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Texas Agricultural Extension Service

Texas Citrus Water Management

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Citrus, a perennial evergreen tree, requires available soil moisture throughout the year—generally a minimum of 50 inches of water annually. Because average annual rainfall in the Lower Rio Grande Valley ranges from 17 to 24 inches across the citrus-production area and rainfall distribution through the year is irregular, supplemental irrigation is essential for sustained economic citrus production.

Moreover, the irregular seasonal distribution patterns of rainfall frequently result in the need to apply more total irrigation water than merely the difference between natural rainfall and total annual water requirement. In irrigation scheduling, rainfall less than 0.25 inches is usually discounted. Moreover, rainfall exceeding that needed to replenish soil moisture to field capacity also is discounted, as the excess cannot be stored in the soil.

The amount and timing of irrigation applications are dependent upon tree age, soil type, weed management, climate and irrigation system. Mature trees require more water than young trees but young trees require more frequent irrigation because of limited root systems. Sandy soils have a lower water holding capacity than heavier soils, thus, requiring more frequent irrigation, preferably with less water per irrigation. Orchards cultivated for weed control require more water than those having chemical weed control, because of the use of water by weeds and the drying of surface soil from cultivation.

Applied water, whether by irrigation or rainfall, is used first to replenish the soil reservoir, assuming that the water soaks into the soil rather than runs off the field. Water in excess of that necessary to replenish available soil moisture percolates through the soil profile to the ground water table, carrying with it salts which have accumulated in the soil profile. A 3-inch rain may provide leaching of a fine sandy loam soil, but may not completely replenish the soil moisture of a sandy clay loam or a clay loam soil.

The available moisture in a soil is lost in two ways—use by plants for growth and transpiration and loss by evaporation from the soil surface. Climate directly and indirectly influences both evaporation and transpiration, primarily through temperature, but also through wind and relative humidity. The combined use and loss of available soil moisture, called evapotranspiration, determines the citrus orchard water requirement at any given time during the year.

Water Sources and Quality

The primary source of irrigation water for the Valley is the Rio Grande River, impounded in the reservoirs of Falcon Lake near Zapata and Lake Amistad near Del Rio from Watersheds in Texas and northern Mexico. This water supply is shared by agricultural, municipal and industrial users on both sides of the river.

Water impoundment, storage and release to all users are carefully administered by the International Boundary and Water Commission. Irrigation water is provided to growers through a series of canals and pipelines established and maintained by some 33 irrigation districts. Although this irrigation water is relatively inexpensive, the cost per irrigation varies between districts, as does overall water district taxes. Moreover, metered water required for some low-volume irrigation systems may be charged at a higher rate than non-metered water.

River water is considered moderately saline, usually containing 700 to 1,200 ppm total salts.

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However, salinity can increase during drought periods to potentially harmful levels that require more careful water management to avoid yield reductions.

In some cases, ground water exists in sufficient volume and of sufficient quality to be used in citrus irrigation. Well water should contain less than 1 ppm boron and have a sodium absorption ratio below 8 for use as irrigation water. Total salinity should be less than 1,200 ppm. Yield reductions of about 10 percent occur with prolonged use of 1,500 ppm water, perhaps as much as 25 percent at salinity levels of 2,000 ppm.

Irrigation Systems—Gravity Flow

Conventional flood irrigation is the primary system used in Texas citrus production. Good irrigation efficiency with minimal labor requirement is possible if the system is properly designed and installed prior to orchard planting. Proper design includes land leveling to the appropriate grade and an adequate delivery system.

Soil permeability affects the length and width of irrigation runs, as well as the necessary grade to assure even distribution of water across the orchard. Permanent borders having a settled height of about 1 foot are installed in every other middle to contain the flow of one irrigation stream for two rows of trees. Assistance in land leveling and design and installation of irrigation systems may be obtained from the Soil Conservation Service.

Water delivery to the head of each irrigation pan can be accomplished by an open ditch or an underground pipeline with turn-out valves. Generally, the open-ditch system is used in conjunction with temporary borders and mechanical weed control, where the ditch and borders are put up for each irrigation and removed for subsequent weed control operations. Water is turned into the tree rows through cuts in the ditch bank. Operation of this system requires more attention to assure good water distribution in all tree rows, and corresponding operation and maintenance costs are quite high.

Mature citrus under flood irrigation.

The permanent valve-pipeline system is almost always used with permanent borders and chemical weed control. Operation requires minimal labor and maintenance costs are comparatively low, although initial installation costs may be high.

Strip flooding is a modification of conventional flood irrigation used primarily to conserve water by limiting water flow to half or less of the orchard floor by the use of strip borders along each side of each tree row. Strip irrigation is practiced mainly during orchard establishment to deliver water quickly to young trees without having to irrigate the entire orchard floor.

Under permanent valve-pipeline systems and chemical weed control, strip irrigation borders usually will remain in place for 2 to 3 years before being removed to permit irrigating the entire orchard floor. In open-ditch systems and/or mechanical weed control, the strip borders may be removed and rebuilt several times prior to final removal.

Bubbler irrigation is a modification of conventional flood irrigation, with the single pipeline being replaced with a main line, numerous submains and lateral lines—all underground. The turn-out valve for each pair of tree rows is replaced by small diameter, open pipe emitters between every two to four trees in each row.

Bubbler systems may be used in flooding the entire orchard floor or may be restricted to strip borders in the case of young trees. The primary advantages of bubble irrigation include uniform water distribution, good control of irrigation volume and low labor requirements. However, an initial installation cost of more than $1,000 per acre limits the use of bubbler irrigation systems.

Irrigation Systems—Pressurized

Pressurized irrigation systems utilize pumps to deliver water under low pressure, usually about 20 psi, through a series of mains, submains and lateral lines directly to the individual trees where the water is distributed through one or more emitters at each tree. The pipeline system is underground, but the lateral lines may be buried or aboveground. Such systems require access to permanently-charged water district canals or lines, a power source for the pump, good filtration and a water meter. The use of manifolds, solenoid valves and controllers (timers) permits complete automation of the system. These systems are readily adaptable for applying fertilizer through the irrigation system (fertigation). Two types of systems currently in use in Texas citrus are drip/trickle and microsprayer/microsprinkler systems. Land leveling generally is not required for the installation and operation of these systems.

Drip/trickle irrigation systems utilize one or more emitters at each tree. The water output per emitter may be selected from 0.5 to 4.0 gallons per hour. The number and spacing of emitters at each tree determines the total water output for each tree over time and the total surface area wetted. It is generally accepted that a minimum of 50 percent of the surface area covered by the tree canopy should be wetted.

Drip irrigation requires high maintenance and good filtration to reduce clogging problems. Periodic flushing of filters and lines and chemical treatment of the system is necessary to alleviate clogging and gradually reduced flow from the emitters. Salinity buildup can occur, particularly because of the small volume of wetted soil per emitter. However, drip irrigation can conserve as much as 33 percent of the amount of water used in flood systems. Moreover, orchard performance should be somewhat higher under well-managed drip irrigation systems because of better water distribution and avoidance of water stress between irrigation cycles.

Initial cost of a drip irrigation system currently is estimated at $600 to $700 per acre, depending on the total acreage involved. Such systems are best installed before planting, but can be installed in mature orchards with minimal disruption.

Microsprayer/microsprinkler irrigation systems utilize only one emitter per tree, usually placed on a riser or stake to hold the emitter upright in place. Emitters are available with outputs of 4 to 30 gallons per hour and microsprayers are available for different configurations of wetted pattern. Most will wet an area up to 7 to 8 feet from the emitter, thereby producing a wetted surface area equal to or slightly greater than the canopy area of a mature tree.

Young orchard under microsprayer irrigation.

Good filtration, regular maintenance and periodic flushing and chemical treatment will greatly reduce the occasional clogging problems experienced. Salinity buildup in the soil has not been a problem. Water conservation of 25 to 35 percent is common. Moreover, these systems can provide some cold protection, particularly those operating at 20 gph or higher. Uniform water distribution and the elimination of water stress through frequent application result in superior orchard performance.

The initial cost of a microsprayer/microsprinkler system currently is estimated at $600 to $700 per acre, depending on the total acreage installed. These systems can be installed easily in mature orchards.

Irrigation Scheduling

The objective of irrigation is to maintain available soil moisture as near optimum as can be accomplished, given the limitations of the delivery system, to avoid any moisture stress. Basically, citrus trees do not exhibit visible symptoms of water stress until most available soil moisture has been depleted. However, fruit set can be adversely affected at soil moisture depletion levels of only 40 to 50 percent, particularly from pre-bloom through June. Consequently, extensive research in other citrus production areas has led to the recommendation that water be applied at one-third depletion during January through June and at two-thirds depletion over the remainder of the year.

Available soil moisture capacity can be roughly calculated for the upper 3 to 5 feet of an orchard soil by using appropriate soil maps and charts in county soil surveys available at local Soil Conservation Service offices. Locate the orchard on the maps, note the soil designation (letters or numbers) and look it up in the appropriate table (Table 5 for Cameron, Table 17 for Hidalgo and Table 14 for Willacy). Multiply available water capacity by the inches of rooting depth to obtain both the high and low values, then average the two to obtain a practical value.

Depletion of available soil moisture can be measured indirectly as a mathematical computation which correlates either temperature or Class "A" pan evaporation data with evapotranspiration. Computed evapotranspiration data were provided by The Texas A&M University System at Weslaco prior to the 1983 freeze, but that service has been discontinued.

Tensiometers and gypsum blocks are relatively inexpensive instruments which growers can use to directly measure available soil moisture and thereby schedule irrigations. Both require servicing and reading (recording) at periodic intervals to be effective.

In the absence of actual soil moisture measurements for precise irrigation scheduling, some general rules can be combined with grower experience to determine the need to irrigate.

Under flood systems, irrigation should begin in late January or early February and continue at 20 to 35-day intervals until a final irrigation in mid- to late November. The irrigation interval should be adjusted for rainfall and time of year, being most frequent during mid-summer.

Drip/trickle systems normally are operated almost daily during the year except during periods of rainfall. The length of time the system is on will vary from just a few hours during the cooler months to a maximum of 12 to 14 hours during mid-summer. It is considered necessary to shut the system down for 10 to 12 hours each day to prevent waterlogging of the wetted root zone.

Microsprayer/microsprinkler systems normally are operated at weekly intervals during the year except during prolonged rainy periods. The length of time the system is on can be varied from just a few hours during the cooler months to 12 to 14 hours during mid-summer. During periods of extreme drought and heat of mid-summer, irrigation frequency can be increased, if necessary, to provide the needed water.

Regardless of the type of irrigation system and other production inputs, final productivity, fruit size and fruit quality can only be as good as the management of supplemental irrigation in the citrus orchard.

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