirable that DU is >80%. C-Irrig assumes 100% uniformity so that if DU = 80%,for example, some containers will be getting more and some will be getting less than indicated by the application rate (inch/hour) alone. C-Irrig allows the user to increase irrigation amounts so that these low areas receive the recommended amount of irrigation. Of course, this means the certain areas will be receiving more than indicated.

Leaching fraction (LF) C-Irrig estimates the amount of irrigation needed to resupply water loss during the past day. If no leaching occurs, fertilizer salts can increase to undesirable levels in the substrate over time. For this reason, many growers use a target LF of 10-15%. The user can input the desired LF for each zone and C-Irrig will adjust irrigation rates accordingly.