Improving Sweet Potato Production Efficiency

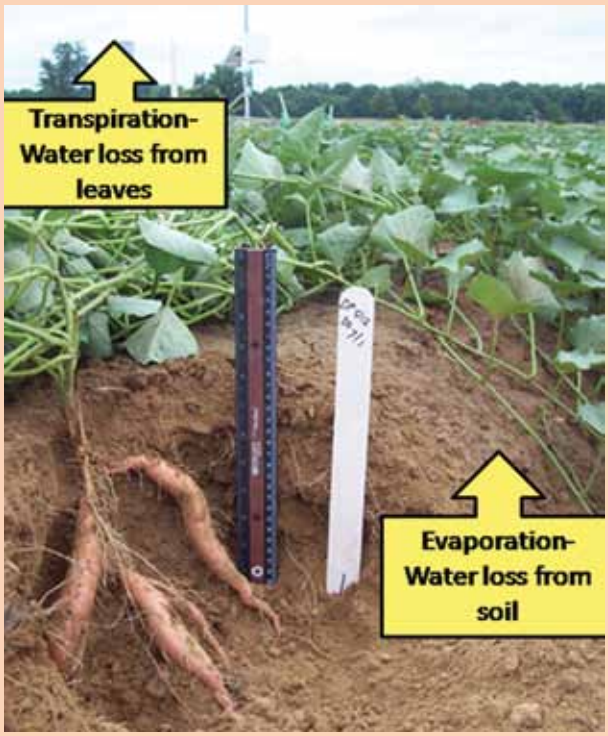
Optimizing Soil Moisture and Irrigation Management

Background

Lack of adequate soil moisture is a limiting variable in sweet potato production. There have been many examples of nearly 100 percent yield loss for whole fields of sweet potatoes.

For several years, the type of damage caused by drought stress was attributed only to herbicide applications. Recent research showed that by turning off supplemental irrigation during the critical storage root initiation stages (SR1-SR2) at conditions approaching wilting point, we were able to induce similar damage symptoms – extensive lignification ("pencil roots") and misshapen roots.

Optimal soil moisture for sweet potatoes grown in Louisiana (silt loam soil) is 15-20 percent volumetric water content at a 6-inch soil depth. This number represents 50 percent of field capacity for soil moisture and needs to be calibrated for specific field conditions. Field capacity represents moisture held in soil after excess water has drained. Available soil moisture can be determined using a soil moisture probe. Soil moisture use and requirements are affected by many processes including transpiration (water loss from the leaves) and evaporation (water loss from the soil).



Key Terms

Wilting point: The minimal point of soil moisture a plant requires not to wilt.

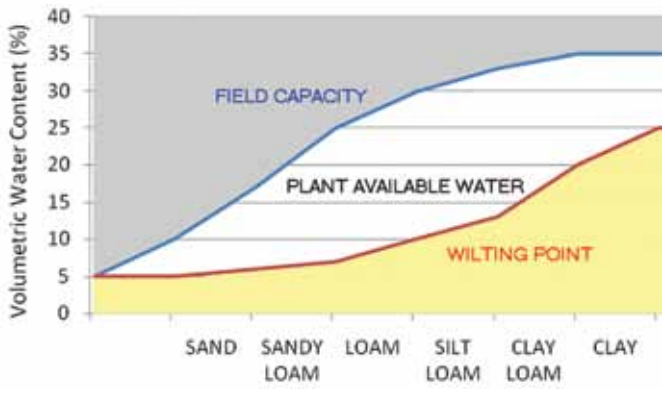
Field capacity: The amount of soil moisture or water content held in soil after excess water has drained away and the rate of downward movement has materially decreased, which usually takes place within two to three days after rain or irrigation in permeable soils of uniform structure and texture.

Volumetric water content: The volumetric water content in the soil represents the fraction of the total volume of soil that is occupied by the water contained in the soil.

Lignification: A physiological and developmental change in an adventitious root that typically yields nonproductive, pencil-type roots. Drought stress can result in lignification. Other biological and agriclimatic factors also may influence this process.

Storage root initiation: The process whereby adventitious roots differentiate into sweet potato storage roots. This process occurs very early after transplanting and can be observed anatomically as early as 13 days after transplanting.

Calibrating volumetric water content for your soil type.



Stages of Storage Root Initiation

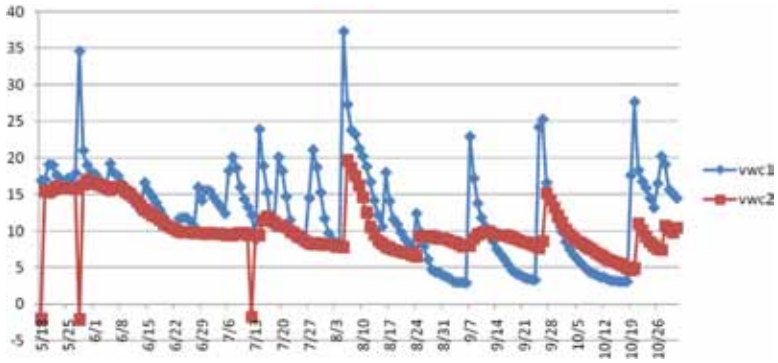
SR1: Appearance of at least one adventitious root in at least 50 percent of transplants.

SR2: Appearance of anomalous cambium in at least one adventitious root in at least 50 percent of transplants.

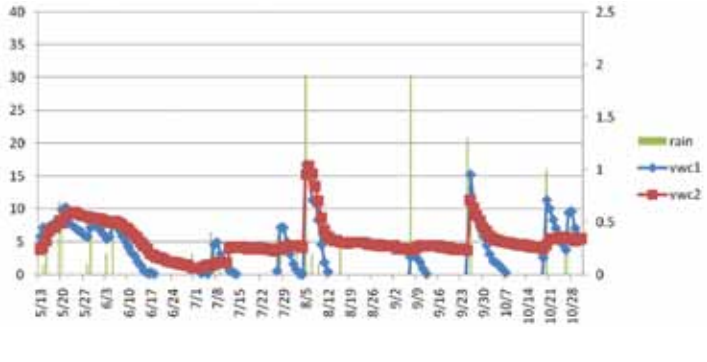
SR3: Presence of at least one visible storage root (adventitious root with visible localized swelling, 0.5 centimeter at its widest section) in at least 50 percent of plants.

Irrigation Management

Figure 1 and Figure 2. Soil moisture data for storage root yield responses.



Irrigated graph



Nonirrigated graph

Figure 3. Storage root development at 60 days in irrigated (A) and nonirrigated (B) plots. The field plots were planted on May 12, 2010, and observed on July 1, 2010. The nonirrigated plots received about 1 inch of rain each month in May and June. Irrigated plots received overhead irrigation from a traveling irrigation gun when soil moisture at the 6-inch depth approached 12 percent volumetric water content. Soil moisture in nonirrigated plots averaged 10 percent volumetric water content within 20 days after planting but remained below 10 percent volumetric water content until sampling. The average volumetric water content at the 6-inch depth for irrigated plots was 15 percent during the first 40 days and averaged 10 percent thereafter.

Irrigation Management

In general, apply water when the crop has used about half of the available water capacity in the root zone. When applying water, don't completely fill or overfill the root zone. Overfilling leaches chemicals, such as nitrate/nitrogen, wastes water and increases costs. Leave room in the soil for storing about 0.5 to 1 inch of rainfall that might occur soon after you irrigate.

An irrigation management plan for sweet potatoes should be based on optimizing soil moisture during the critical storage root initiation period and for supporting maximum storage root bulking until harvest. This requires that moisture be present around the propagule at transplanting. Transplanting depth typically varies from 2 to 6 inches. After five to 10 days, root depth can vary from 4 to 8 inches, depending on moisture uniformity and the presence of a hard pan. After 10 to 20 days, storage root length is determined, and the bulk of the root system is within the upper 12 to 15 inch depth of soil, depending on soil moisture uniformity and the presence of a hard pan, with lateral root growth accounting for nearly 80 percent of the root volume.

The lateral root system accounts for at least 80 percent of the total soil water absorption. The lateral roots branch out at 85- to 90-degree angles, indicating that the root system will be able to efficiently use soil moisture at the 15- to 20-inch depth. Starting at about 30 days after planting until harvest time, lateral root lengths differ as a response to spatial and temporal soil moisture variations while the main storage root expands in diameter. In light-textured soils or fields without a hardpan, overirrigation can lead to undesirable lengthening of storage roots in some varieties.

Center Pivot Irrigation of a Sweet Potato Crop

Irrigation Methods

Center Pivot Irrigation

Center pivot irrigation is the most efficient means of providing supplemental water to a sweet potato crop. Timing and placement of the water are more accurately controlled compared to other irrigation systems. Center pivots can be effectively used during all stages of production. In addition, center pivots can be used during harvest to increase soil moisture and improve harvesting conditions.

Furrow Irrigation

If properly managed, furrow irrigation can be an efficient method for irrigating an established sweet potato crop. This method may not be the most efficient method when used to help establish the crop, however. During transplanting, moisture is needed around the base of the propagule, which typically is set at the top of the ridge. This requirement typically necessitates a longer application time from furrow irrigation to enable the wet zone to reach the top of the ridge. Depending on the length of the run, this results in saturated conditions in the upstream end. In addition, a rainfall event can further saturate the field during the critical period of storage root initiation.

Travelling Irrigation Gun

Reel guns can be used during all phases of sweet potato production. They commonly are used after the crop has become established to supplement water during the season. This method also is used to water sweet potato fields prior to planting and during harvest to improve harvesting conditions.

Tara P. Smith, Associate Professor
Sweet Potato Extension Specialist, Sweet Potato Research Station

Arthur Villordon, Professor
Sweet Potato Research Station

Project: Participatory modeling and decision support for improving sweet potato production efficiency, quality and food safety. (2009-51181-06071)

Funding Agency: U.S. Department of Agriculture's National Institute of Food and Agriculture, Specialty Crop Research Initiative

Participants: Louisiana State University Agricultural Center
Mississippi State University
North Carolina State University
University of California Cooperative Extension

www.LSUAgCenter.com

Louisiana State University Agricultural Center
William B. Richardson, Chancellor
Louisiana Agricultural Experiment Station
John S. Russin, Vice Chancellor and Director
Louisiana Cooperative Extension Service
Paul D. Coreil, Vice Chancellor and Director

Pub. 3235 B (500) 4/12