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Irrigation Notes

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Micro-Irrigation Scheduling and Management

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The two distinct features which characterize micro-irrigation are high irrigation frequency and localized water application to only part of the crop's potential rootzone. These two factors underscore the basic difference between micro-irrigation and conventional irrigation methods.

Research indicates there is a minimum level of available soil moisture required for plants to maintain growth potential. Well managed micro-irrigation systems should be capable of maintaining a level above this threshold. However, over-irrigation should be avoided. Saturated or nearly saturated soils can injure a plant, causing inadequate root aeration or promoting root rot.

ROOT DEVELOPMENT

The root system of micro-irrigated plants is often thought to be confined to the zone wetted by the irrigation system. In reality, perennial plants growing in areas of appreciable rainfall develop roots throughout the soil volume of a normal rootzone. Once the soil outside the irrigated zone is fully depleted of available water, the root system essentially goes dormant in the dry soil. However, the root system remains ready to resume activity once the soil is rewetted. Thus, only in areas of marginal rainfall is the root system largely confined to the irrigated zone. It is in the irrigated zone where root density is the highest and water extraction capability the greatest.

Monitoring soil moisture and proper scheduling are two keys to an effective irrigation program.

Water is applied to satisfy the crop's requirements. Water losses from the cropped area into the atmosphere come from two sources: evaporation from the soil (E) and transpiration from the plant surface (T). The combination of these two is commonly referred to as evapotranspiration (ET).

UNDERSTANDING ET

The ET value is equivalent to the crop's water requirement in the field. Additional applied water may move beyond the reach of the crop's roots as deep percolation losses. However, this leaching may be necessary where salinity is a concern.

With micro-irrigation, the applied water (AW) is either used in the ET process, lost as deep percolation, or stored in the rootzone (this assumes runoff is not a problem, which is usually the case). If the water content in the rootzone is kept fairly constant under high frequency irrigation, and deep percolation losses are minimized by monitoring the soil water status at the bottom of the rootzone, a grower can apply water to match the approximate ET. Thus, knowledge of ET is essential for the most efficient irrigation scheduling.

Reference daily evapotranspiration (ETp or ETo) values can be obtained from consultants, local media, or governmental agencies. This ET value is an accurate estimate of water used by a reference crop (alfalfa or grass) in a 24-hour period.

Once you have obtained the daily evapotranspiration (ETo) rate, you need to adjust this value for your own orchard situation, i.e. cover crop, age of planting, and plant size. This value is commonly referred to as the crop factor or crop coefficient (Kc). The Kc value changes during the course of the year and should be available through your local farm advisor's office. For established orchards this value ranges from 0.7 to 1.

To determine the actual daily water requirements (ETc) for a mature orchard, we need to multiply the ETo by the appropriate Kc factor (e.g., 0.27 in/day (ETo) x 0.9 (Kc) = 0.24 in/day (ETc). Once the daily ETc has been estimated the amount of water required can be translated into gallons per tree (GTD) by the following formula.

GTD = ETc x L x W x 0.623

ETc is the crop ET rate in inches per day; L is the length between trees in feet; W is the width between trees in feet; and 0.623 is a conversion factor from inches to gallons.

Using our estimated ETc of 0.24 inch/day, and assuming a tree spacing of 15 feet by 20 feet, we have GTD = 0.24 inch/day (ETc) x 15 feet (L) x 20 feet (W) x 0.623 = a daily requirement of 45.4 gallons per tree. For a young orchard this value would have to be adjusted downward as we are assuming mature trees with full coverage. When salinity is a problem, you may need to allow for a leaching fraction (LF). The LF depends on the plant's salt tolerance and the salinity (EC) of the soil and water. Further adjustments are necessary for the potential application efficiency (PAE) of the irrigation system. This can range from 60% to 95%, depending on the type of irrigation system installed, how well the underground pipe network is designed, and how well the system is maintained.

For this example we will assume no LF, but a PAE of 85%. To calculate the total water required daily (adjusted GTD) for each tree, use the following.

$$\text{Adjusted GTD} = \frac{45.4\ (\text{GTD})}{0.85\ (\text{PAE})}$$

In this example, adjusted GTD is equal to 53.4

Now, if we multiply the adjusted GTD by the number of trees (e.g., 1,000) it will give us the total daily system demand in gallons (53,400 gal/day). If we divide the 53,400 by the flow rate (i.e. 95 gpm), we get the required daily system operation time of 562 minutes or 9.4 hours.

SOIL MOISTURE MONITORING

The measurement of soil moisture is an important aspect of irrigation scheduling. This measurement verifies that the proper amount of water is being applied. Here are a few common methods used for soil moisture measurement.

Soil feel test. A shovel, soil auger, or push tube can be used to obtain soil samples. Samples should be taken from a depth of 8 to 9 inches to the bottom of the effective rootzone. Squeeze the soil between the thumb and index finger to form a ribbon. Soil type and the grower's experience will indicate the relative amount of moisture in the soil.

Tensiometers. Tensiometers give a direct reading of the soil moisture tension existing in the rootzone. These instruments should be placed in strategic locations within the plant root- and wetted zone. Depending on the plant's maximum rooting depth and soil type, more than one tensiometer may be required per site. For example, one might be placed at a depth of 12 inches and another at a depth of 30 inches. These should be located just at the inner edge of the normal wetted area.

Tensiometers require frequent supervision and must be correctly installed and serviced in order to obtain reliable results. Some growers feel that graphing daily readings is a good way to track moisture status. Generally, for optimum results the tensiometers should read in the 10 to 30 centibar range.

Electrical resistance blocks. These instruments measure available soil moisture percentage. A calibration curve is required to determine the soil moisture percentage based on soil type and ohm resistance. Electrical resistance blocks should be installed at locations similar to those discussed for tensiometers.

In a field watered via micro-irrigation, the main objective of soil moisture monitoring is not to determine the moisture content of the soil. This can become too difficult because of the spatial variability of moisture content. Rather, use of soil moisture monitoring equipment is primarily to evaluate the size of the wetted area and secondarily to determine the moisture content within the wetted area.

Regardless of the device chosen to monitor the wetted zone-soil feel test, tensiometers, electrical resistance blocks, or others-the principle is the same. If the wetted area is expanding, the system is applying more water than the crop is using. If the wetted area is contracting, the crop is using more water than the system is applying. By monitoring the wetted area frequently, adjustments can be made and the system operation fine tuned.

TEST SYSTEM

Finally, the first irrigation should be run early enough in the season to allow for repairs and system maintenance. Each spring, the system should be thoroughly flushed out, including mainlines, laterals, drip lines, and filter stations. In the first irrigation, the system should be operated long enough to fill the soil profile. Subsequent irrigations should be scheduled to maintain this wetted profile throughout the growing season.

The scheduling of irrigations should be updated regularly. Many micro-irrigation systems are operated daily. During periods of sufficient rainfall, the plants may not require an irrigation. However, if salinity is a problem, it may be critical to run the system during rainy periods to prevent salts which accumulate at the edge of the normal wetted zone from being pushed back into the rootzone. We suggest that you contact your local farm advisor or irrigation dealer on specific problems in your area.

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