Great Lakes Fruit, Vegetable & Farm Market EXPO

Michigan Greenhouse Growers EXPO

December 9 - 11, 2014

DeVos Place Convention Center, Grand Rapids, MI

Irrigation Management Decision Tools for Economic and Environmental Benefit in Fruit and Vegetable Production

Thursday morning 9:00 am

Where: Grand Gallery (main level) Room D

CCA Credits: SW(2.0)

Moderator: Lyndon Kelley, Extension Irrigation Educator, MSU-Purdue

9:00 am Soil Moisture Monitoring System Compared and Reviewed

- Steve A. Miller, Irrigation Specialist, Biosystems Engineering Dept., MSU

9:40 am Management of Drip Irrigation - Adequate Moisture in Root Zone Without Over Filling

- Bob Hochmuth, Suwannee Valley Agricultural Extension Center, Univ. of Florida

10:20 am Irrigation Scheduling - Bring It All Together

- Lyndon Kelley, Extension Irrigation Educator, MSU-Purdue

10:45 am Session Ends

Soil Moisture Monitoring System Compared and Reviewed

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There is wide range of technical soil moisture monitoring equipment currently available for irrigators to use to help manage and monitor water use in the field. The type of soil moisture monitoring equipment available can be divided into two categories: soil suction measurement systems and soil moisture content measurement systems.

The readings for all types of soil moisture monitoring equipment are dependent of soil texture, organic matter content and many other factors it addition to moisture content. Therefore, all systems need to be calibrated and readings evaluated in order to be helpful in irrigation scheduling. Used in conjunction with a scheduling program, these systems can be an important component to efficient water use for irrigation.

Soil suction measurement systems

Soil suction devices measure the negative pressure required by the plant to be able to extract water from the soil. This force from the plant on the soil to draw the amount of water it needs to grow can be measured as tension. The drier the soil, the more tightly the water is held, and the more energy the plant has to use to extract the water from the soil. Therefore, devices that measure soil water potential are very good indicators of the stress plants are under. These devices enable irrigators to keep crop stress to a minimum by managing irrigation to ensure the correct soil water potential is maintained.

Tensiometers: A tensiometer is a tube filled with water that has a porous ceramic tip which is buried in the soil at the depth which soil moisture need to be measured. Tensiometers can be buried at different depths in the root zone in order to obtain a soil moisture profile. The water will move out to the drier soil until the potential within the tensiometer is the same as that of the soil water. A vacuum gauge records the level of suction required by the plant to draw water from the soil. The vacuum gauge can be read manually by the farmer, but can also be measured electronically and logged.

• **Granular Matrix Sensors:** Resistance blocks such as gypsum blocks are made from a porous material with two electrodes embedded in the material. They are buried in the soil and they take on the soil water characteristics of the surrounding soil, creating equilibrium. The electrical resistance within the blocks is measured. The electrical resistance of a block is directly proportional to its water content, which is related to the soil water potential of the soil surrounding the block.

Figure 1 Granular Matrix Sensor Data – Watermark Block manufacted by Irrometer Company

Soil volumetric moisture content measurement systems

Instruments that indirectly measure soil moisture content use sensors that are placed in the soil at various depths in the root zone. The sensors measure properties that are closely related to soil water content. Calibration equations are used to convert the property being measured by the sensor to soil water content.

Time Domain Reflectometry (TDR): TDR devices use the dielectric constant of the soil water media to calculate soil water content. An electromagnetic signal is sent down a steel probe which is buried in the soil at the desired depth. The signal reaches the end of the probe and is reflected back to the control unit. The return time of the signal varies with the soil dielectric constant and therefore relates to the water content of the soil surrounding the probe.

An example of the TDR sensors is the Hydrosense sensors manufactured by Campbell Scientific.

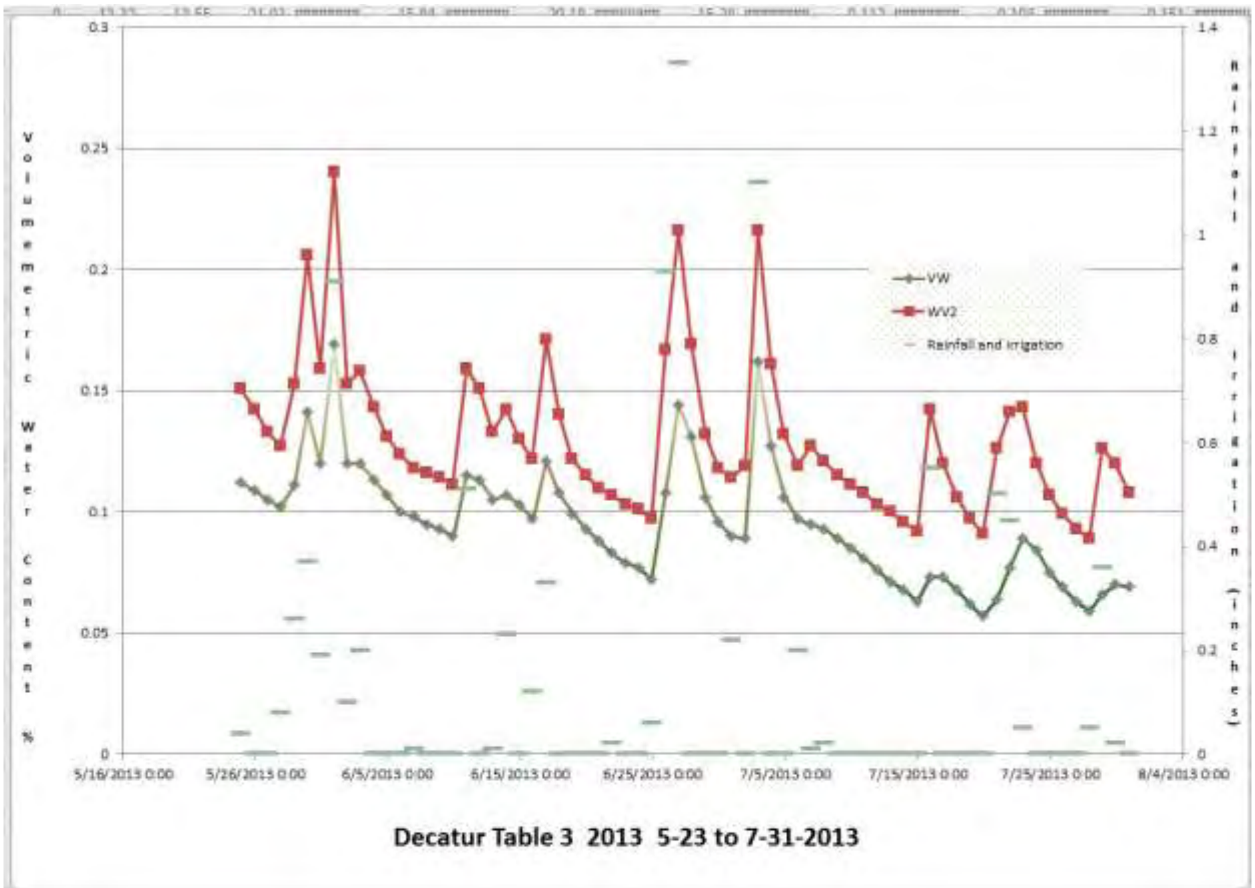

Figure 2: Hydrosense senor Data

Frequency Domain Reflectometry (FDR): FDR devices use the dielectric constant of the soil water media to calculate soil water content. These types of instruments work on the basis that the dielectric of dry soil is much lower than that of water. The soil dielectric is calculated by applying a voltage to the plates and measuring the frequency.

An example of FDR devices is the ENVIROSMART Water-Content-Profile Probe: The probes provide volumetric soil water content profiles for irrigation scheduling or other water movement systems. The measurement range is oven dry to saturation. The probes measure soil moisture at multiple depths at 10 cm increments. It is customized for individual applications by adding sensors at user-specified measurement depths. The maximum measurement depth of the standard configuration is 6 feet (2 m); deeper measurements are possible with special provisions.

The John Deere Field Connects is another example of a FDR device which measures the soil moisture at various depths of the soil. The device then sends the information to a web based interface where you can log in and track the data from any location and at any time.

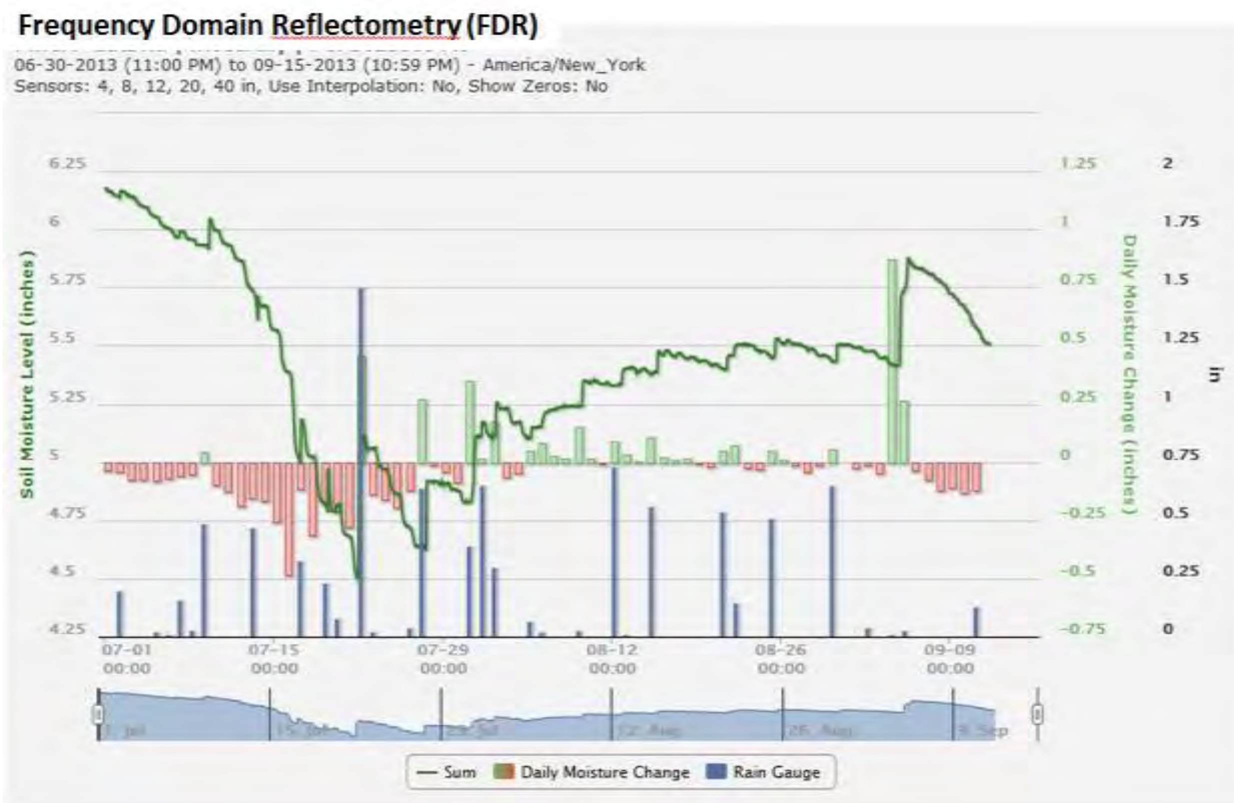

Figure3: John Deere Connect 2013 – Sandy Loam - Sum

Neutron Probe**:** Neutron probes emit fast moving neutrons. When the neutrons collide with hydrogen in the soil they are slowed and deflected. A detector on the probe counts returning slow neutrons. The number of slow neutrons detected can be used to calculate soil water content because changes in the amount of hydrogen in the soil between readings will only come about from changes in water content. A wet soil will contain more hydrogen than a dry soil and therefore more slow neutrons will be detected.

Additional information on water quantity managements can be found at:
http://www.egr.msu.edu/bae/water/
More detailed information on soil moisture monitoring can be found on the web site at:
http://www.egr.msu.edu/bae/water/feature/irrigation-management-drought-scheduling

Management of Drip Irrigation –
Adequate Moisture in Root Zone Without Over-Filling

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Introduction

Most vegetable growers in the Suwannee Basin region of North Florida are small to mid-sized growers (one to 300 acres), many who have adopted drip irrigation and plastic mulch cultural practices since the late 1980s to produce vegetable such as tomato, bell pepper, eggplant, cucumber, muskmelon, and watermelon. Soils in the area are sandy with low water holding capacity (<10%) and low organic matter content (<1.5%). Hence, vegetable production in northeastern Florida requires intense irrigation and fertilization management. The recommendations of University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS) for irrigation management for vegetable crops include using a combination of target irrigation volume, a measure of soil moisture to adjust this volume based on crop age and weather conditions, a knowledge of how much water the root zone can hold, and an assessment of how rainfall contributes to replenishing soil moisture.

Previous educational efforts in northeastern Florida have focused on plant establishment and fertilizer management. The recent development and adoption of statewide Best Management Practices in Florida in rule 5M-8 of the Florida Administrative Code (Florida Department of Agriculture and Consumer Services Office of Ag Water Policy) and the increase in production costs, have emphasized the need for improved irrigation practices and a better understanding of water movement in mulched beds. Growers' understanding of the interdependence between fertilization, irrigation, and nutrient leaching below the root zone was increased through a targeted effort of on-farm projects.

UF/IFAS county extension agents and specialists have been working with Suwannee Valley's vegetable growers who use plastic mulch and drip irrigation to refine their management of the technology since it was introduced to the region in the late 1980s. The emphasis of the educational programs after the turn of the century has been to improve efficiency of water and nutrient management. County extension agents and specialists have coordinated several projects at the regional UF/IFAS Center, Suwannee Valley Agricultural Extension Center, near Live Oak, FL. The educational approach was to first demonstration the new technology at the Center via field days and workshops, then follow-up by demonstrating that technology on leading grower's fields throughout the region.

Materials and Methods

The Extension mission of the University of Florida is to take the latest research findings to the citizens of Florida. In this case, Extension specialists and county extension agents developed outreach programs to take the latest findings regarding water and nutrient management in plasticulture to the farmers in Suwannee Valley.

The first programs included demonstrating soil moisture sensors such as tensiometers, granular matrix sensors, and time domain reflectometry (TDR) devices. Each can help growers to determine when to irrigate and for how long. This program has been taken to dozens of farms in nine counties since the late 1990s. The growers learned they were likely to over water in the first month of the season. Early season over watering is important to change because they learned the greatest risk of leaching nutrients is during this early season period. Growers adopted changes in their early season irrigation management based on the information from these various soil moisture sensors. The remainder of the season water use was changed very little; however, the improved irrigation efficiency early in the season led to reduced fertilizer.

A second specific program to help continue to teach growers water and nutrient management was the initiation of the Florida Drip Irrigation School. The first such school was held at the Suwannee Valley Agricultural Extension Center in 2001 and was so popular it was adopted statewide as a UF/IFAS program and over 25 such schools have been held in Florida since 2001. The school is an intensive hands-on training for growers to learn to better manage their drip irrigation systems for the delivery of water and fertilizer. Presentations were delivered by University faculty and representatives from the allied industry. Well over 500 growers have attended these trainings at the Suwannee Valley's Center and other locations and learned several practices including: using soil moisture sensors, cleaning the system, proper design and maintenance, calculating fertilizer rates, selecting drip tape, and determining proper lengths of irrigation events, etc.

Plant nutrient status can be determined in the field by squeezing plant sap onto meters (Cardy) that measure either nitrogen or potassium. This gives a grower an instant result to guide their fertilizer program week to week. The Cardy meters have been used and demonstrated by several county extension agents in the area over the last 15 years. Most County Extension agents in the Suwannee Valley area of Florida are proficient in petiole sap testing and a few growers and industry representatives have also learned to run this test. Over 90% of the Suwannee Valley watermelon acreage has benefited from this program. Research is being conducted to refine petiole sap guidelines for seeded and seedless cultivars separately.

The most recent and perhaps most popular demonstration being taken to farms is the use of blue dye injected into the irrigation system to see how quickly the water moves downward in the soil in their field. This has been demonstrated on at least 25 farms from 2004 to 2013 after demonstrations began at the Center in 2001. The blue dye is used to be able to actually visualize the wetting pattern of the soil profile under the drip tape. After injection of the blue dye growers followed their normal irrigation schedules for one week and then a cross section of the soil profile under the mulch was dug to measure how far the water and nutrients moved.

Results and Discussion

The growers showed great interest in using new technology such as moisture sensors and Cardy meters, and seeing the movement of dye on the "digging" visits. It was very common for growers to make immediate changes in irrigation schedules, especially irrigation event durations early in the season based on what they observed. The greatest challenge in managing the leaching from over irrigation occurred in the early part of the season, weeks 1-5 after planting. Most growers apply a portion of the total fertilizer program to the soil prior to bedding and mulching. This fertilizer is especially vulnerable to being leached early in the season before the root system and crop become well developed. It was shown that single irrigation events of more than one hour in sandy soils can move the blue dye more than a foot deep. This can move fertilizer below the root zone, especially in the early part of the season. Many growers have reduced the preplant fertilizer as a result of these programs.

The blue dye tests conducted on these farms and also at the Center near Live Oak, Florida have provided a very good estimate of movement of the dye in sandy soils. Each grower involved in these demonstrations made adjustments based on the visualization of the movement of the dye. Area growers and Extension agents began to coin the phrase "The blue dye don't lie", showing the undeniable lessons learned in watching the results of the blue dye demonstrations. The changes were immediate, short term changes to their management. The longer term changes leading to actual adoption are those make from one year to the next based on these educational experiences. The on-farm trials, in addition to other educational programs, such as the Drip Irrigation School and various field days have resulted in significant changes on several farms. Growers involved with the dye demonstrations and other events for three years or more have adopted long term changes. One of the main changes has come in the fertilizer program by reducing the total nitrogen rate applied prior to bedding and mulching. Pre-plant N rate for watermelon has been typically reduced from 100-150 down to 25-50 pounds per acre since the beginning of these programs. The remaining N is now applied via the drip system over the season. This part of the fertility program, where fertigation is used, has not dramatically changed over that period of time. Therefore, a total reduction of 75 to 100 pounds of N per acre per year has resulted directly from these demonstrations without affecting yield or quality. The final resulting N and water management programs on this farm are accepted Best Management Practices for growing watermelon using plasticulture.

In summary, combining these several educational programs in the Suwannee Valley watermelon growing area has made a great impact toward adopting BMPs voluntarily. During this long term effort, 50 growers saw and learn from one or more demonstration on their own farm and they often served as early adopters which helped Extension agents teach other plasticulture growers how to adopt the BMPs. These programs integrated together have resulted in growers:

- Reducing early season irrigation events by over 50% saving water and reducing nutrient leaching.
- Improving early season irrigation efficiencies, growers reduced preplant fertilizer rates. Most growers have reduced preplant nitrogen rates by 20-50%.
- Suwannee Valley watermelon and other vegetable growers using plasticulture techniques have adopted several BMPs including: irrigation sensors, petiole-sap testing, and refining fertilization rates; resulting in adoption of UF/IFAS nutrient recommendations on nearly 90% of the area watermelon acreage.

Conclusions

Increased concern over the impact of agricultural practices on water quality in Florida has resulted in the grower's need to adopt Best Management Practices (BMPs). The successful adoption of BMPs in plasticulture production of vegetables in North Florida has been greatly facilitated by Extension programs in conjunction with industry and other agency involvement. Growers are more likely to adopt BMPs when they can evaluate them on their own farm. Long term educational program efforts including hands-on teaching workshops at a research facility combined with on-farm demonstrations proved to be a very effective strategy in helping vegetable growers using plasticulture improve water and nutrient management practices on well over 5,000 acres.