Monitoring irrigation efficiency

Monitoring irrigation efficiency is an important component of practicing ET-based irrigation with C-Irrig. A leaching fraction test (LF) is a simple procedure that provides a snapshot of how efficient the irrigation was on a given day. LF is the amount of leachate collected out of the bottom of the container relative to the total amount of irrigation water entering the container and can be determined by weighing before and after irrigation. It is desirable for LF<15%. If the LF was found to be >15%, then C-Irrig was overestimating the irrigation requirement and further investigations are needed to determine whether it was from overestimating ET or underestimating CF, the two components in the irrigation recommendation (see Concepts). If no leachate was collected during LF testing, then a determination needs to be made to the severity of the underestimation. The insufficiency can be determined by the calculating the difference between the weight of the container after irrigation and the weight of the container when it is well-watered (container capacity). Below is a description of the LF test and how to measure ET and CF for troubleshooting inaccurate C-Irrig output.

Equipment needed for LF, ET and CF testing: portable bench scale with range of 0-30 kg and a precision of at least 0.01 kg handles most situations. Approx. cost: $400-600.

Fig.1. A portable bench scale is needed to weigh containers in the nursery for determining water loss and gain for LF, ET and CF measurements. Weight change relates directly to volume of water: 1 kg water = 1000 cm^3 and 1 g water = 1 cm^3.

Leaching Fraction (LF) Procedure

1. Select and label representative containers.
2. Place each container in a similar empty pot lined with plastic bag to collect leachate. It is important that irrigation water only enter the bag if it goes into the planted container first. Getting the container manufacturer to provide you with hole-less versions of your containers will simplify the procedure by eliminating the need for bags.
3. Weigh the container assembly with plastic bag prior to irrigation (record dry weight).
4. Put containers back in production area in normal arrangement
5. After irrigation but before significant ET has occurred, weigh the container assembly with plastic bag and record wet weight.
6. Remove the plant, reweigh and record weight with leachate
7. Empty leachate, re-weigh and record weight without leachate
8. An alternative to steps 6&7 is to pour out leachate and determine volume with a graduated cylinder or by weighing on a 1-gram scale (1 g=1 cm^3)

Calculations:

a) Irrigation water captured (cm^3) = [wet weight (kg) – dry weight (kg)]*1000 cm^3/kg

b) Leachate volume (cm^3) = [weight with leachate (kg) –weight without leachate (kg)]*1000 cm^3/kg

c) LF = leachate volume (cm^3)/total water captured (cm^3)

Example LF calculations

Data dry weight = 10.60 kg
wet weight =11.60 kg
weight with leachate = 0.35 kg
weight without leachate = 0.15 kg

Calculations

a) irrigation captured (cm^3) = [11.60 - 10.60 kg/container]*1000 cm^3/kg = 1000 cm^3

b) leachate volume (cm^3) = [0.35 – 0.15 kg/container]*1000 cm^3/kg = 200 cm^3

c) LF = 200/1050 = **19%**

Procedures for Measuring Container ET

1. Select and label representative containers.
2. Weigh containers early at dawn after irrigation but before appreciable water loss has occurred (record wet weight). It is important that containers are well-watered in the morning so that ET during the day is not limited.

3. Put containers back in production area in normal arrangement for the rest of the day.
4. At dusk reweigh same containers (record dry weight).
5. Container ET is equal to the weight loss during the day. Because the density of water is 1 g/cm^3 metric units are used to convert weight to volume of water.

Calculations

a. Container top area (cm^2) = πr^2 = 3.14159 *[container diameter (cm)/2]^2
b. Container ET (cm^3) = [wet weight (kg) – dry weight (kg)]*1000 (cm^3/kg)
c. Container ET (cm) = container ET (cm^3)/container top area (cm^2)

Example ET Calculations

Data wet weight = 11.45 kg/container
dry weight = 10.30 kg/container
container diameter = 11 inch = 28 cm

Calculations

a. Container top area (cm^2) = πr^2 = 3.14159*(28/2)^2=616
b. Container ET (cm^3) = (11.45-10.30 kg)*1000 (cm^3/kg)=1150
c. Container ET (cm) = 1150/616=1.87 cm = **0.73 inch**

Fig. 2. Irrigation cups are placed above the canopy in the vicinity of test plants to determine irrigation rate applied during CF testing.

Procedures for Determining CF

1. Follow the same steps as for LF plus the following
2. Place cups to capture irrigation in the vicinity of test containers (Fig. 2).

3. After irrigation measure the volume of water in each irrigation cup (cm^3)

Calculations

a) irrigation cup area (cm^2) = πr^2

b) depth of irrigation (cm) = volume collected (cm^3)/cup area (cm^2)

c) area of container (cm^2) = πr^2

d) irrigation water captured (cm^3) = [wet weight (kg) – dry weight (kg)]*1000 cm^3/kg

e) depth of irrigation captured (cm)=irrigation captured (cm^3)/container area (cm^2)

f) CF = depth of irrigation captured (cm)/ depth of irrigation (cm)

Example CF calculations

Data dry weight = 10.60 kg/container

wet weight =11.60 kg

container diameter = 11 inch = 28 cm

irrigation cup diameter = 9 cm

average volume of water collected in irrigation cups = 94 cm^3

Calculate irrigation water applied

a) irrigation cup area (cm^2) = πr^2 = 3.14159 *[9 /2]^2= 63.6 cm^2

b) depth of irrigation (cm) = 84 cm^3/63.6 cm^2 = 1.32 cm

c) container top area = πr^2 = 3.14159 *[28 /2]^2= 616 cm^2

d) irrigation water captured (cm^3) = [11.60 - 10.60 kg/container]*1000 cm^3/kg = 1000 cm^3

e) depth of irrigation captured (cm) = 1000cm^3/616 cm^2 = 1.62 cm

f) CF = depth of irrigation captured/depth irrigation = 1.62 cm/1.32 cm = **1.23**