UF UNIVERSITY of FLORIDA
IFAS Extension

E X T E N S I O N
Institute of Food and Agricultural Sciences

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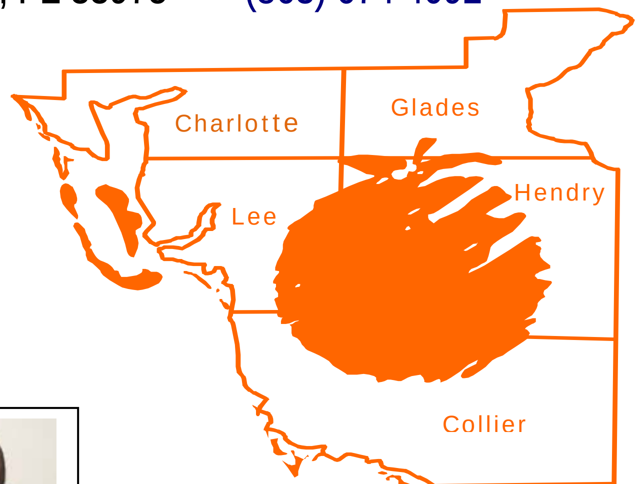
Flatwoods Citrus



Vol. 20, No. 6 **June 2017**

Dr. Mongi Zekri
Multi-County Citrus Agent, SW Florida

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Seminar

Citrus Undercover Production Systems (CUPS) and Controlled-Release Fertilizers (CRFs)

Date & time: **Wednesday, June 28, 2017, 10:00 AM – 12:10 PM**
Location: UF-IFAS Southwest Florida Research and Education Center, Immokalee
Speakers: Dr. Arnold Schumann, Pete Spyke, and Ward Gunter
Program Coordinator: Dr. Mongi Zekri, UF-IFAS
Program Sponsor: **Ward Gunter, ICL Specialty Fertilizers**

2 CEUs for pesticide license renewal
2 CEUs for certified crop advisors (CCAs)

Pre-registration is required. No registration fee and lunch is free Thanks to **Ward Gunter, ICL Specialty Fertilizers**. To reserve a seat, call 863 674 4092, or send an e-mail to Dr. Mongi Zekri at: maz@ufl.edu

Agenda

----10:00 AM – 10:50 AM

1. Planning a citrus undercover production system (CUPS)

Dr. Arnold Schumann, UF-IFAS

10:50 AM – 11:00 AM Break

----11:00 AM - 11:40 AM

2. Controlled-release fertilizer (CRF) blends and biological control

Pete Spyke, Arapaho Citrus Management, Inc.

----11:40 AM - 12:10 PM

3. Maximizing the efficiency of citrus nutritional programs

Ward Gunter, Sales Lead & Business Development Manager, ICL Specialty Fertilizers

Seminar

Use of soil microbial amendments and other plant health products in agriculture

The Unseen Soil: the importance of soil microbes in agriculture

Date & time: **Wednesday, July 26, 2017, 10:00 AM – 12:00 Noon**
Location: UF-IFAS Southwest Florida Research and Education Center, Immokalee
Speakers: Dr. Ute Albrecht, UF-IFAS and Dr. Sarah Strauss, UF-IFAS, UF-IFAS
Program Coordinator: Dr. Mongi Zekri, UF-IFAS
Program Sponsor: Charles McCartney with Timac Agro

2 CEUs for pesticide license renewal
2 CEUs for certified crop advisors (CCAs)

Pre-registration is required. No registration fee and lunch is free Thanks to **Charles McCartney with Timac Agro**. To reserve a seat, call 863 674 4092, or send an e-mail to Dr. Mongi Zekri at maz@ufl.edu

Agenda

----10:00 AM – 10:55 AM
"Use of soil microbial amendments and other plant health products in agriculture"
an overview of different biostimulant products (beneficial microbes, humic substances, seaweed, etc.), their effects on plant health, and information on ongoing citrus trials.
Dr. Ute Albrecht, UF-IFAS, Immokalee

10:55 AM – 11:05 AM Break

----11:05 AM - 12:00 Noon
"The Unseen Soil: the importance of soil microbes in agriculture"
an overview of how microbes influence soil nutrient cycling and plant growth, along with preliminary data from ongoing citrus trials.
Dr. Sarah Strauss, UF-IFAS, Immokalee

Certified pile burners class July 12, 2017 (Class is full)

Class size is limited to the first 50 people.

The $50 fee covers the training sessions, a booklet with all the presentations in color, other handouts, refreshments, and lunch.

The Florida Division of Forestry and University of Florida Cooperative Extension Service will be conducting a Certified Pile Burners Course that will show you how to burn piles ***legally, safely and efficiently***.

Most importantly, it could save a life. This training will be held from 8:00 am till 4:30 pm at the **Southwest Florida Research and Education Center in Immokalee**.

Look at other class schedule:

http://www.freshfromflorida.com/Divisions-Offices/Florida-Forest-Service/Education/For-the-Community/Withlacoochee-Training-Center-WTC/Class-Schedule

University of Florida Will be Celebrating a Century of Citrus Research on November 29, 2017, Lake Alfred CREC

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1. **Evaluate the value of the information presented: Useful 100%   No use 0%**
2. **Have you gained any knowledge or new information from this program?**
   Yes 100%   No 0%
3. **Will you share the gained information with others? Yes 99%   No 1%**
4. **Will you change or improve your practices because of the information gained from this program? Yes 97%   No 3%**
5. **Did you attend the 2016 Farm Safety Day?   Yes 72%   No 28%**
6. **If you answered yes to the previous question, did you have the chance to apply the information you learned from the program last year?**
   Yes 98%   No 2%

<u>Attendance</u>: Total: 227

EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

issued by
CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society
11 May 2017

ENSO Alert System Status: Not Active

Synopsis: ENSO-neutral and El Niño are nearly equally favored during the Northern Hemisphere summer and fall 2017.

ENSO-neutral persisted during April, with near-average sea surface temperatures (SSTs) observed across the central equatorial Pacific and above-average SSTs in the eastern Pacific (Fig. 1). The latest weekly Niño index values were +0.5°C in the Niño-3 and Niño-3.4 regions, and +0.3 and +0.8°C in the Niño-4 and Niño-1+2 regions, respectively (Fig. 2). The upper-ocean heat content anomaly was slightly positive during April (Fig. 3), reflecting the strengthening of above-average temperatures at depth around the Date Line (Fig. 4). Atmospheric convection anomalies were weak over the central tropical Pacific and Maritime Continent (Fig. 5), while the lower-level and upper-level winds were near average over most of the tropical Pacific. Overall, the ocean and atmosphere system remains consistent with ENSO-neutral.

Most models predict the onset of El Niño (3-month average Niño-3.4 index at or greater than 0.5°C) during the Northern Hemisphere summer (Fig. 6). However, the NCEP CFSv2 and most of the statistical models are more conservative and indicate that while Niño-3.4 index may be near or greater than +0.5°C for several months, the warmth may not last long enough to qualify as an El Niño episode (5 consecutive overlapping seasons) and/or may not significantly impact the atmospheric circulation. Relative to last month, the forecaster consensus reflects slightly lower chances of El Niño (~45%), in part due to the conflicting model guidance and lack of a clear shift toward El Niño in the observational data. In summary, while chances are slightly lower than 50%, ENSO-neutral and El Niño are nearly equally favored during the Northern Hemisphere summer and fall 2017 (click CPC/IRI consensus forecast for the chance of each outcome for each 3-month period).

This discussion is a consolidated effort of the National Oceanic and Atmospheric Administration (NOAA), NOAA's National Weather Service, and their funded institutions. Oceanic and atmospheric conditions are updated weekly on the Climate Prediction Center web site (El Niño/La Niña Current Conditions and Expert Discussions). Forecasts are also updated monthly in the Forecast Forum of CPC's Climate Diagnostics Bulletin. Additional perspectives and analysis are also available in an ENSO blog. The next ENSO Diagnostics Discussion is scheduled for 8 June 2017. To receive an e-mail notification when the monthly ENSO Diagnostic Discussions are released, please send an e-mail message to: ncep.list.enso-update@noaa.gov.

Climate Prediction Center
National Centers for Environmental Prediction
NOAA/National Weather Service
College Park, MD 20740

Hurricane season started June 1 -- are you ready?

2017 Atlantic Hurricane Season Forecast Calls For a Near-Average Number of Storms, Less Active Than 2016

The 2017 Atlantic hurricane season is forecast to be less active than a year ago with the number of named storms and hurricanes near historical averages, according to an outlook released by The Weather Company.

A total of 12 named storms,
six hurricanes and two major hurricanes are expected this season, which matches the 30-year average (1981-2010) for the Atlantic basin. A major hurricane is one that is Category 3 or stronger on
the Saffir-Simpson Hurricane Wind Scale.

Numbers of Atlantic Basin named storms, those that attain at least tropical storm strength, hurricanes, and hurricanes of Category 3 intensity forecast by The Weather Company, an IBM business, and Colorado State University compared to the 30-year average.

The outlook cited that the potential development of El Niño later this summer along with current and forecast sea-surface temperature anomalies played a role in their forecast for a near-average season.

But there remains plenty of uncertainty regarding El Niño's possible development, and therefore, how much of an effect it could have on the hurricane season.
"If El Niño fails to launch, we may be too low with our numbers," said Dr. Todd Crawford, chief meteorologist with The Weather Company.

The Colorado State University (CSU) Tropical Meteorology Project outlook headed by Dr. Phil Klotzbach calls for a similar number of named storms with 11 expected. CSU forecasts fewer hurricanes this year compared to average, however, with four expected in the Atlantic basin.

The official Atlantic hurricane season begins June 1 and runs through Nov. 30. Occasionally storms can form outside those months as happened last season with January's Hurricane Alex and late May's Tropical Storm Bonnie.

2017 Atlantic hurricane season names. Arlene will be the name given to the first Atlantic tropical storm that develops in 2017.

Here are three questions about what these outlooks mean.
Q: What Does This Mean For the U.S.?
There is no strong correlation between the number of storms or hurricanes and U.S. landfalls in any given season. One or more of the 12 named storms forecast to develop this season could hit the U.S., or none at all. Therefore, residents of the coastal United States should prepare each year no matter the forecast.
A couple of classic examples of why you need to be prepared each year occurred in 1992 and 1983.
The 1992 season produced only six named storms and one subtropical storm. However, one of those named storms was Hurricane Andrew, which devastated South Florida as a Category 5 hurricane.
In 1983 there were only four named storms, but one of them was Alicia. The

Category 3 hurricane hit the Houston-Galveston area and caused almost as many direct fatalities there as Andrew did in South Florida.

In contrast, the 2010 season was active. There were 19 named storms and 12 hurricanes that formed in the Atlantic Basin.

Despite the large number of storms that year, not a single hurricane and only one tropical storm made landfall in the United States.

In other words, a season can deliver many storms, but have little impact, or deliver few storms and have one or more hitting the U.S. coast with major impact.

The named storms that affected the U.S. in 2016 were clustered in the Southeast.

The U.S. averages one to two hurricane landfalls each season, according to NOAA's Hurricane Research Division statistics.

In 2016, five named storms impacted the Southeast U.S. coast, most notably the powerful scraping of the coast from Hurricane Matthew, and its subsequent inland rainfall flooding.

Q: Will El Niño play a role?

As mentioned earlier, El Niño could return at some point during the 2017 hurricane season, but there remains plenty of uncertainty regarding that.

This periodic warming of the central and eastern equatorial waters of the Pacific Ocean tends to produce areas of stronger wind shear (the change in wind speed with height) and sinking air in parts of the Atlantic Basin that is hostile to either the development or maintenance of tropical cyclones.

NOAA put the odds of El Niño's development at 50 percent during August-December, according to their latest update.

Crawford said in The Weather Company hurricane season forecast that the latter portion of the season could be less active if El Niño conditions develop. But it's unclear how much and how soon any type of atmospheric response there would be if El Niño did materialize.

In the CSU outlook, Klotzbach said the potential development of El Niño is different than anything seen since 1980, complicating the forecast.

"Current SST (sea-surface temperature) anomalies in the Nino 1+2 region are some of the warmest ever observed," wrote Klotzbach.

"These warm SST anomalies off the west coast of South America may be a harbinger of a developing El Niño event."

Klotzbach also cautions there is considerable uncertainty regarding the eventual strength of El Niño, assuming it even occurs.

Q: Any Other Factors in Play?

Dry air and wind shear can be detrimental to tropical storm or hurricane development no matter whether El Niño is present or not.

The 2013 and 2014 seasons featured prohibitive dry air and/or wind shear during a significant part of the season, but El Niño was nowhere to be found.

The Time to Prepare is NOW!

What should you do to prepare for a hurricane?

Get a plan. The most important step is to identify your hurricane risk. Do you live in an evacuation zone? If so, you need to plan on where you and your family would ride out the storm if you are told to evacuate. Most people only need to evacuate a few miles from the coast to avoid the dangers of storm surge. Find a friend or relative that lives outside the storm surge evacuation zone and have a plan to ride out the storm with them. You should also establish a family communications plan in case you are not together when you need to evacuate.

Once a person understands their risk for hurricane impacts, an appropriate disaster safety plan should be developed to help ensure an individual's and a family's safety. A disaster safety plan is a comprehensive plan that identifies all of the steps a family needs to take before, during, and after a disaster to ensure maximum personal safety and property protection. For a step-by-step guide on creating a family disaster plan please see Florida's "Get a Plan" guide. Citizens should also visit their State Emergency Management Agency websites for family disaster plan templates that may be more suited to a local area.

2017 Hurricane season should be calm, but still prepare

How to prepare

Dr. Corene Matyas, a professor at UF who specializes in severe weather, advises people to have copies of important documents, extra medications, plenty of drinking water and nonperishable foods. Flashlights, batteries and a first-aid kit are also good ideas. A National Oceanic and Atmospheric Administration (NOAA) weather radio can be set to alert you of any watches or warnings and also provide weather forecasts.

When going to the shelter, bring:
Sufficient nonperishable food for 72 hours, medicine and baby needs, games for children, bedding and a change of clothes for the entire family, flashlight with extra batteries.
If you are unable to evacuate during a hurricane, go to your wind-safe room. If you do not have one, follow these guidelines:
Stay indoors during the hurricane and away from windows and glass doors.
Close all interior doors — secure and brace external doors.
Keep curtains and blinds closed. Do not be fooled if there is a lull; it could be the eye of the storm — winds will pick up again.
Take refuge in a small interior room, closet or hallway on the lowest level.
Lie on the floor under a table or another sturdy object.
Avoid elevators.
What to do with your pet during a hurricane:
Keep it inside with you unless you must evacuate your home.
If you have to evacuate, there are shelters that can care for your pet until the storm passes.
Have pictures of your pets in case they get lost during a storm.
Keep your pets up-to-date on their vaccinations. Many shelters require proof of vaccination.
Have a pet emergency kit with identification, immunization records, medication, supply of food and water, a muzzle, collar and leash.

HEDGING, TOPPING, AND SKIRTING CITRUS TREES

The interception and utilization of sunlight should be an important consideration in citrus grove design. The effect of insufficient light is frequently observed in mature citrus groves that are not pruned (hedged, topped) regularly. Shading reduces yield and foliage on the lower parts of the trees. Sunlight not only influences flowering and fruit set but also enhances fruit quality and color development. Increased sunlight penetration within the tree canopy might also allow foliage to dry quicker after a rain shower and could help reduce establishment of fungal pathogens. Therefore, adjustments must be made in tree height and hedging angle to maximize sunlight interception.

Hedging and topping are important cultural grove practices. Severe hedging or topping of citrus trees during the winter can reduce cold hardiness. Trees with exposed internal scaffold wood and new tender growth are susceptible to cold injury.

In general, tree response to hedging and topping depends on several factors including variety, rootstock, tree age, growing conditions, time of pruning, and production practices. No one system or set of rules is adequate for the numerous situations encountered in the field. Growers are encouraged to gain a clear understanding of the principles involved in hedging and topping, and to take advantage of research results as well as consulting knowledgeable colleagues and custom operators for their observations.

Hedging should be started before canopy crowding becomes a problem. As a general rule of thumb, pruning of branches greater than 0.13”- 0.25” in diameter should be avoided. Developing a pro-active pruning program should assist managers in removing the right-sized branches. Removal of a significant portion of the tree will result in excessive vegetative growth and a drastic reduction in subsequent yield. Hedging is usually done at an angle, with the boom tilted inward toward the treetops so that the hedged row middles are wider at the top than at the bottom. This angled hedging allows more light to reach the lower skirts of the tree. Hedging angles being commonly used vary from 10 to 15 degrees from vertical.

Topping should be done before trees have become excessively tall and should be an integral part of a tree size maintenance program. Long intervals between toppings increase the cost of the operation due to heavy cutting and more brush disposal. Furthermore, excessively tall trees are more difficult and expensive to harvest and spray. Topping trees will improve fruit quality and increase size. Some common topping heights are 10 to 12 ft at the shoulder and 13 to 14 ft at the peak (Figure 2). As a general rule, topping heights should be two times the row middle width.

After severe hedging or topping, heavy nitrogen applications will produce vigorous vegetative regrowth at the expense of fruit production. Therefore, nitrogen applications should be adjusted to the severity of hedging and/or topping. Reducing or omitting a nitrogen application before and possibly after heavy hedging will reduce both costs and excessive vegetative regrowth. Light maintenance hedging should not affect fertilizer requirements.

Large crops tend to deplete carbohydrates and results in a reduced fruit yield and increased vegetative growth the following year. Pruning after a heavy crop additionally stimulates vegetative growth and reduces fruit yield the following year. Pruning after a light crop and before an expected heavy crop is recommended because it can help reduce alternate bearing which can be a significant problem in Valencia and Murcott production.

Severe hedging may create problems of brush disposal and stimulates vigorous new vegetative growth, especially when done before a major growth flush. This happens because an undisturbed root system is providing water and nutrients to a reduced canopy area. The larger the wood that is cut, the larger is the subsequent shoot growth. Severe pruning reduces fruiting and increases fruit size.

The best time of year to hedge and/or top depends on variety, location, severity of pruning, and availability of equipment. Since pruning is usually done after removal of the crop, early maturing varieties are generally hedged before late maturing varieties. Most growers prefer to hedge before bloom, but trees will get more vegetative regrowth, which may not be desirable. Pruning could begin as early as November prior to harvesting in warmer areas. During this period, conducted pruning operations should only cut minimal foliage and fruit from the trees.

Valencia trees may be hedged in late fall with only minimal crop reduction when the hedging process removes only a small amount of vegetative growth. In cases where excessive growth is to be removed, the trees are usually harvested before hedging is conducted. Light maintenance pruning can be done throughout the summer and until early fall with little or no loss in fruit production. Moderate to severe pruning should not continue into the winter in freeze-prone areas, as trees with tender regrowth are susceptible to cold injury.

With citrus canker and greening diseases, selecting the best time for hedging and topping is becoming more complicated. New growth flushes promoted by hedging and topping in late spring, during the summer, and early fall can increase the population of leafminers and psyllids and aggravate the spread of citrus canker and greening. Declining trees with defoliated tops, dieback, reduced cropping, and severe root loss due to citrus greening are being hedged and topped to help balance the shoot to root ratio to improve tree performance and extend tree longevity.

Skirting is the pruning to raise tree skirts. Without skirting, the movement of herbicide booms and mechanical harvesting equipment is impeded. Fruit and limbs near the ground are often damaged by the passage of such equipment and by herbicide spray and fertilizer contact. Skirting allows uniform distribution of granular fertilizers and good water coverage of microsprinkler irrigation systems under tree canopies. Skirting facilitates the inspection of microirrigation systems and reduces the incidence of Phytophthora foot rot and brown rot because it allows good air circulation.

HOW TO REDUCE DRIFT?

■ Avoid high spray pressure, which create finer droplets. Use as coarse a spray as possible and still obtain good coverage and control.

■ Don't apply pesticides under windy or gusty conditions; don't apply at wind speeds over 10 mph. Read the label for specific instructions.

■ Maintain adequate buffer zones to insure that drift does not occur off the target area.

■ Be careful with all pesticides. Insecticides and fungicides usually require smaller droplet sizes for good coverage and control than herbicides; however, herbicides have a greater potential for nontarget crop damage.

■ Choose an application method and a formulation that is less likely to cause drift.

■ Use drift reduction nozzles.

■ Use wide-angle nozzles, lower spray boom heights, and keep spray boom stable.

■ Use drift control/drift reduction agents. These materials are designed to minimize the formation of droplets smaller than 150 microns. They help produce a more consistent spray pattern and aid in deposition. Drift control additives do not eliminate drift. Therefore, common sense is still required.

■ Apply pesticides early in the morning or late in the evening; the air is often more still than during the rest of the day.

■ Don't spray during thermal inversions, when air closest to the ground is warmer than the air above it. When possible, avoid spraying at temperatures above 90° F.

■ Know your surroundings! You must determine the location of sensitive areas near the application site. Some crops are particularly sensitive to herbicides, which move off-site.

■ Be sure you are getting the spray deposition pattern you think you are; service and calibrate your equipment regularly.

■ Whenever possible, cut off the spray for missing trees in the row. Spray that does not enter the tree canopy is wasted and contributes significantly to drift problems.

■ Keep good records and evaluate pesticide spray results.

Remember,
ALWAYS read and follow label directions.

Field Identification of Citrus Blight

http://edis.ifas.ufl.edu/hs241

S. H. Futch, K. S. Derrick and R. H. Brlansky

Citrus blight is a disease that causes thousands of trees to become unproductive every year, resulting in losses in excess of $60 million annually.

The cause of blight is unknown. The disease is found in many citrus-producing regions including North America, the Caribbean, South America, South Africa and Australia. Blight is found in mostly tropical or semitropical regions with moderate to heavy rainfall but is not reported in more arid regions such as the Mediterranean Basin and California. Blight has been present in Florida for more than 100 years and was frequently called young tree decline in the 1960s and 70s. Trees affected by blight grow normally until they reach five to six years of age or older and then begin to wilt and to exhibit leaf loss, reduced growth flushes, die back and general decline. In early stages of blight, the symptoms may be restricted to one sector of the tree and then expand to the entire tree. Trees remain in various stages of decline and become unproductive, but they rarely die. As the tree declines, vegetative sprouts may be produced on the trunk or on larger interior branches near the trunk. Trees affected with blight will not recover from the disease even if they are severely pruned. Pruning merely makes the tree look acceptable for a year or two before it declines again.

Blight affects all major rootstocks and seedlings to varying degrees but is most severe on rough lemon, Rangpur lime, trifoliate orange and citrange rootstocks. Trees grown on sweet orange, sour orange, mandarin and some citrumelo rootstocks usually have lower incidences of blight and usually do not exhibit symptoms before trees are 15 to 20 years old.

As the trees decline, water uptake within the xylem (wood) is reduced, zinc accumulates in the bark and outer xylem tissue, and zinc deficiency patterns develop in the leaves. As the xylem vessels in the trunk become plugged with amorphous occlusions, water transport is reduced, causing a general wilt appearance. New xylem vessels are produced in higher numbers but are smaller in size and eventually become plugged.

When blight first appears within a grove, the distribution pattern of affected trees appears to be random. Thereafter, the disease spreads to adjacent trees within the row more frequently than across rows. Blight has not been transmitted by ordinary budding or grafting practices. However, grafting roots of blight-infected trees to healthy ones will cause the healthy tree to develop blight symptoms in about two years. Natural root grafting of adjacent trees has been associated with the spread of the disease.

At present, the only control measure for blight is to replace declining trees with trees on rootstocks that are less susceptible to the disease. Trees on Cleopatra mandarin develop symptoms more slowly than other commonly used rootstocks, but symptoms will eventually occur with time. Blight is uncommon in trees on sweet orange rootstock.

An easy and rapid field test for blight is to inject water with a syringe into the trunk of the tree. Trees that have blight will not accept water via the syringe test method regardless of the amount of pressure applied to the syringe. To conduct this field test you will need the following tools: battery powered drill, 9/64-inch drill bit, 30 ml syringe and water (Figure 2). The drill bit diameter may vary depending on syringe type but it must be slightly smaller than the tip on the end of the syringe to allow for a tight fit. This tight fit between the tree trunk and syringe will restrict water flow out of the drilled hole when pressure is applied to the syringe. To force water into the tree trunk, significant pressure must be applied to the syringe because injecting water into the tree requires more pressure than when injecting water into other types of tissue.

Figure 2. Items needed to check tree for citrus blight.

Steps To Use in Conducting a Field Blight Test

Step one: Drill a hole into the trunk of the tree above the bud union using a sharp drill bit and a battery powered drill (Figure 3). The hole should be at least one inch deep into the tree trunk.

Figure 3. Drilling hole into tree trunk above bud union.

Step two: Fill the syringe with water, making sure all the air within the syringe is purged before inserting the tip of the syringe into the tree trunk.

Step three: Insert the tip of the syringe into the drilled hole, making sure that a tight fit between the tree trunk and syringe tip exists. Apply pressure to the syringe to see if water is accepted by the tree (Figure 4). As water is accepted, one can see the plunger of the syringe move slightly forward. Healthy trees with no visual symptoms in the canopy should accept at least 3 ml in 10 seconds, whereas fully blighted trees will accept less than 0.5 ml of water in the same 10 second period. Trees in early stages of the disease will accept 1 to 2 ml per 10 seconds. Trees infected with blight will accept very little or no water, whereas a tree declining from other diseases or disorders will accept water readily, thus providing an easy field diagnostic test for citrus blight.

Figure 4. Determining water uptake.

Summary from Causes and Prevention of Emitter Plugging In Microirrigation Systems

Dr. Dorota Haman, UF-IFAS

In the past two decade, the use of microirrigation to provide water to citrus trees has increased dramatically. Microirrigation, properly managed, offers several potential advantages over other methods of irrigation:

--greater water application uniformity.

--improved water use efficiency.

--minimized deep percolation and runoff.

--reduced bacteria, fungi, disease, and other pests that require a moist environment and a wet canopy.

--efficient delivery of fertilizer (fertigation) and other chemicals (chemigation) through the irrigation system.

--ability to irrigate land too steep for other means of irrigation.

The plugging of emitters is one of the most serious problems associated with microirrigation use. Emitter plugging can severely hamper water application uniformity.

I. Causes of Emitter Plugging

Emitter plugging can result from physical (grit), biological (bacteria and algae), or chemical (scale) causes. Frequently, plugging is caused by a combination of more than one of these factors.

Influence of the Water Source

The type of emitter plugging problems will vary with the source of the irrigation water. Water sources can be grouped into two categories: surface or ground water. Algal/bacterial growth is a major problem associated with the use of surface water. Whole algae cells and organic residues of algae are often small enough to pass through the filters of an irrigation system. These algal cells can then form aggregates that plug emitters. Chemical precipitation is normally not a major problem when using surface water. Groundwater, on the other hand, often contains high levels of minerals in solution that can precipitate and form scale. Water from shallow wells (less than 100 ft) often will produce plugging problems associated with bacteria. Chemical precipitation is more common with deep wells. Physical plugging problems are generally less severe with groundwater.

Physical

Sources of physical plugging problems include particles of sand and suspended debris that are too large to pass through the openings of emitters. Sand particles, which can plug emitters, are often pumped from wells. Water containing some suspended solids may be used with microirrigation systems if these suspended solids consist of clay-sized particles, and flocculation does not occur. Research has shown that using water with over 500 ppm suspended solids did not cause emitter plugging as long as the larger particles were filtered. Under some conditions, however, clay will flocculate and form aggregates causing plugging. Unflocculated clay and silt-sized particles are normally too small to plug emitters. Turbidity is an indicator of suspended solids, but turbidity alone is not an accurate predictor of the plugging potential of a water source. Turbidity should be combined with a laboratory filtration test to measure plugging potential.

Biological

A microirrigation system can provide a favorable environment for bacterial growth, resulting in slime buildup. This slime can combine with mineral particles in the water and form aggregates large enough to plug emitters. Certain bacteria can cause enough precipitation of manganese, sulfur, and iron compounds to cause emitter plugging. In addition, algae can be transported into the irrigation system from the water source and create conditions that may promote the formation of aggregates. Emitter plugging problems are common when using water that has high biological activity and high levels of iron and hydrogen sulfide. This is a frequent problem in Florida, because iron and sulfur are common constituents of many Florida waters.

Soluble ferrous iron is a primary energy source for certain iron-precipitating bacteria (Gilbert and Ford, 1986). These bacteria can attach to surfaces and oxidize ferrous iron to its insoluble ferric iron form. In this process, the bacteria create a slime that can form aggregates called ochre, which may combine with other materials in the microirrigation tubing and cause emitter plugging. Ochre deposits and associated slimes are usually red, yellow, or tan. Sulfur slime is a yellow to white stringy deposit formed by the oxidation of hydrogen sulfide commonly present in shallow wells in Florida. Hydrogen sulfide (H_2S) accumulation in groundwater is a process typically associated with reduced conditions in anaerobic environments. Sulfide production is common in lakes and marine sediments, flooded soils, and ditches; it can be recognized by the rotten egg odor. Sulfur slime is produced by certain filamentous bacteria that can oxidize hydrogen sulfide and produce insoluble elemental sulfur.

The sulfur bacteria problem can be minimized if there is not air-water contact until water is discharged from the system. Defective valves or pipe fittings on the suction side of the irrigation pump are common causes of sulfur bacteria problems (Ford and Tucker, 1975). If a pressure tank is used, the air-water contact in the pressure tank can lead to bacterial growth in the tank, clogging the emitter. The use of an air bladder or diaphragm to separate the air from the water should minimize this problem.

Chemical

Water is often referred to as the universal solvent since almost everything is soluble in it to some extent. The solubility of a given material in water is controlled by variations in temperature, pressure, pH, redox potential, and the relative concentrations of other substances in solution. Three gases (oxygen, carbon dioxide, and hydrogen sulfide) are important in determining the solubility characteristics of water. These gases are very reactive in water, and they determine to a significant extent the solubility of minerals within a given water source.

In order to predict what might cause chemical plugging of microirrigation system emitters, the process of mineral deposition must be understood. Carbon dioxide gas (CO_2) is of particular importance in the dissolution and deposition of minerals. Water absorbs some CO_2 from the air, but larger quantities are absorbed from decaying organic matter as water passes through the soil. Under pressure, as is groundwater, the concentration of CO_2 increases to form carbonic acid. This weak acid can readily dissolve mineral compounds such as calcium carbonate to form calcium bicarbonate which is soluble in water. This process allows calcium carbonate to be dissolved, transported, and under certain conditions, again redeposited as calcium carbonate.

Calcium carbonate is the most common constituent of scale. Calcite, aragonite, and vaterite are mineral forms of calcium carbonate that have been found in carbonate scale. Calcite is formed at temperatures common within microirrigation systems, and is the most common and stable of the mineral forms.

Calcium minerals occur extensively in the form of limestone and dolomite (magnesium-calcium carbonate). Calcite is the principal constituent of limestone, and occurs in many calcareous metamorphic rocks such as marble. Therefore, it is not surprising to encounter calcium carbonate in solution in almost all surface and ground waters, especially in Florida where much of the groundwater is pumped from large underlying limestone formations. As groundwater passes through these limestone formations it dissolves the limestone and carries calcium carbonate with it.

Chemical plugging usually results from precipitation of one or more of the following minerals: calcium, magnesium, iron, or manganese. The minerals precipitate from solution and form encrustations (scale) that may partially or completely block the flow of water through the emitter. Water containing significant amounts of these minerals and having a pH greater than 7 has the potential to plug emitters. Particularly common is the precipitation of calcium carbonates, which is temperature and pH dependent. An increase in either pH or temperature reduces the solubility of calcium in water, and results in precipitation of the mineral.

When groundwater is pumped to the surface and discharged through a microirrigation system, the temperature, pressure, and pH of the water often changes. This can result in the precipitation of calcium carbonates or other minerals to form scale on the inside surfaces of the irrigation system components. A simple test for identifying calcium scale is to dissolve it with vinegar. Carbonate minerals dissolve and release carbon dioxide gas with a fizzing, hissing sound known as effervescence.

Iron is another potential source of mineral deposit that can plug emitters. Iron is encountered in practically all soils in the form of oxides, and it is often dissolved in groundwater as ferrous bicarbonate. When exposed to air, soluble ferrous bicarbonate oxidizes to the insoluble or colloidal ferric hydroids and precipitates. The result is commonly referred to as 'red water,' which is sometimes encountered in farm irrigation wells. Manganese will sometimes accompany iron, but usually in lower concentrations.

Hydrogen sulfide is present in many wells in Florida. Precipitation problems will generally not occur when hard water, which contains large amounts of hydrogen sulfide, is used. Hydrogen sulfide will minimize the precipitation of calcium carbonate ($CaC0_3$) because of its acidity.

Fertigation

Fertigation is the application of plant nutrients through an irrigation system by injection into the irrigation water. Fertilizers injected into a microirrigation system may contribute to plugging. Field surveys have indicated considerable variation in fertilizer solubility for different water sources. To determine the potential for plugging problems from fertilizer injection, the following test can be performed:

Add drops of the liquid fertilizer to a sample of the irrigation water so that the concentration is equivalent to the diluted fertilizer that would be flowing in the lateral lines.

If no apparent precipitation has occurred, the fertilizer source will normally be safe to use in that specific water source.

II. Prevention of Emitter Plugging

A properly designed microirrigation system should include preventive measures to avoid emitter plugging. Differences in operating conditions and water quality do not allow a standardized recommendation for all conditions. In general, however, the system should include the following:

--a method of filtering the irrigation water.

--a means of injecting chemicals into the water supply.

--in some cases a settling basin to allow aeration and the removal of solids.

--equipment for flushing the system.

Prevention of plugging can take two basic approaches: 1) removing the potential source of plugging from the water before it enters the irrigation system; or 2) treating the water to prevent or control chemical and biological processes from occurring. Both approaches will be discussed. In many cases, a combination of both approaches will be applicable.

Water Quality Analysis

Knowing the quality of proposed irrigation water is necessary before designing a microirrigation system. Water quality analyses are performed at water testing laboratories. A water analysis specifically for microirrigation should be requested. The analysis should include the factors listed in Table 1. If the source is groundwater from a relatively deep well (over 100 ft), analysis for bacteria population may be omitted. Conversely, if the source is surface water, hydrogen sulfide will not be present and can be omitted.Table 1 provides concentration levels for evaluating the water quality analysis in terms of the potential for emitter plugging.

part per million (ppm) = mg/L = mg/kg

dS/m = mmho/cm

mmho/cm x 700 = dS/m x 700 = ppm (for salts typically found in Florida surface and ground water)

mmho/cm = 1000 µmhos/cm

µS/cm = µmho/cm

µmho/cm x 0.7 = µS/cm x 0.7 = ppm

A water quality analysis usually lists electrical conductivity in micromhos per centimeter (µmho/cm). To estimate parts per million (ppm) dissolved solids, multiply µmho/cm by 0.7. For example, if the electric conductivity meter reads 1000 µmho/cm, then dissolved solids can be estimated as 700 ppm.

Hardness is primarily a measure of the presence of calcium (Ca) and magnesium (Mg), and is another indicator of the plugging potential of a water source. If Ca and Mg are given in ppm rather than hardness, hardness can be estimated from the relationship shown in Equation 1: where calcium (Ca) and magnesium (Mg) are given in milligrams per liter (mg/L or ppm).

Equation 1:

$$Hardness = (2.5 \times Ca) + (4.1 \times Mg)$$

Note that 1 mg/L equals 1 ppm. If the analysis lists the Ca and Mg concentrations in milliequivalents per liter (meq/l), they can be converted to ppm by the factors shown in Equation 2:

Equation 2:

Ca (meq/L) X 20 = Ca (ppm)
Mg (meq/L) X 12 = Mg (ppm)

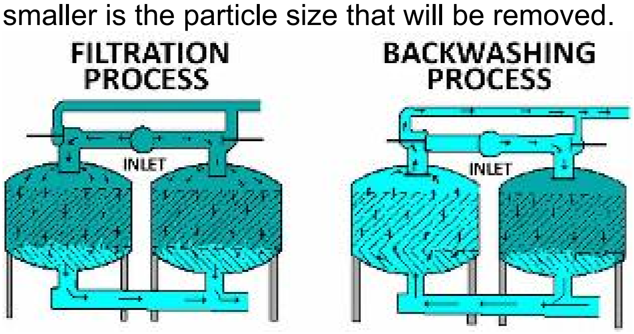
Filters for Prevention of Physical Plugging

Many types of microirrigation filter systems that will perform adequately are available commercially. Important factors to consider in selecting a filtering method are emitter design and quality of the water source. Consider the emitter's minimum passageway diameter when selecting the filter mesh size. Filters should be sized according to the emitter manufacturer's recommendations. In the absence of manufacturer's recommendations, remove any particles larger than one-tenth the diameter of the smallest opening in the emitter flow path.

Screen filters come in a variety of shapes and sizes. Screen material may be slotted PVC, perforated stainless steel, or synthetic or stainless steel wire. Mesh size-- the number of openings per inch-- determines the fineness of the material filtered.

Surface water sources should have a coarse screen filter installed on the pump inlet (suction) line to block trash and large debris. To avoid floating debris, the pump inlet should be located two feet below the water surface but suspended above the bottom.

Media (sand) filters are available with the capacity to efficiently remove most types of physical plugging sources. These filters will remove colloidal and organic material usually present in surface waters. The size and type of media used determines the degree of filtration. The finer the media, the smaller is the particle size that will be removed.



Size of the media filter required is determined by the flow rate of the system, and is measured by the top surface area of the filter. Media filters should be sized to provide a minimum of one square foot of top surface area for every 20 GPM of flow, or as the manufacturer recommends.

Filters are cleaned by reversing the direction of water flow through them; this procedure is called backwashing. Backwashing can be manual or automatic, on a set time interval or at a specific pressure drop. When using a media filter, install it with an additional screen filter (200-mesh or manufacturer's recommendation) downstream to prevent the transport of sand to the irrigation system during the backwash procedure.

Settling Ponds

In addition to filtration, the quality of water with high levels of solids can be improved with settling ponds or basins to remove large inorganic particles. Settling ponds can also be used for aeration of groundwater containing high amounts of iron or manganese.

Experiments have shown that a ferrous iron content as low as 0.2 ppm can contribute to iron deposition. Iron is very common in shallow wells in many parts of Florida, but it can often be economically removed from irrigation water by aeration (or by some other means of oxidation), followed by sedimentation and/or filtration.

Existing ponds can sometimes be used as settling basins. They should be accessible for cleaning and large enough that the velocity of the flowing water is sufficiently slow for particles to settle out. Experience based on municipal sedimentation basins indicates that the maximum velocity should be limited to 1 foot per second.

A settling basin should be designed to remove particles having equivalent diameters exceeding 75 microns, which corresponds to the size of a particle removed by a 200-mesh screen filter. The basin works on the principle of sedimentation, which is the removal of suspended particles that are heavier than water by gravitational settling. Materials held in suspension due to the velocity of the water can be removed by lowering the velocity. In some cases, materials that are dissolved in solution oxidize (through exposure to a free air surface), precipitate, and flocculate to form aggregates large enough to settle out of the water.

Settling ponds are also recommended when the irrigation water source is a fast-moving stream. Velocity of the water is slowed in the settling pond, thus allowing many particles to settle out.

Flushing

To minimize sediment build up, regular flushing of microirrigation pipelines is recommended. Valves large enough to allow sufficient velocity of flow should be installed at the ends of mains, submains, and manifolds. Also, allowances for flushing should be made at the ends of lateral lines. Begin the flushing procedure with the mains, then proceed to submains, manifolds, and finally to the laterals. Flushing should continue until clean water runs from the flushed line for at least two minutes. A regular maintenance program of inspection and flushing will help significantly in preventing emitter plugging.

To avoid plugging problems when fertigating, it is best to flush all fertilizer from the lateral lines prior to shutting the irrigation system down.

Chemical Treatment

Chemical treatment is often required to prevent emitter plugging due to microbial growth and/or mineral precipitation. The attachment of inorganic particles to microbial slime is a significant source of emitter plugging. Chlorination is an effective measure against microbial activity. Acid injection can remove scale deposits, reduce or eliminate mineral precipitation, and create an environment unsuitable for microbial growth.

Chlorine Injection

Chlorination is the most common method for treating bacterial slimes. If the microirrigation system water source is not chlorinated, it is a good practice to equip the system to inject chlorine to suppress microbial growth. Since bacteria can grow within filters, chlorine injection should occur prior to filtration.

Liquid sodium hypochlorite (NaOCl)--laundry bleach--is available at several chlorine concentrations. The higher concentration products are often more economical. Powdered calcium hypochlorite ($CaCOCl_2$), also called High Test Hypochlorite (HTH) is not recommended for injection into microirrigation systems since it can produce precipitates that can plug emitters, especially at high pH levels.

The following are several possible chlorine injection schemes:

Inject continuously at a low level to obtain 1 to 2 ppm of free chlorine at the ends of the laterals.

Inject at intervals (once at the end of each irrigation cycle) at concentrations of 20 ppm and for a duration long enough to reach the last emitter in the system.

Inject a high concentration (50 ppm) weekly at the end of an irrigation cycle and for a duration sufficient to distribute the chlorine through the entire piping system.

The method used will depend on the growth potential of microbial organisms, the injection method and equipment, and the scheduling of injection of other chemicals.

The amount of liquid sodium hypochlorite required for injection into the irrigation water to supply a desired dosage in parts per million can be calculated by the simplified method in Equation 3:

Equation 3:

$$I = (0.006 \times P \times Q)/m$$

where,

I = gallons of liquid sodium hypochlorite injected per hour,

P = parts per million desired,

Q = system flow rate in gpm,

m = percent chlorine in the source, usually 5.25% or 10%.

When chlorine is injected, a test kit should be used to be sure that the injection rate is sufficient. Color test kits (D.P.D.) that measure 'free residual' chlorine, should be used. The orthotolidine-type test kit, which is often used to measure total chlorine content in swimming pools, is not satisfactory for this purpose. D.P.D. test kits can be purchased from irrigation equipment dealers. Check the water at the

outlet farthest from the injection pump. There should be a residual chlorine concentration of 1 to 2 ppm at that point. Irrigation system flow rates should be closely monitored and action taken (chlorination) if flow rates decline.
Chlorination for bacterial control is relatively ineffective above pH 7.5, so acid additions is necessary to lower the pH to increase the biocidal action of chlorine for more alkaline waters. This may be required when the water source is the Floridian aquifer.
Since sodium hypochlorite can react with emulsifiers, fertilizers, herbicides, and insecticides, bulk chemicals should be stored in a secure place according to label directions.

Acid Treatment

Acid can be used to lower the pH of irrigation water to reduce the potential for chemical precipitation and to enhance the effectiveness of chlorine injection. Sulfuric, hydrochloric, and phosphoric acids are all used for this purpose. Acid can be injected in much the same way as fertilizer; however, extreme caution is required. The amount of acid to inject depends on how chemically base (the buffering capacity) the irrigation water is and the concentration of the acid to be injected.
If acid is injected on a continuous basis to prevent calcium and magnesium precipitates from forming, the injection rate should be adjusted until the pH of the irrigation water is just below 7.0. If the intent of the acid injection is to remove existing scale buildup within the microirrigation system, the pH will have to be lowered more. The release of water into the soil should be minimized during this process since plant root damage is possible. An acid slug should be injected into the irrigation system and allowed to remain in the system for several hours, after which the system should be flushed with irrigation water. Acid is most effective at preventing and dissolving alkaline scale. Avoid concentrations that may be harmful to emitters and other components of the irrigation system.
Phosphoric acid, which is also a fertilizer source, can be used for water treatment. Some microirrigation system operators use phosphoric acid in their fertilizer mixes. Caution is advised if phosphoric acid is used to suppress microbial growth. Care should be used with the injection of phosphoric acid into hard water since it may cause the precipitation of calcium carbonate at the interface between the injected chemical and the water source.
For safety, dilute the concentrated acid in a non-metal, acid-resistant mixing tank prior to injection into the irrigation system. When diluting acid, always add acid to water, never water to acid. The acid injection point should be beyond any metal connections or filters to avoid corrosion. Flushing the injection system with water after the acid application is a good practice to avoid deterioration of irrigation system components in direct contact with the acid.
Acids and chlorine compounds should be stored separately, preferably in epoxy-coated plastic or fiberglass storage tanks. Acid can react with hypochlorite to produce chlorine gas and heat; therefore, the injection of acid should be done at some distance (2 feet), prior to the injection of chlorine. This allows proper mixing of the acid with the irrigation water before the acid encounters the chlorine.
Hydrochloric, sulfuric, and phosphoric acids are all highly toxic. Always wear goggles and chemical-resistant clothing whenever handling these acids. Again, acid must be poured into water; never pour water into acid.

Pond Treatment

Algae problems which often occur with surface water sources such as a pond can be effectively treated with copper sulfate ($CuS0_4$). Dosages of 1 to 2 ppm (1.4 to 2.7 pounds per acre foot) are sufficient and safe to treat algae growth. Copper sulfate should be applied when the pond water temperature is above 60°F. Treatments may be repeated at 2 to 4-week intervals, depending on the nutrient load in the pond. Copper sulfate should be mixed into the pond (i.e., sprinkled into the wake of a boat). The distribution of biocides into surface water must be in compliance with EPA regulations.
Copper sulfate can be harmful to fish if alkalinity, a measure of the water's capacity to neutralize acid, is low. Alkalinity is measured volumetrically by titration with H_2S0_4 and is reported in terms of equivalent $CaC0_3$.

Backflow Prevention

To ensure that the water source does not become contaminated, Florida law, EPA regulations, and county and municipal codes require backflow prevention assemblies on all irrigation systems injecting chemicals into irrigation water. Appropriate backflow prevention should include the following setup:

--a check valve upstream from the injection device to prevent backward flow
--a low pressure drain to prevent seepage past the check valve
--a vacuum relief valve to ensure a siphon cannot develop
--a check valve on the injection line

If an externally-powered metering pump is used for injection, it should be electrically interlocked with the irrigation pump. This interlock should not allow the injection pump to operate unless the irrigation pump is operating. If irrigation water is being used from municipal or other public water supply systems, special backflow precautions must be taken.

<u>Summary</u>

Emitter plugging can occur from physical, biological and chemical causes.
A water quality analysis is vital to the proper design and operation of the microirrigation system.
Every microirrigation system needs some method of filtration.
Regular flushing of the lateral and main lines will help to prevent plugging.
Most microirrigation systems will require a method of chemical treatment of the water source, and a backflow prevention system will also be required.

Table 1. Criteria for plugging potential of microirrigation water sources.

	Plugging Hazard Based on Concentration		
	Concentrations		
Factor	**Slight**	**Moderate**	**Severe**
<u>Physical</u>			
Suspended solids(filterable)	< 50	7.0 to 7.5	> 7.5
<u>Chemical</u>			
pH	< 7.0	7.0 to 7.5	> 7.5
Dissolved solids (ppm)	< 500	500 to 2000	> 2000
Manganese (ppm)	< 0.1	0.1 to 1.5	> 1.5
Iron (ppm)	< 0.1	0.1 to 1.5	> 1.5
Hydrogen sulfide (ppm)	< 0.5	0.5 to 2.0	> 2.0
Hardness* (ppm)	< 150	150 to 300	> 300
<u>Biological</u>			
Bacteria (population)	< 10,000	10,000 to 50,000	> 50,000
*Hardness as ppm $CaCO_3$			

Fertigation Practical Example

Use only complete soluble fertilizers for fertigation

Enter your numbers:

--The percentage of nitrogen in your fertilizer (example 8% = 0.08)
--Weight in pounds of one gallon of your fertilizer (example 10 lb/gal)
--How many pounds of nitrogen you want to apply per acre (example 5 lb N/acre)
--The total acreage of your block (example 20 acres)
--Your irrigation flow rate of your irrigation system in gallons per minute (example 1,000 gal/min)
--The nitrogen concentration in parts per million you want to inject (example 200 ppm)

Here is an example

We will use a fertilizer (8% N or 0.08 N, 10 pounds per gallon) to apply 5 lb N per acre to a 20-acre field. The irrigation flow rate is 1,000 gallons per minute and the target N concentration in the irrigation line is 200 ppm. To calculate the injection rate and time:

Step 1: **Total N**: 5 lb/acre N × 20 acres = 100 lb N

Step 2: **Pounds of Fert-8**: 100 lb N ÷ 0.08 = 1250 lb of the fertilizer

Step 3: **Gallons of Fert-8**: 1250 lb ÷ 10 lb/gal = 125 gal

Step 4: **Dilution factor**: 0.08 × 1,000,000 ppm ÷ 200 ppm = 400

Step 5: **Injection rate**: 1000 gal/min ÷ 400 = 2.5 gal/min

Step 6: **Injection time**: 125 gal ÷ 2.5 gal/min = 50 min

Therefore, in this particular case, we need 125 gallons of fertilizer to be injected in 50 minutes.

Assume it takes 10 minutes for the water to travel from the injection point to the farthest emitters and reach full system pressure. Then, we need 50 minutes to inject the fertilizer and 15 minutes to flush the remaining fertilizer through the system.

As a result, a total fertigation event should have:
---10 minutes for water to travel from the injection point to the farthest emitter and reach full pressure +
---50 minutes to inject the fertilizer solution +
---10 minutes for the last bit of fertilizer solution to reach the farthest emitter +
---5 minutes extra to be sure that the system is flushed=
---**Total time of 75 minutes (1hour 15 minutes)**

When preparing to inject fertilizer, first allow time for the irrigation system to fully pressurize. In most small irrigation zones, the full system pressure is reached in 10 minutes or less, but you should check each zone to determine the actual time. Once the system reaches full pressure, you can begin fertigation. For most sandy soils, the total run time of a single irrigation event should not be more than 2 hours in duration to avoid fertilizer leaching. Calculations may be done by timing an actual injection, or by calculations. After fertigation, continue to run water to evenly distribute all of the fertilizer throughout the zone. The length of this run is generally a little longer than the time required initially to bring the system up to full pressure. After each fertigation application, flush the system and be sure that all the fertilizer is flushed from the lines. Determine the time required to inject the quantity of fertilizer needed.

In summary, the total time for an entire fertigation event includes the following:

- Time for water to travel from the injection point to the farthest emitter and bring the system up to full pressure
- Time to inject the fertilizer solution
- Time for the last bit of fertilizer solution to reach the farthest emitter
- Additional time to flush the system

Fertilizer must be completely flushed from the system after fertigation in order to keep microirrigation lines clean and prevent emitters from clogging.

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Racial-Ethnic Background

__American Indian or native Alaskan
__Asian American
__Hispanic
__White, non-Hispanic
__Black, non-Hispanic

Gender

__Female

__Male