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Water table measurement and monitoring

By Mongi Zekri, Brian Boman and Thomas Obreza

Most flatwoods citrus soils have a restrictive layer that can perch the water table and, as a result, significantly affect tree water relations. Simple and practical observation wells can generate important information that can simplify irrigation and drainage decisions.

WATER TABLE BEHAVIOR

Most Florida flatwoods soils are poorly drained because of low elevation, flat landscape and the restrictive layer that normally exists below the root zone. Consequently, flatwoods citrus is typically planted on raised soil beds in order to create the unsaturated soil volume that is necessary for root growth and development. Therefore, the first goal of water table management is to drain excess water and avoid saturated water conditions in the root zone.

Improper water table management can result in conditions detrimental to tree health. On the other hand, in certain times of the year, a properly managed water table can provide a large portion of the tree's water needs through upflux from a water table below the root zone. Managing the water table properly is cost effective and enhances tree growth and fruit production.

The water table under flatwoods citrus may rise rapidly in response to either rainfall or irrigation because sandy soils are highly conductive to water flow. A general rule of thumb is that 1 inch of rain will cause the water table to rise about 10 inches in fine-textured soils, 6 inches in most of the flatwoods sandy soils and 4 inches in coarse sands. It may take several days for the water table to return to its desired levels following rains of 1 inch or more. It is also possible for drip or microsprinkler (low-volume) irrigation to raise the water table under citrus beds if the irrigation system is run for a long time. In most cases, low-volume systems run for more than two to three hours can result in irrigation water moving below the root zone.

Some irrigation managers have used low-volume irrigation as a method for water table management. In this case, a float switch can be used in conjunction with a water table well to turn the irrigation system on and off as the water table fluctuates between desired minimum and maximum levels. Water table observation wells should be considered as a useful tool to determine irrigation cycle times (duration).

UPFLUX

The movement of water upward within the soil profile from the water table is called capillarity or upflux. Water in excess of field capacity drains by gravity into the shallow water table after a saturating rain or irrigation cycle. The removal of soil water by evaporation and transpiration results in water movement upward (upflux) by capillary action to replace some of the water in the root zone.

Soils with smaller particle sizes have the ability to move water greater distances by capillary action than coarser soils. Thus, the upflux process can move water into the root zone from a much deeper water table in clay soils than it can in sandy soils. The deeper the water table, the farther the water has to travel upward into the root zone. Therefore, the effectiveness of the water table for providing moisture to the roots decreases as the water table level drops. If the water table level falls too low, upflux will not provide water to the tree roots until another saturating rain or irrigation cycle refills the soil profile or until the water table is raised to re-establish capillarity or upflux to the root zone.

Figure 1. Observation well installed in a citrus grove.

OBSERVATION WELLS

A water table observation well is made by burying a porous pipe vertically in the ground. The pipe permits the groundwater level to rise and fall inside it as the water level depth varies in the adjacent soil (Figure 1). Observation wells with a simple float indicator can provide rapid evaluation of shallow water table depths. The float and indicator level move with the water table, allowing an above-ground indication of the water level.

Water table observation wells installed in flatwoods soils usually penetrate only to the depth of the restrictive (clay or organic hard pan) layer. Typically, this layer is within 30 to 48 inches of the soil surface. Observation wells in these soils need water-level indicators that respond to a minimal amount of recharge water so that even slight perching of the water table can be detected.

WELL CONSTRUCTION

The basic components of the well include a short section of perforated PVC pipe (3 to 5 feet long), PVC cap, screening material, a float, indicator rod and small stopper (Figure 2, page 14). Typically, observation well casings are constructed from 3-inch diameter PVC pipe (Class 160). A circular saw or drill can be used to perforate the pipe prior to installation. Perforations should be staggered in rows around the pipe to allow flow into the well from the sides in addition to the

CRDF Considers the Next Round of Projects

By Harold Browning

The Citrus Research and Development Foundation (CRDF) has moved forward with the process to identify and review projects of value that pursue solutions to HLB. During March, committees and the board approved invitations for full proposals from both research and delivery areas of the foundation's portfolio. Among the projects invited, 28 were under the Research Management area. These projects range from one to three years and will be subjected to peer review and industry review for the value they might contribute to getting solutions into the hands of growers. Highlights of the successful research pre-proposals include:

- Eleven projects are directed toward development and testing of rootstocks and scions that show tolerance or resistance to HLB. These projects represent the core breeding programs at the University of Florida/Institute of Food and Agricultural Sciences and the U.S. Department of Agriculture Agricultural Research Service, but also include projects with non-traditional approaches to developing HLB-resistant plants. This topical area is viewed by many as long-term, but due to prior investment and a continuous effort for more than two decades, many candidates exist, and those submitting new proposals will focus most clearly on getting available materials to the field.
- Four projects focus on continued efforts to culture the bacteria causing HLB. This goal has not yet been met, despite considerable effort. Since it is vital to understanding HLB, tracing movement and disease development and screening for potential solutions, continued culturing effort is warranted. Those writing proposals for this area have been encouraged to join forces and share approaches to reach the goal.
- Two projects continue to focus on Asian citrus psyllid (ACP) movement and transmission of *Candidatus Liberibacter asiaticus*.
- Citrus nutrition in the face of HLB is the topic of one proposal, building on previous attention to this area.

Twenty project ideas were invited for full proposals in the Commercial Product Delivery area. These projects test solutions that can be implemented in the short term and include:

- Eight projects support development and testing of bactericides to provide therapy to infected trees. These range from assays to field trials to development of required regulatory information.
- Three projects address ACP efforts through continuing support for citrus health management areas and for pesticide effectiveness and resistance monitoring in areas under increased pesticide use. These projects emphasize the importance of continued diligence in managing ACP populations across the state.
- Five project ideas provide support for continued field trials, including the PCR testing necessary to evaluate treatments and other general support functions related to getting solutions to the field.
- Support for one field site for testing citrus breeding candidates also is included in this set of ideas approved for full proposals.

CRDF plans to put successful projects in place by July 1 as the new fiscal year begins. Close communication with federally funded programs is vital to ensuring that high priorities are met and that solutions come forward more quickly.

Harold Browning is Chief Operations Officer of CRDF. The foundation is charged with funding citrus research and getting the results of that research to use in the grove.

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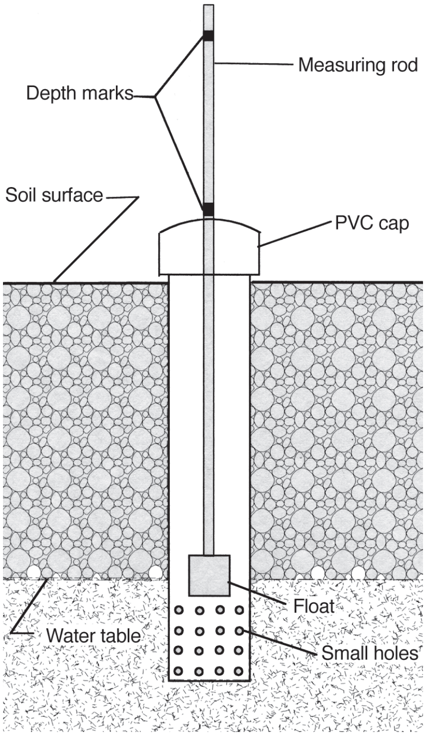

Figure 2. Schematic of an observation well.

bottom. Perforations totaling about 5 percent of the well's surface area are adequate for sandy soils encountered in the flatwoods. No perforations should be made within 12 inches of the surface in order to minimize the chances of ponded water from high-intensity storms creating flow channels into perforations near the soil surface.

The pipe should be wrapped (sides and bottom) with a screening material to prevent soil particles from moving into the well. Materials such as cheesecloth, polyester drain fabric and fiberglass screen have been used successfully as filters. The filter material should be taped in place with duct tape. A 3-inch soil auger can be used to bore holes in the ground for the wells. When possible, the observation wells should be installed when no water table is present in order to minimize chances of the well sides sloughing into the bore as it is dug.

When a water table is present, it is easiest to install the well by starting off with a larger diameter pipe. For a 3-inch observation well, a 4-inch installation pipe (Schedule 40 preferred) will be needed. The installation pipe should be cut at least 6 inches longer than the intended depth of the well. The soil should be backfilled around the observation well casing and tamped to compact the soil and get a tight fit between the soil and the sides of the pipe. A measurement should be taken of the distance from the bottom of the well to the soil surface. The float assembly can then be lowered into the well. Make sure that the indicator rod and float do not bind against the sides of the observation well. The well is now ready for calibration.

CALIBRATION

Calibration should be performed when the water table is above the bottom of the well. The weight of the float assembly and rod will affect how much of the float is submerged while floating. Typically, the float assemblies can respond to water levels less than a half inch above the bottom of the observation well. The range of water table depths providing sufficient upflux for tree water needs is largely determined by soil type. A mark on the indicator stake or rod should be made at the top of the well when the float is at the bottom. This level is the reference mark for the well depth. The indicator stake or rod can then be marked with major divisions (feet) and minor divisions (inches) for easy reading of the water table depth. These rings can be painted at appropriate intervals using different colors for major and minor divisions. Marks painted at 2-inch increments provide enough accuracy for most users.

Month	Typical ET (in./day)	Water table depth (in.)
Jan.	0.07	32
Feb.	0.10	29
March	0.15	28
April	0.16	27
May	0.18	26
June	0.19	26
July	0.19	27
Aug.	0.19	26
Sept.	014	28
Oct.	0.12	28
Nov.	0.10	29
Dec.	0.06	35

Table 1. Typical water table depths needed to meet the requirements for citrus trees on many of the flatwoods soils calculated from long-term monthly evapotranspiration (ET) and typical upflux data.

The mark at the upper level depends on the depth of the water furrow and root depth. The upper depth should be selected so that water does not pond in water furrows, and it should be at least 6 inches below the bottom of the root zone to prevent root pruning. The lower depth marks should be at points where the upflux of moisture is equal to the average daily evapotranspiration (Table 1). When the water table drops any lower, the tree will not receive the moisture it needs that day.

Observations with time will help determine the water table level depth that will prevent root damage or excessive wetness in the root zone. In contrast, if the water table is allowed to drop to the point where there is not enough water moving upward to supply the moisture needs of the tree, irrigation will be required. The zone between the maximum and minimum depths can be painted on the float assembly. A quick glance at the observation well will indicate whether or not the water level is within desired limits.

OPERATION

The water table observation well is an excellent tool for determining when to irrigate or when the water table is too high. The goal of water table management is to maintain the water table at a level just below the root zone, but not high enough to cause root damage. After a soaking rain or irrigation cycle, water adheres to the surface of soil particles until all available pore spaces are filled. If the water table is close enough to the surface (as in the case of most flatwoods soils), this water may be available to the plant due to upflux, which generally lasts for several days as the water table gradually declines. If the water table is allowed to get too low, the soil dries out, and the capillarity to the root zone is broken. At this point, another rain or irrigation is needed.

While knowledge of the soil type can provide a reasonable prediction of water table behavior, observations and records from specific blocks will help one to understand how rainfall and irrigation affect the water table. This information can be used to develop an irrigation/drainage schedule that optimizes soil moisture availability. Modify markings on the water table observation well indicator stake or rod to fine-tune the observation well accuracy to tree conditions.

Maintenance of the water table observation wells is minimal. The painted rings may fade and require periodic repainting. If an indicator stake or rod is suspected of erroneous readings, the assembly can be quickly removed to inspect the well. As routine maintenance, the observation wells should be closely inspected on an annual basis to ensure that they are functioning properly.

The purpose of water table observation wells is to assist in management of plant-available moisture through knowledge of fluctuating water tables in bedded flatwoods soils. Using observation wells is a best management practice for irrigation and drainage. The information these wells provide helps set realistic irrigation and drainage schedules that avoid harmful over- or under-watering. Assistance in installing and calibrating water table observation wells can be obtained from most Natural Resources Conservation Service offices.

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