IRRIGATION FOR PEACHES
Irrigation Scheduling

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In the southeastern United States, peach yields and tree growth respond very favorably to irrigation. Daniell in 1982 and Chesness and Couvillon in 1989 showed yield increases of 29% to 54% with drip irrigation of peach in Georgia, while year-to-year yield variation decreased by up to 35% using irrigation rates of 6 to 11 inches per season. Numerous other peach irrigation studies have shown similar results.

Irrigation scheduling is an important aspect of peach orchard management and attempts to answer two management questions - *when* to irrigate and *how much* to apply. In peach, optimal productivity is experienced with rain or irrigation at intervals of no longer than one week. During peak water use periods, individual peach trees consume 36-45 gallons per tree per day. On a weekly basis, this is 252-315 gallons per tree; at a tree spacing of 16 ft. x 20 ft. (136 trees/acre) this comes to 34,272 to 42,840 gallons of water per acre of orchard. One acre-inch of water equals approximately 27,000 gallons. Therefore, actual water consumption for one acre of peach trees during peak water usage is between 1.3 and 1.6 acre-inches of water per week.

Assessing Moisture Needs

Optimal use of irrigation enhances yield and tree performance by closely approximating tree needs without overwatering. The objective is to apply just enough water to provide for optimal yield and tree health. It is important to know how droughty soils become before trees experience stress. Irrigation scheduling relies on measuring the soil water status and/or the tree's moisture utilization and needs. Table 1 lists instruments and techniques used to assess these parameters, along with the pros and cons of each.

Table 1. Orchard irrigation scheduling methods and their characteristics.

Method	Principle	Advantages	Disadvantages
Tensiometer	measures soil water tension directly	rapid, easy to use; inexpensive	sensitive to placement; requires frequent servicing; limited measurement range
TDR (time domain reflectometry)	estimates soil water from dielectric potential	accurate; requires no calibration	sensitive to placement; expensive
Porous blocks (gypsum)	estimates soil water from electrical resistance	rapid, easy to use; inexpensive	sensitive to placement; insensitive in critical range; requires calibration
Neutron probe	estimates soil water from neutron absorption	accurate	sensitive to placement; expensive ; requires calibration; radioactivity
Stem water potential	measures plant water potential directly	plant-based index; accurate; relatively simple	moderately expensive; time consuming
CWSI (crop water stress index)	measures leaf temperature; index of transpiration rate	plant-based index; rapid, easy to use	extensive calibration; moderately expensive; sensitive to placement, time of day, weather
Weather station-derived estimates	calculates potential evapotranspiration	accurate, validated, proven method;	requires crop coefficient

of water use	(PET) from weather data	requires no field measurements; internet-based; amenable to large acreage	

Soil moisture measurements estimate how much water trees have available to them. Variables such as soil type, slope, vegetation on the orchard floor, variety, tree age, and crop load make it complicated, even problematic, to rely solely on soil moisture status to schedule irrigation. Multiple instruments in representative sites within each block are needed. Instruments must be read frequently and records kept to facilitate efficient irrigation.

Direct measurement of tree water status is the conceptual alternative to measuring soil water status to schedule irrigation. Evaluating plant moisture utilization is also fraught with complexity. **Stem water potential** directly measures the water tension in the tree and gives an index of tree stress. As with soil water status measurements, stem water potential thresholds must be established and a number of trees must be sampled to obtain a meaningful average. **Crop water stress indexes (CWSI)** use infrared thermometry to measure leaf temperature; stressed leaves will be warmer than non-stressed leaves due to insufficient transpirational cooling. Repeated sampling of representative trees is necessary, and thresholds may change with weather conditions.

Crop moisture utilization models, initially developed in the 1990s, offer the promise of simplified irrigation scheduling and more effective water use. Moisture utilization models rely on weather monitoring and crop-specific potential evapotranspiration (PET) coefficients. PET estimates daily water utilization relative to a base or reference crop. Naturally, the actual water utilization for a peach orchard differs from the well-studied reference crop, but the southeastern peach PET crop coefficient customizes peach's moisture utilization relative to the reference species. The PET value is multiplied by the peach coefficient to estimate actual in-orchard water consumption. Actual water loss is what must be replaced through irrigation. Crop moisture utilization models have been validated for crops worldwide. For example, the California Avocado Growers Association has developed a website that calculates irrigation requirement based on a statewide weather monitoring network and a few simple inputs (http://www.avocado.org/static/growerres/cimiscalculator.php). In the avocado, the crop coefficient is 0.65. This means that a mature avocado orchard uses about 65% of daily water consumption in the reference crop. Accordingly, a PET of 0.22 inches per day in the reference crop indicates actual water lost in avocado would be 0.65 x 0.22 = 0.14 inches.

Southeastern Peach PET Moisture Utilization Model. A basic moisture utilization model has been developed for southeastern peaches. The interim scheduling model is available under "Irrigation" on the Georgia Peach website at http://www.griffin.peachnet.edu/caes/gapeach/. The University of Georgia's Automated Environmental Monitoring Network, a statewide weather-monitoring network accessible through its College of Agricultural and Environmental Sciences website, continuously records temperatures, rainfall, and potential PET for multiple sites in Georgia and adjacent states. It provides peach growers with the data necessary for irrigation scheduling.

Refinement of southeastern peach PET crop coefficients is ongoing, but the system provides reliable daily estimates of peach moisture utilization. Mature peaches have a standard range of crop coefficient values (0.4 to 1.0). These coefficients are multiplied times the reference crop’s daily PET. Peach’s crop coefficient varies with time of year and other factors. Base peach coefficients are reduced 10% to 35% when tree canopies cover less than 70% of the orchard surface, as with young trees that haven't filled their allotted space or in blocks with unusually wide spacing or high tree mortality. Coefficients are also reduced by 20% to 30% if the orchard floor is vegetation-free (cultivated or chemically mowed) versus a typical sod middle/herbicide strip system. Rieger and Taylor are researching crop coefficients to better guide irrigation of Georgia peach orchards.

In-Orchard Validation. Peach irrigation scheduling based on the region's PET moisture utilization model offers simplicity, accuracy, flexibility, and low cost. However, periodic "ground truth" determination of in-orchard soil moisture conditions remains important. Tensiometers and theta probes are the most practical instruments for cross-checking orchard irrigation efficiency by measurement of soil moisture. Pressure bombs provide direct assessment of tree status. When properly used, each of these instruments is a complementary tool to check and refine scheduling of orchard irrigation.

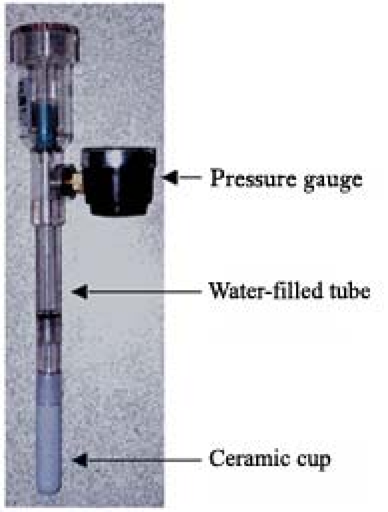

Figure 1. Tensiometer.

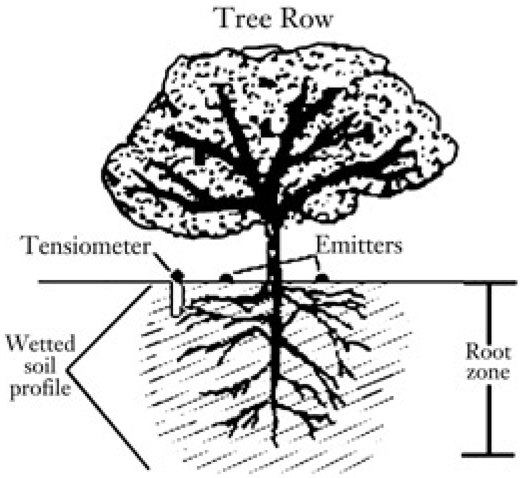

Figure 2. Tensiometer placement in the root zone.

Tensiometers are sealed, water-filled tubes with porous ceramic tips at the lower end and a vacuum gauge on the upper end (Figure 1). In peaches, two tensiometers should be installed with the ceramic tips placed in the root zone at depths of 8 and 12 inches (Figure 2). As the soil dries, water is drawn through the ceramic tip out of the tensiometer, creating a partial vacuum that is registered on the gauge in centibars (bars). The drier the soil, the greater the vacuum and the higher the reading. When the soil receives moisture through rainfall or irrigation, the action is reversed. The vacuum inside the tube is reduced as water moves back into the instrument, reducing the gauge reading. Table 2 provides interpretive guides for tensiometer use in peaches.

Table 2. Soil moisture status with accompanying tensiometer ranges. Guidelines to interpret tensiometer gauge readings.

Soil Moisture Status	Tensiometer Reading
Nearly saturated soil. May occur 1-2 days following rain or irrigation. Roots may suffer for lack of oxygen if readings in this range persist longer.	0-10 centibars
Field capacity. Irrigations discontinued in this range to prevent waste of water by percolation and leaching of nutrients below the root zone.	10-20 centibars
Irrigation range. Early stress for peach trees at 40-50 centibars. Trees should be irrigated.	20-60 centibars
In this range, the vacuum column will be broken in coarse soils. The tensiometer may need maintenance to reestablish the vacuum in the tensiometer tube.	> 70 centibars

Tree growth, yield, and fruit size are significantly increased when rain or supplemental irrigation keeps tensiometer readings (8-inch depth) below 50 centibars from April through harvest.

Preparation and service of tensiometers is very important. The ceramic tip should be in close contact with undisturbed soil and roots. Prepare the hole by driving a steel rod or pipe of the same diameter as the instrument tube to the desired depth. Carefully remove the rod and push the tensiometer to the bottom of the hole. Press the soil around the tensiometer at the surface and pile it slightly so water will not collect and seep down along the tube of the tensiometer. Another method for installing tensiometers with good results is to bore the hole with a soil auger (1-1/4 inches) to the desired depth. Next make a slurry in the bottom of the hole with screened soil, place the tensiometer, and backfill with screened soil, tamping the soil firmly around the tube with a 1/2-inch dowel.

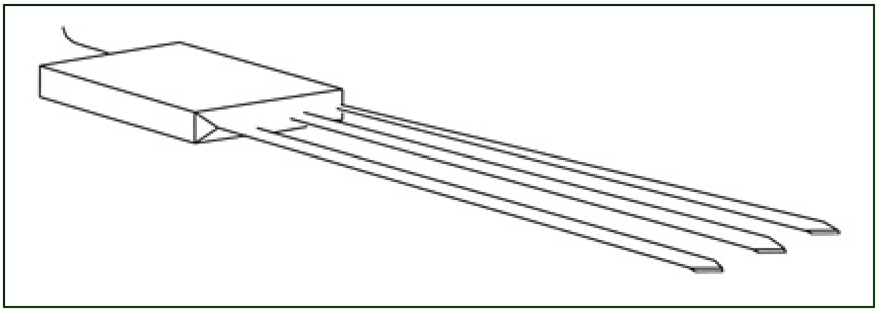

Figure 3. Dielectric potential probe.

Theta probes measure the dielectric potential across two probes in the soil relative to a reference probe (Figure 3). Dielectric potential is governed primarily by soil water content, and probes indicate the percent soil water on a volume basis. Although expensive, only a single unit is necessary compared to the purchase of at least two tensiometers per monitoring site. The unit probes three inches into root zone soil at depths of 8 to 12 inches. Readings are taken at representative locations in each block. Monitoring stations are constructed using PVC pipe placed into the root zone to depths of 8 and 12 inches. Soil within the pipes is excavated to these depths. The pipe remains capped until the probe is inserted three inches into the soil at each depth.

Stem pressure potential is an assessment of evapotranspiration. Stem pressure potential is an accurate, direct measurement that has been validated in *Prunus*, providing peach irrigation threshold values. Aside from time and expense, it is difficult to sample enough representative trees for a given orchard. Tree age, crop load, bearing status, and health should be considered when selecting which trees to evaluate.

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