Measured Irrigation Scheduling

more crop per drop

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1. Soil moisture probe

The amount of water that your plants need will depend on many factors in addition to the weather. For example, as the plants grow and become bigger they will need more water. Plants growing in sandy soil will need more water than plants growing in heavy soil.

To take account of all these additional factors, you may need a soil moisture probe is to check the moisture level in the soil at various depths. A very simple soil moisture probe is a length of steel pipe with a long slot. I suggest that the diameter of the pipe be between 30 and 40 mm. An angle grinder can be used to cut a long slot in the steel pipe to that you can inspect the soil inside the pipe. I suggest that the width of the slot be about 15 mm. You can also use the angle grinder to sharpen the edge of the end of the soil moisture probe.

By checking the moisture level in the soil through the slot in the steel pipe, you can decide whether your plants have been irrigated with too much or not enough water. A control dripper may be used to adjust the water usage.

Hammer the steel pipe into the soil near a dripper so that the slot faces the dripper. Remove the steel pipe from the soil and use the slot to inspect the moisture level in the soil and the position of the wetting front. You may wish to use the slot to remove some soil from the pipe and to squeeze the sample between your fingers.

An angle grinder can be used to make a long slot in a length of steel pipe

Hammer the steel pipe into the soil near a dripper so that the slot faces the dripper.

Remove the steel pipe from the soil and use the slot to inspect the moisture level in the soil and the position of the wetting front.

2. Introduction to root zone scheduling

Irrigation scheduling should take account of the soil type and the depth of the root zone.

For plants with deep roots or for plants in clay soils, it is preferable to irrigate with more water less frequently to enable the water to reach the bottom of the root zone. Between irrigation events the soil near the surface is allowed to dry out, but there should still be moisture in the root zone. Root zone scheduling takes account of evapotranspiration, the soil type and the depth of the root zone.

There are two ways to implement root zone scheduling. The first way is to use an adjustable dripper as the control dripper (see Section 3). The second way is to use one or more irrigation drippers as the control dripper and to select an evaporator with an appropriate surface area (see Section 4).

Root zone scheduling can be applied to sprinkler irrigation as well as drip irrigation.

3. Root zone scheduling using an adjustable dripper

The following steps can be applied to any irrigation zone, regardless of the size of the zone.

Step 1. How much water is needed?

Allow the soil to dry out over several days until the soil is dry between the surface and the bottom of the root zone (use the soil moisture probe).

Place a measuring container under one of the drippers to collect the water and start irrigating just before sunset. For sprinkler irrigation, place a measuring container under a non pressure compensating dripper that has been added to the irrigation zone. For porous hose irrigation, connect a small length of porous hose to the irrigation system so that the discharge from the small length of porous hose enters a measuring container.

While irrigating, check the moisture level in the soil by hammering the soil moisture probe into the soil near a dripper. Stop irrigating when the position of the wetting front is near the bottom of the root zone (or when the wetting front has reached the desired level).

The volume of water in the measuring container is called the **dripper control volume** and it is the amount of water that each dripper should deliver during the irrigation event to moisten the soil from the surface to the bottom of the root zone.

By following this procedure, the volume of water that each dripper discharges during the irrigation event can be adjusted to match the dripper control volume. Alternatively, your knowledge of your plants requirements at their current stage of growth can be used to adjust the volume the volume of water that each dripper discharges during the irrigation event.

Place a measuring container under one of the irrigation drippers

Dripper control volume for root zone scheduling

Step 2. How much evaporation is required between irrigation events?

You need to estimate the evaporation in mm before the soil is dry between the surface and the bottom of the root zone.

Position any container with vertical sides at a suitable location so that the evaporation from the container matches the evaporation near your plants. Fill the container with water and weigh it at sunset.

Reweigh the container to determine the volume of water that has evaporated

At sunset each day, check the moisture in the soil until the soil is dry between the surface and the bottom of the root zone. If you wish to water your plants more frequently, you could wait until the soil is dry between the surface and the middle of the root zone.

Reweigh the container to determine the volume of water that has evaporated. The number of mm that has evaporated is the volume of water divided by the surface area of the container. This is called the **root zone evaporation** and it is the evaporation required to dry out the soil from the surface to the bottom of the root zone.

For manual measured irrigation, mark a low level on the inside of the evaporator so that the gap between the high level and the low level is equal to the root zone evaporation. For the Unpowered Irrigation Controller, make adjustments to the float so that the net evaporation between irrigation events corresponds to the root zone evaporation

Step 3. Run the irrigation

Empty the measuring container and place it below the same dripper used in Step 1. Adjust the control dripper so that the flow rate is roughly the same as the flow rate of the dripper used in Step 1.

For manual measured irrigation, adjust the water level in the evaporator at sunset until it is at the low level and start irrigating. For the Unpowered Irrigation Controller, the irrigation starts automatically when the water level reaches the low level.

For manual measured irrigation, stop irrigating (turn off the water supply) when the water level in the evaporator reaches the high level. For the Unpowered Irrigation Controller, the irrigation stops automatically when the water level reaches the high level.

Step 4. Adjusting the control dripper

Check the volume of water in the measuring container at the end of the irrigation event. If the volume in the measuring container is less than the dripper control volume, then the wetting front is unlikely to have reached the bottom of the root zone. So reduce the flow rate of the control dripper (to increase the duration of the irrigation event) in preparation for the next irrigation. If the volume in the measuring container is more than the dripper control volume, then the wetting front is probably below the bottom of the root zone. So increase the flow rate of the control dripper (to decrease the duration of the irrigation event) in preparation for the next irrigation.

Check the volume of water in the measuring container.

Adjusting the control dripper

Repeat Steps 3 and 4 until the volume of water in the measuring container matches the dripper control volume. It is preferable that the above steps are done in a period when there is no rain.

4. Root zone scheduling using an evaporator with an appropriate surface area

The following steps can be applied to any irrigation zone, regardless of the size of the zone.

Step 1. How much water is needed (see Step 1 in Section 3)

Step 2. How much evaporation is required between irrigation events (See Step 2 in Section 3)

Step 3. How to choose a suitable evaporator

You need to choose an evaporator with an appropriate surface area so that the dripper control volume is delivered during the irrigation event. Calculate the **reference surface area** by dividing the dripper control volume by the root zone evaporation. Then choose an evaporator with vertical sides so that the surface area is an integral multiple ***m*** of the reference surface area. It is preferable that the surface area be at least 0.05 $m^{2.}$

Step 4. How to set-up the evaporator

Position the evaporator at a suitable location so that the evaporation matches the evaporation near your plants. Mark a high level on the inside of the evaporator about 1.5 cm below the overflow level, and mark a low level so that the gap between the high level and the low level is the same as the root zone evaporation.

Position ***m*** drippers so that they will drip water into the evaporator during the irrigation event. The drippers should be identical to the dripper used in Step 1.

For example, if the surface area of the evaporator is twice the reference surface area (*m* = 2), then two drippers should be positioned over the evaporator.

Step 5. How to use the evaporator

At sunset, fill the evaporator with water until the water level is at the low level and start irrigating.

Stop irrigating when the water level reaches the high level.

Check the water level at sunset each day, and start irrigating again when the water level has fallen below the low level.

As your crop grows and the water requirement of the crop changes, you may wish to repeat the process of root zone scheduling.

Most weather-based irrigation controllers use data from a weather station to control the irrigation scheduling. Root zone scheduling responds to the prevailing weather conditions in your garden rather than the weather at a weather station. For example, it responds to the actual evapotranspiration of your plants, rather than the theoretical evapotranspiration at a weather station. This is particularly important if you are using a greenhouse.