Leaching Fraction Testing

Fig. 1. Routine leaching fraction tests can help growers monitor and adjust irrigation rates to maximize water use efficiency in container nurseries.

Scheduling irrigation in container nurseries can be a daunting task for producers. The finite rooting volume imposed by the container provides little buffer against under- or over-watering. The leaching fraction (LF) test described in this publication is a valuable tool for monitoring the effectiveness of the irrigation program, and when performed routinely, can be used to schedule irrigation efficiently. We will describe how to perform the test, give example calculations, and provide some suggestions on how to utilize LF testing when managing irrigation. LF tests can be used to monitor ET Zone Type irrigation efficiency or can be directly used to guide LF Zone Type irrigation.

Irrigation Fraction (LF) is the volume of leachate (container drainage) collected during an irrigation event relative to the volume of irrigation water entering the container (water retained plus leachate). When performed routinely, adjustments to irrigation can be made to maintain low LF values (e.g. <15%).

Measuring LF and Manually Adjusting Irrigation

The measurement of LF during an irrigation event requires the measurement of two separate components: (1) the amount of leachate and (2) the amount of water applied to the container substrate. The following assumes the same units of measurement for both components:

$$LF\ (\%) = \frac{Amount\ of\ leachate}{Amount\ of\ water\ applied\ to\ container} \times 100\%$$

For low-volume, micro-irrigation systems (e.g. spray stakes) the amount of water entering the container is not affected by the plant canopy and can be determined by directly collecting output from an emitter. For sprinkler irrigation, on the other hand, the amount of water entering the container substrate is affected by the plant canopy so collecting irrigation water in an empty container will not always give a true value. For sprinkler irrigation, amount of leachate and amount of water applied to the container can be easily determined by weighing with an appropriate scale.

Once LF is determined, adjustments to the irrigation run time can be made with the following formula:

$$Adjusted\ run\ time\ (minutes) = \frac{(100\% - measured\ LF\%)}{(100\% - desired\ LF\%)} \times\ run\ time\ (minutes)$$

Step-by-Step Procedures

A. Sprinkler irrigation

1. Select and label representative containers
2. Place each container in a pail to collect leachate. The container should fit in the pail leaving head-room for drainage to be collected without reabsorption. The collector should not elevate the plant container so high that its capture of irrigation water will be greatly affected.
3. Weigh the container and pail together and record the pre-irrigation weight to the nearest 0.01 kg.
4. Put containers back in the production area in their normal arrangement and irrigate normally. Record the irrigation run time in minutes.
5. After irrigation and drainage, reweigh the container and pail and record the post-irrigation weight to nearest 0.01 kg.
6. Remove the container from the pail and determine the amount of leachate to nearest 0.01 kg.

Fig. 2. Sprinkler-irrigated plants are placed inside a pail to collect leachate (drainage) during LF testing.

B. Micro-irrigation

1. Select and label representative containers.
2. Place each container on a 17” aluminum pizza pan raised above the ground on sections of 4 inch x 4 inch lumber **(Fig. 3)**. A drainage hole in the pizza pan allows drainage to be collected in a pan underneath. This setup can be left in the field for routine LF testing.
3. To determine the amount of water applied during the LF test, collect water from an adjacent emitter placed in a 4-gal pail. A notch in the rim of the pail allows the emitter tubing not to crimp with the lid of the pail on. After irrigation, determine volume of water collected in the pail to the nearest 0.01 kg.
4. After allowing time for drainage (30-60 minutes), measure the volume of leachate collected in the pan by weighing to the nearest 0.01 kg.

Note for cyclic irrigation When irrigation entails two or more cycles (or pulses), you can collect leachate and emitter output and sum over all cycles as long as you minimize evaporation between cycles. A piece of plywood can be used to keep the pan from blowing away and to prevent evaporation.

Fig. 3. Micro-irrigated plants can be placed on an aluminum pizza pan raised off the ground with pieces of 4”x4” lumber. A drain hole punched out of the pizza pan allows leachate to drain into an aluminum pan for easy measurement. An emitter from an adjacent container is placed in a 4-gallon pail to determine the irrigation amount applied. This setup can remain in the field to facilitate routine testing. A plywood cover can be placed over the pan when collecting leachate over multiple irrigation cycles.

Step-by-Step Calculations

A. Sprinkler System

Example Data

Pre-irrigation weight = 6.34 kg

Post-irrigation weight = 7.16 kg

Leachate weight = 0.32 kg

Irrigation run time = 50 minutes

Calculate LF

1) Amount of water entering the container substrate = 7.16 - 6.34 = 0.82 kg

2) LF% = amount of leachate ÷ amount of water entering the substrate X 100%

= 0.32 kg ÷ 0.82 kg X 100% = 39%

Calculate adjustment in irrigation to achieve target LF of 15%

a) Adjusted irrigation time = (100-measured LF) ÷ (100-desired LF) x irrigation time
= (100-39) ÷ (100-15) x 50 minutes = 0.72 x 50 min = 36 minutes

Conclusion

Adjusting the irrigation run time from 50 minutes to 36 minutes will reduce LF from 39% to 15% under similar environmental conditions. If using LF zone type in CIRRIG, LF test results would be input and CIRRIG would calculate the adjustment to irrigation needed.

B. Micro-Irrigation System

Data

Irrigation water applied by adjacent emitter = 4.24 kg
Leachate = 1.35 kg
Irrigation run time = 8 minutes

Calculate LF

LF = leachate (kg) ÷ water applied (kg) X 100%
= 1.35 ÷ 4.24 X 100% = 32**%**

Calculate adjustment in irrigation to achieve target LF of 20%

a) adjusted irrigation time = (100%-measured LF%) ÷ (100%-target LF%) x irrigation time
= (100-32) ÷ (100-20) x 8 min = 0.847 x 8 min = 6.8 min

Conclusion

Adjusting the irrigation run time from 8 minutes to 6.8 minutes will reduce LF from 32% to 20% under similar environmental conditions. If using LF zone type in CIRRIG, LF test results would be input and CIRRIG would calculate the adjustment to irrigation needed.

Using LF in an irrigation program

LF testing can be used in several ways to help guide irrigation scheduling. It is important to note that any given LF test is only a 'snap-shot' of irrigation efficiency and, like most tests, methods used and results obtained are only useful when considered in light of other variables that come into play. For example, plant selection for LF tests is critical as plant size and plant position (e.g. border plants) can affect water loss and thus pre-irrigation water status. Also, plant selection should consider location because application of water may not be uniform throughout the irrigation zone. With that in mind, here are a few suggestions on using LF tests.

1) **Select 3-5 containers per irrigation zone.** The more plants selected, the better the results and interpretations will be.
2) **Select plants that represent the range of conditions expected.** For example, include an average plant, a border plant, a larger-size plant, and a plant in an area known or suspected of having a lower irrigation application rate. By selecting plants for LF tests that represent a range of conditions in the irrigation zone, you will learn a great deal about the variability that exists and can make better decisions regarding irrigation rates that would be most efficient for a given irrigation area.
3) **Conduct LF tests following days where water loss is typical for that period of time**. Conducting LF tests following a cloudy day when ET was low may result in high LF values that are not representative of a typical sunny or partly sunny day when ET is higher. That being said, information from LF tests made on low versus high ET days does provide valuable information on day-to-day adjustments that could be made based on weather.
4) **Establish a routine for periodically retesting LF during the season (e.g. once every 2-4 weeks) as plants grow and weather changes.** Other times to retest LF are after significant pruning or when plants are respaced.
5) **Keep records** of LF testing and irrigation rate adjustments along with plant species, size, spacing, etc. as this information can help direct future irrigation scheduling. Records also document the nursery’s use of an irrigation BMP.
6) **Ensure high LF values are not due to poor retention of water by the substrate**. A typical example is poor lateral movement of drip irrigation water resulting in disproportional drainage. High LF values can also be due to the development of water-repelling (hydrophobic) properties in the substrate.
7) **Train and monitor staff** on the proper procedures to follow and instill the importance of their work on irrigation scheduling, and therefore, profitability and sustainability of the nursery.