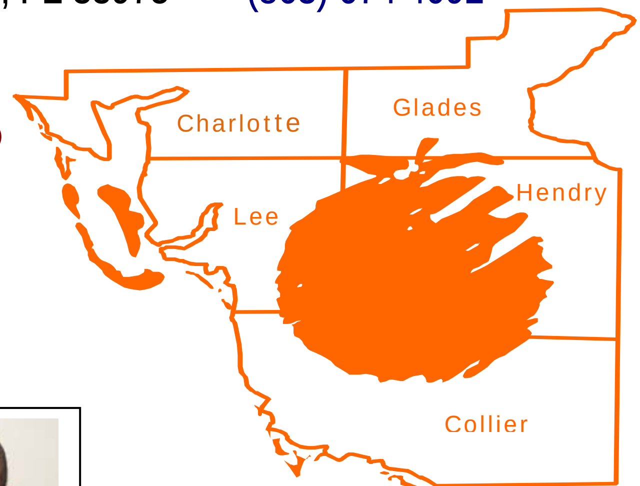
UNIVERSITY of FLORIDA
IFAS Extension

E X T E N S I O N

Institute of Food and Agricultural Sciences

Hendry County Extension, P.O. Box 68, LaBelle, FL 33975 (863) 674 4092

Flatwoods Citrus



Vol. 23, No. 5 **May 2020**

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

Table of Contents

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If you would like to be among them, please contact me at 863 674 4092 or maz@ufl.edu

Steve Fletcher
Fletcher Flying Service, Inc.
Phone: 239 860 2028
fletcherflying@hotmail.com

Scott Houk
Dow AgroSciences
13543 Troia Drive
Estero, FL 33928
Phone: 239-243-6927
SEHouk@dow.com

Adrian Jahna
BASF Corporation
Cell: 863 443 2404
Adrian.jahna@basf.com

Nufarm
Brad Lang
Territory Sales Manager
Phone: 229 894 0568
brad.lang@nufarm.com

Clint Wise Jr.
AGLIME SALES, INC.
P.O. Box 60
Babson Park, FL 33827
863-241-9007
clint.wise@aglimesales.com

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EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by

CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society

9 April 2020

ENSO Alert System Status: Not Active

Synopsis: **ENSO-neutral is favored for the Northern Hemisphere summer 2020 (~60% chance), remaining the most likely outcome through autumn.**

During March 2020, above-average sea surface temperatures (SSTs) were observed across most of the tropical Pacific Ocean (Fig. 1). The latest weekly Niño-3.4 and Niño-3 indices were slightly elevated (+0.6°C), while the Niño-4 and Niño-1+2 index values were +0.7°C and +0.8°C, respectively (Fig. 2). Equatorial subsurface temperatures (averaged across 180°-100°W) remained above average overall, but the anomalies decreased during the month (Fig. 3) due to the expansion of below-average temperatures into the central Pacific at depth (Fig. 4). Also during the month, low-level wind anomalies were easterly in the eastern Pacific, while upper-level wind anomalies were westerly over the central and eastern portions of the basin. Tropical convection was near average around the Date Line, and slightly suppressed over parts of Indonesia (Fig. 5). Overall, the combined oceanic and atmospheric system remained consistent with ENSO-neutral.

The majority of models in the IRI/CPC plume (Fig. 6) favor ENSO-neutral (Niño-3.4 index between -0.5°C and +0.5°C) through the Northern Hemisphere autumn. While the Niño 3.4 index values remained elevated during March, the consensus of forecasters expects these values to decrease between the spring and summer. In summary, ENSO-neutral is favored for the Northern Hemisphere summer 2020 (~60% chance), remaining the most likely outcome through autumn (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 14 May 2020. 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

Neutralizing Excess Bicarbonates from Irrigation Water in Florida

By Gerald Kidder and Ed Hanlon, UF-IFAS

Many sources of irrigation water in Florida contain dissolved bicarbonates. Irrigation with such water can cause adverse plant growth by excessively raising the pH of the soil. The magnitude of the effect depends on the concentration of the bicarbonates in the water, the amount of the water applied, the buffering capacity of the soil, and the sensitivity of the citrus variety/rootstock being grown.

This publication addresses this important water quality problem and suggests management practices to minimize adverse effects on citrus tree growth and production.

1. Where in Florida is the problem most likely to occur?

The problem of high dissolved bicarbonates is likely to occur wherever water comes from a limestone aquifer, such as the Floridan or Biscayne, or from lakes or canals that cut into limestone. Thus, this is a potential problem in most of Florida.

2. How can I find out if I have high-bicarbonate water?

A water test is the surest means of determining if a problem exists.

3. Isn't it sufficient to just measure the water's pH?

If the pH of your irrigation water is below 7.0, then we may safely assume that it will not be a significant source of liming materials. However, if the pH is above 7.0, we know that the water contains bases but we don't know how much. For example, one water source may have a relatively high pH of 8 and yet contain a very low level of bicarbonates. Another water source, with the same pH, may have a very high bicarbonate level.

4. How are Ca and Mg analyses useful?

Multiplication of parts per million (ppm) Ca by 0.05 and ppm Mg by 0.083, and summing the two products, will give the milliequivalents of those cations per liter (me/L) of water. In many cases, Ca and Mg will be associated with bicarbonate and carbonate salts. Under those conditions, the me/L of Ca plus Mg will be a good estimate of the me/L of associated bases. However, if other non-basic ions such as sulfate are present, the calculation would overestimate the base content of the water. Thus, Ca and Mg analyses may be useful in estimating base content but should be used with caution.

5. In which crop situations am I likely to have a problem with high pH water?

Trifoliate and most trifoliate hybrid rootstocks are particularly sensitive to high pH soil, are trees budded onto them usually exhibit ill effects of high bicarbonate water through micronutrient deficiency symptoms. Trees budded on Swingle rootstock are well-known for their sensitivity to pH-induced iron chlorosis. Trees budded on citrange rootstocks have shown manganese and zinc deficiencies when the soil pH has been raised by heavy or prolonged use of "hard" water (i.e., water with lots of Ca and Mg bicarbonates).

6. Which irrigation situations are most problematic?

Heavy irrigations applied to soils of low buffering capacity will present the most problems to citrus trees.

7. What can I do to minimize the adverse effects of high-bicarbonate water?

Be careful not to over-irrigate. Know the water holding capacity of your soil and apply only enough water without exceeding the root zone water-holding capacity. Over-irrigation is costly in many ways -- the cost of pumping, of leached nutrients, of wasted water resources and, in this case, of accelerating the increase in soil pH. Avoid these with good irrigation management.

Apply acids or acid-forming materials to the soil to counteract the bases applied in the water.

Neutralize the liming effect of the water by adding acid to the water before it is applied to the trees.

8. What can be done if the trees are already suffering from water-induced high pH?

Where high levels of bicarbonates in the water have caused soil to be too high for proper tree performance, it may be necessary to lower the soil pH. This may be accomplished by addition of extra acid in the irrigation water, use of acid-forming fertilizer in certain cases, or application of elemental sulfur to the soil.

It is important to note that the acid-producing effect of sulfur comes from the formation of sulfuric acid when soil bacteria act on the elemental sulfur. The sulfate form of sulfur applied in fertilizers such as potassium sulfate, magnesium sulfate, or gypsum (calcium sulfate) does not have the acid-producing effect of elemental sulfur.

Sulfur application rates of 300 to 500 pounds per acre should not be exceeded. This rate is equivalent to between 0.7 and 1.1 lbs/100 square feet of treated surface area. Over-application of sulfur or acid can cause damage to trees, an effect you certainly want to avoid. Monitor changes carefully.

Remember the pH will increase again as you continue to irrigate with high bicarbonate water. Water or soil acidification will be a continuing effort.

9. Can acid-forming fertilizers keep the soil pH from getting too high?

Under many circumstances, the quantity of bases that is being supplied in the irrigation water far exceeds the quantity of acid formed by addition of fertilizers. Under those conditions acid-forming fertilizer will not control the problem of increasing soil pH.

10. How can I neutralize the bicarbonates in my irrigation water?

Injection of acid into the irrigation water is a direct way of neutralizing the bases present. Acid may be injected in much the same way as fertilizer. You must take precautions to avoid injuring yourself and your trees and to avoid contamination of the aquifer. These points are discussed below.

11. How much acid should I apply?

The amount of acid that you mix with the irrigation water will depend on the quantity of bases your water contains and on the strength of the acid you use. The base content of the water is determined in the water test and the strength of the acid is given on the container. One milliequivalent (me) of acid completely neutralizes one milliequivalent of base. For example, if an irrigation water contains 5.2 me of bases per liter, it would take 5.2 me of acid to completely neutralize the liter of water. Neutralization of 80 to 90% of the bases in water is a reasonable goal for most irrigation situations.

Multiply the factor by the milliequivalents of base per liter (me/L) which your water contains. This value is determined in the laboratory test of your water or is estimated from its Ca and Mg contents. The result is the milliliters of your acid which you should apply to each 100 gallons of your water. The factor is calculated to neutralize 80% of the bases in the water. There are 29.6 ml in one U.S. fluid ounce. Divide the number of ml by 29.6 to convert to U.S. fluid ounces.

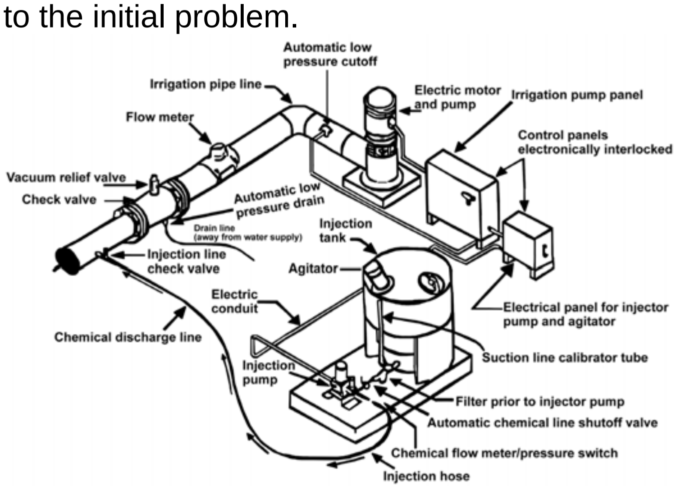
$$80\% \times \frac{me\ base}{L\ water} \times \frac{378\ L}{to\ be\ neutralized} \times \frac{1}{34.7\ N\ acid} = 8.7 \times \frac{me\ base}{L\ water}$$

NOTE: When calculating your rates for larger volumes, be careful not to round off too soon when making conversions.

12. Why not neutralize 100 percent of the bases?

Some of the reasons for not attempting to neutralize 100% of the bases are:

It is not necessary to neutralize all of the bases in order to reduce the problem to insignificant levels. Not trying for 100% neutralization allows some room for error in acid application rates, variability in water, etc. The risk of over-acidifying is not worth the benefit of neutralizing the last 10 or 20 % of the bases. It is poor management to spend money and effort creating new problems by over-reacting to the initial problem.



13. In what kind of irrigation system can I practically inject acid?

Neutralization is relatively easy to accomplish in microirrigation systems. The system must allow careful addition of known volumes of acid to known volumes of water. Since acids can be quite corrosive to metals, the system must be able to withstand this possible adverse effect.

NOTE: It is illegal to inject any chemicals into irrigation systems without appropriate safety devices which will automatically prevent the backflow of water and chemicals to the water supply. This is done to protect our water resources.

14. What kind of acid can I use?

The most commonly used acids are sulfuric, hydrochloric, and phosphoric acid. Other acids could be used but cost and availability usually limit the choices to these three. Phosphoric and sulfuric acids may have some nutritional value but this should be a minor consideration in choosing an acid for water neutralization.

15. What are the dangers of using acids for water neutralization?

Hydrochloric, sulfuric and phosphoric acids are highly toxic materials irritating to the skin, eyes, nose, throat, lungs, and digestive tract. Always wear goggles and chemical resistant (rubber, neoprene, vinyl, etc.) gloves, apron and boots whenever handling these acids. Acid must be poured into water, never vice versa, and should be done in a well-ventilated area.

Should a spill or splash occur, remove all clothing and shower immediately. Immediately irrigate eyes with large quantities of water. Seek immediate medical attention.

It is generally advisable to dilute concentrated acid in a nonmetal mixing tank prior to injection into the irrigation system, rather than injecting concentrated acid directly. Most metal fittings, tanks, and other parts of the irrigation system will be damaged by acid, so proper precautions must be taken. Flushing the system after application is frequently sufficient to avoid significant damage.

In addition to the dangers involved with handling strong acids there is also the danger of over-application of acid. Excess acid addition could result in injury to tree parts, which come in direct contact with the water, such as leaves. Also, an excessive acidification of the soil could result in tree injury or death. These problems can be avoided by (1) determining the proper amount of acid to apply and (2) monitoring the irrigation system to ensure that the correct amount is applied.

16. How can I assure that I'm adding the correct amount of acid to my water?

Monitoring the pH of the acid-treated water is one way of checking on a daily operational basis. You can do this with a pH meter. Add acid to bring the water pH to between 4.5 and 5.0. Because the neutralization reaction continues slowly over a period of a day or two, the measured pH of the water immediately after acid addition will usually be lower than that measured once the reaction is complete. For monitoring purposes during acid additions, use the pH measured immediately after acid addition as a guide to avoid over-acidifying.

If the pH after treatment is very different from that calculated from the chemical analysis, you may want to have another water sample analyzed.

Summary

1. Have your irrigation water tested.
2. Select an acid of known strength.
3. Determine how much of your acid is needed to neutralize 80% of the bases in your water.
4. Add the calculated amount of acid to your water.
5. Measure the pH of the water as it comes out of the irrigation line.
6. If the pH is not between 4.5 and 5.0, increase or decrease the amount of acid.
7. If the amount of adjustment in Step 6 is more than 15 to 20% of the calculated value, consult a specialist before extended use of the system.
8. Retest the well water and irrigated soil about once a year and keep a record of the test results.

CITRUS RUST MITES

The citrus rust mite (CRM) is an important pest of fruit grown for the fresh market. On some specialty varieties (such as Sunburst tangerine), damage may be particularly severe on stems and foliage, causing leaf injury and possible abscission. Fruit damage is the main concern with other varieties. CRM feeds on green stems, leaves, and fruit. Egg deposition begins within 2 days after the female reaches sexual maturity and continues throughout her life of 14 to 20 days. The female lays one to two spherical transparent eggs per day and as many as 30 during her lifetime. Eggs hatch in about 3 days at 81°F. The newly hatched larva resembles the adult, changing in color from clear to lemon yellow (CRM). After about 2 days at 81°F, molting occurs. The first nymphal stage resembles the larval and requires about 2 days to molt to an adult at the above temperature. The CRM adult has an elongated, wedge-shaped body about three times longer (0.15 mm) than wide. CRM usually is straw to yellow in color. CRM population densities increase in May-July and then decline in late August, but can increase again in late October or early November. Mite densities in the fall rarely approach those early in the summer. During the summer, CRM are more abundant on fruit and foliage on the outer margins of the tree canopy. Generally, the north bottom of the tree canopy is preferred and supports the highest mite populations. The least favorable conditions for CRM increase are found in the south top of the tree canopy.

Visible characteristics of injury differ according to variety and fruit maturity. When rust mite injury occurs on fruit during exponential growth, before fruit maturity (April to September), epidermal cells are destroyed resulting in smaller fruit. Early season rust mite injury is called "russeting." Rust mite injury to mature fruit (after September) differs significantly from early "russeting." Unlike "russeting" on fruit, fall damaged fruit will polish since the natural cuticle and wax layer remain intact. This condition is known as "bronzing." While the primary effect of fruit damage caused by rust mites appears to be a reduction in grade, other conditions have been associated with severe fruit injury that include reduced size, increased water loss, and increased drop.

Leaf injury caused by feeding of CRM exhibits many symptoms on the upper or lower leaf epidermis. When injury is severe, the upper cuticle can lose its glossy character, taking on a dull, bronze-like color, and/or exhibit patchy yellowish cells in areas of "russeting" that have been degreened by ethylene release during the wounding process. Lower leaf surfaces often show "mesophyll collapse" appearing first as yellow degreened patches (collapsed spongy mesophyll cells) and later as necrotic spots. With the exception of upper leaf epidermal injury to some specialty varieties, such as Ambersweet, Fallglo, and Sunburst, defoliation caused by CRM is rarely severe.

The need for chemical treatments to control rust mites is dictated by numerous biological attributes of the mites, marketing objectives for the fruit, and horticultural practices. These key biological factors include: 1) inherent ability of mites to quickly increase to injurious densities on fruit and sustain the potential for reproductive increase over time; and 2) small size, which makes it difficult to monitor population densities in the field and detect injurious levels until visible injury has occurred on the fruit. The marketing objective for fruit is particularly important. Cosmetic appearance is a priority for fruit grown for the fresh market. Fruit growth and abscission are not affected until 50% to 75% of the surface has been injured. Thus, there is reduced justification for chemical control of rust mites on fruit grown for processing. Citrus groves producing fruit designated for the fresh market may receive three or four miticides per year, typically during April, June, August, and October. In contrast, groves producing fruit designated for processing receive zero to two treatments per year. Miticides applied for the control of rust mites on fresh fruit varieties are often combined with compatible fungicides in the spring and summer. An alternative approach is using FC 435-66, FC 455-88, or 470 petroleum oil as a fungicide for greasy spot control and to suppress pest mites.

From a horticultural perspective, canopy density has an effect on rust mite populations and their ability to increase over a short period of time. The denser the canopy, the less favorable conditions are for a rapid rust mite increase. Since most registered miticides have no ovicidal activity and short residual activity on fruit and foliage, residual control is generally better if the miticide is applied when rust mite adult and egg population densities are low for fresh market varieties.

Since external blemishes caused by rust mites, fungal diseases, and wind are less important when fruit are grown for processing, the chemical control strategy for rust mites can be modified significantly. A summer spray is often required for greasy spot control. Use of petroleum oil in place of copper will reduce the likelihood of requiring a subsequent miticide treatment. Further miticide treatment may be unnecessary. However, a second petroleum oil application may be required for greasy spot control on summer flush.

Many scientific methods for sampling or scouting rust mite populations have been described. Of these, three general approaches are in widespread use: 1) determining the percentage of fruit and/or leaves infested with rust mites, 2) qualitative rating scales and 3) individual adult mite counts taken from fruit on randomly selected trees. These sampling approaches are similar in that they are designed to avoid bias by randomly selecting different representative areas within a grove for sampling, avoiding border rows, and selecting fruit and/or leaves within a tree randomly.

One sampling method based on rust mite density (rust mites/square centimeter [cm^2]) is described.

Processed Fruit: Initiate rust mite monitoring in April on leaves and fruit through casual observations and continue every 2 to 3 weeks throughout the fruit season. Select trees at random and within uniformly distributed areas throughout a 10- to 40-acre block representing a single variety with uniform horticultural practices. Avoid sampling adjacent trees. Fruit should be sampled at random representing the four quadrants of the tree and taken midway in the canopy (between interior and exterior). One fruit surface area should be examined midway between the sun and shade areas. The number of rust mites per cm^2 should be recorded and averaged for the 10 acres, represented by 20 trees with four fruit per tree or 80 readings per 10 acres. Six rust mites/cm^2 would be a planning threshold where pesticide intervention may be required within 10 to 14 days. Ten rust mites/cm^2 would be an action threshold where treatment would be required as soon as possible.

Fresh Fruit: Similar to above except monitor every 10 to 14 days with an average of 2 CRM/cm^2 as an action threshold.

For more information, go to:

https://crec.ifas.ufl.edu/media/crecifasufledu/production-guide/Rust-Mites.pdf

TABLE 1. Control Thresholds and Appropriate Sample Sizes for 10 Acres

If the control threshold is:	Sample size (Sample trees should be uniformly scattered across a 10-acre block. Do not sample adjacent trees.)
5 mites/leaf	Examine 4 leaves/tree from 6 trees/area from 4 areas/10 acres = 96 leaves on 24 trees/10 acres
8 mites/leaf	Examine 4 leaves/tree from 6 trees/area from 3 areas/10 acres = 72 leaves on 18 trees/10 acres
10 mites/leaf	Examine 4 leaves/tree from 5 trees/area from 2 areas/10 acres = 40 leaves on 10 trees/10 acres
15 mites/leaf	Examine 4 leaves/tree from 4 trees/area from 2 areas/10 acres = 32 leaves on 8 trees/10 acres

TABLE 2. Citrus Miticide Selection*

Supplemental (early Spring)	Post Bloom	Summer	Fall	Supplemental Fall
--	--	Agri-mek + oil	--	--
Apta	Apta	--	Apta	Apta
--	--	--	Comite	Comite
Envidor	Envidor	Envidor	Envidor	Envidor
--	Petroleum oil	Petroleum oil	Petroleum oil	--
--	--	--	Sulfur	Sulfur
--	--	Micromite	Micromite	--
--	--	--	Nexter	Nexter
Movento	Movento	Movento	--	--
Vendex	Vendex	--	Vendex	Vendex

*Except for petroleum oil, do not use the same miticide chemistry more than once a year.

GREASY SPOT FUNGAL DISEASE

Management of greasy spot must be considered in groves intended for processing and fresh market fruit. Greasy spot is usually more severe on leaves of grapefruit, pineapples, Hamlins, and tangelos than on Valencias, Temples, Murcotts, and most tangerines and their hybrids.

Greasy spot spores germinate on the underside of the leaves and the fungus penetrates through the stomates (natural openings on lower leaf surface). Warm humid nights and high rainfall, typical of Florida summers, favor infection and disease development.

On processing Valencias, a single spray of oil (5-10 gal/acre) or copper + oil (5 gal/acre) should provide acceptable control when applied from mid-May to June. With average quality copper products, 2 lb of metallic copper per acre usually provide adequate control. The strobilurin fungicides (Abound, Gem, Headline or Quadris), as well as Enable 2F, are also suitable with or without petroleum oil. On early and mid-season oranges and grapefruit for processing, two sprays may be needed especially in the southern part of the state where summer flushes constitute a large portion of the foliage. Two applications also may be needed where severe defoliation from greasy spot occurred in the previous year. In those cases, the first spray should be applied from mid-May to June and the second soon after the major summer flush has expanded. Copper fungicides provide a high degree of control more consistently than oil sprays. Control of greasy spot on late summer flushes is less important than on the spring and early summer growth flushes since the disease develops slowly and defoliation will not occur until after the next year's spring flush. Thorough coverage of the underside of leaves is necessary for maximum control of greasy spot, and higher spray volumes and slower tractor speeds may be needed than for control of other pests and diseases.

The program is essentially the same for fresh fruit. That is, a fungicide application in May-June and a second in July should provide control of rind blotch.

A third application in August may be needed if rind blotch has been severe in the grove. Petroleum oil alone is less effective than other fungicides for control of greasy spot rind blotch (GSRB). Heavier oils (455 or 470) are more effective for rind blotch control than are lighter oils (435).

Copper fungicides are effective for control of GSRB, but may result in fruit spotting especially if applied at high rates in hot, dry weather or if applied with petroleum oil. If copper fungicides are applied in summer, they should be applied when temperatures are moderate, at rates no more than 2 lb of metallic copper per acre, without petroleum oil or other additives, and using spray volumes of at least 125 gal/acre. Enable 2F can be applied for greasy spot control at any time but is especially indicated in mid to late summer for rind blotch control.

The strobilurin fungicides (Abound, Gem, Headline, Pristine or Quadris Top) or Enable 2F can be applied at any time to all citrus and provide effective control of the disease on leaves or fruit. Use of a strobilurin (Abound, Gem, Headline, Pristine or Quadris Top) is especially indicated in late May and early June since it will control both melanose and greasy spot and avoids potential fruit damage from the copper fungicides at that time of year. A strobilurin fungicide should not be applied more than once a year for greasy spot control. Addition of petroleum oil increases the efficacy of these products.

•Processed fruit

May-June

- Petroleum oil (455, 470) 5-10 gal
- Cu fungicides 2-4 lb metal
- Abound, Gem, Headline + 5 gal oil
- Pristine
- Amistar Top
- Enable

July

- Petroleum oil (455, 470) 5-10 gal
- Cu fungicides 2-4 lb metal
- Abound, Gem, Headline + 5 gal oil
- Pristine
- Amistar Top
- Enable

•Fresh fruit

May-June

- Petroleum oil (455, 470) 10 gal
- Cu fungicides < 2 lb metal, No oil
- Abound, Gem, Headline + 5 gal oil
- Pristine
- Amistar Top
- Enable

July

- Petroleum oil (455, 470) 10 gal
- Cu fungicides < 2 lb metal
- Abound, Gem, Headline + 5 gal oil
- Pristine
- Amistar Top
- Enable 8 oz

For more information on greasy spot, go to:

https://crec.ifas.ufl.edu/media/crecifasufledu/production-guide/Greasy-Spot.pdf

FIRE ANTS

Imported fire ants are reddish brown to black and are 1/8 to 1/4 in long. These ants are aggressive and notorious for their painful, burning sting that results in a pustule and intense itching, which may persist for a week. Some people have allergic reactions to fire ant stings that range from rashes and swelling to paralysis or even death. In addition to stinging humans, imported fire ants can sting pets, livestock, and wildlife. Crop losses are also reported due to fire ants feeding on plants and even citrus trees. Fire ants may damage young citrus by building nests at the trunk bases. The ants feed on the bark and cambium to obtain sap, often girdling and killing young citrus trees. Fire ants also chew off new growth at the tips of branches and feed on flowers and developing fruit. In groves infested with ants, harvesting crews may not be willing to work and may request a higher fee to do their job. The ants are also known to cause extensive damage to irrigation lines and plug emitters. They aggregate near electrical fields where they can cause short circuits or interfere with switches and equipment such as water pumps, computers and air conditioners.

BIOLOGY

Red imported fire ants live in colonies that contain cream-colored to white immature ants, called brood. The brood is comprised of the eggs, larvae, and pupae. Also within the colonies are adult ants of different types. They include winged males and winged females, workers, and one or more queens. While thousands of winged males and females can be produced per year in large colonies, they do not sting. Newly-mated queens can fly as far as 12 miles from the nest (or even farther in the wind), but most land within a mile. New colonies do not make conspicuous mounds for several months. Once a colony is established, a single queen can lay over 2,000 eggs per day. Depending on temperature, it can take 20 to 45 days for an egg to develop into an adult worker. Workers can live as long as 9 months at 75°F, but life spans usually are between 1 and 6 months under warmer outdoor conditions. Queens live an average of 6 to 7 years.

Fire ants are omnivorous feeders. Workers will forage for food more than 100 feet from the nest. They can forage during both the day and the night, generally when air temperatures are between 70° and 90°F. When a large food source is found, fire ants recruit other workers to help take the food back to the colony. Liquids are ingested at the food source, and stored within the ants until they are regurgitated to other ants within the colony. Liquids from solid foods are extracted at the source, or are carried back as solid particles. Large solids may be cut into smaller pieces so they can be carried back to the colony. There are two types of fire ant colonies: single-queen, and multiple-queen colonies. A colony may contain as many as 100,000 to 500,000 workers.

CONTROL STRATEGIES AND TECHNIQUES

Numerous methods have been developed to control fire ants. Unfortunately, there are no control methods that will permanently eliminate fire ants. Four strategies are currently being used to control fire ants: broadcast bait applications, individual mound treatments, a combination of broadcast baiting and individual mound treatments, and barrier/spot treatments.

1. Broadcast Bait Applications

This strategy attempts to reduce fire ant populations by applying insecticides incorporated into an attractant or bait. The ants carry the bait to the colony. The slow action of the toxicant allows the ants to feed it to other members of the colony before they die. When the toxicant is fed to the queen(s), she either dies or no longer produces new workers and the colony will eventually collapse.

●***Keep baits dry.*** Wet baits are not attractive to fire ants. Apply baits when the grass and ground are dry or drying, and rain is not expected, preferably for the next 24 hours.

●***Apply baits when fire ants are actively foraging.*** During hot, summer weather, apply baits in the late afternoon or evening because fire ants will forage at night under these conditions.

●***Follow the directions on the label.*** It is against the law to apply baits in areas not listed on the label.

2. Individual Mound Treatments

This strategy attempts to eliminate colonies of fire ants by treating mounds individually. Individual mound treatments are time consuming and labor intensive. However, colonies treated individually may be eliminated faster than colonies treated with broadcast bait applications.

Baits

Bait products used for broadcast bait applications can be applied to individual mounds. Sprinkle the recommended amount of bait around the base of the mound up to three feet away. In addition, follow the Guidelines for Effective Bait Applications given previously. As with broadcast bait applications, the use of baits for individual mound treatments may take one to several weeks to eliminate colonies.

Dusts

Dusts are dry powder insecticidal products. The dusts stick to the bodies of ants as they walk through treated soil. Ants that contact the dust will eventually die. Dusts are applied by evenly sprinkling a measured amount of dust over the mound. Avoid inhaling or touching the dust. Some dusts, such as those containing 75% acephate, should kill an entire colony within a week.

Aerosols

Some products are available in aerosol cans equipped with a probe, and contain insecticides that quickly immobilize and kill ants on contact. As the probe is inserted into a mound, the insecticide should be injected into the mound for a specified amount of time. Similar to other individual mound treatments, application on cool, sunny mornings will help maximize contact with the colony.

3. Combining Broadcast Baiting and Individual Mound Treatments

This strategy utilizes the efficiency of broadcast baiting and the fast action of individual mound treatments. Baits must be broadcast first to efficiently reduce fire ant populations. Wait a minimum of 3 days after broadcasting to allow fire ants to forage and distribute the bait before individually treating mounds. Treat mounds preferably with a dust, granular, or aerosol insecticide specifically labeled for fire ant control.

4. Barrier/Spot Treatments

These products are usually sold as sprays or dusts. They may be applied in wide bands on and around building foundations, equipment and other areas to create barriers that exclude ants. They also may be applied to ant trails to eliminate foraging ants. Barrier and spot treatments do not eliminate colonies.

Lovebugs in Florida

J. Weston, D. E. Short, and M. P. Lehnert
UF IFAS Extension

The "lovebug" (Figure 1) is a fly in the family Bibionidae that is easily identified by its black, slender body and red thorax. These small flies, also known as March flies, are closely related to mosquitoes and gnats. The males are about 1/4 inch in length, while females are 1/3 inch in length. There are two known species of lovebugs in the United States. One is a native species, and the other is an invasive species that first appeared in southern Louisiana during the 1920s. The outbreak soon spread southward, crossing deep into Mississippi and Alabama, and finally reaching Florida in 1947. They have since migrated northward, reaching from Georgia to South Carolina. Both species have two key outbreaks in population a year: once during April–May and the next in August–September. They are often found near or by highways and are a nuisance and hindrance to drivers.

Figure 1.
Mating pair of lovebugs. Female on right.

Life Cycle

Female lovebugs lay 100 to 350 eggs that are deposited underneath debris and decaying vegetation. After about 20 days the larvae hatch and feed on the decaying plant vegetation. The larvae act as a decomposer in the natural habitat by converting the plant material into nutrients that can then be used by the growing plants. Once the larvae mature and have stopped feeding on the decomposing vegetation, they pupate. In warmer climates such as Florida, the generation during the summer is significantly shorter than the winter generation because the rate at which the larvae pupate increases significantly with an increase in temperature. The pupal stage generally lasts about seven to nine days.

Adult lovebugs are nonthreatening to humans because they do not bite or sting. They primarily feed on nectar from various plants, particularly sweet clover, goldenrod, and Brazilian pepper. Under laboratory conditions, male lovebugs live for about 92 hours, whereas females live up to 72 hours. In nature, the adults live just long enough to mate, feed, disperse and deposit a batch of eggs—about three to four days. Lovebug flights are usually restricted to daylight hours and temperatures above 68°F. At night lovebugs rest on low-growing vegetation.

Mating

In the lovebug, copulation begins with males flying and swarming above females, who remain on or close to the ground. The swarm is most dense from one foot to about five feet off the ground, but the swarm can be as high as 20 feet above the ground and can contain up to 40-plus males. Larger males often dominate the bottom of the swarm in competition to get a fit mate. The males prefer larger, heavier females because they provide better odds of reproducing and mating.

Males hover over the females by orienting themselves with the wind in order to ease flight. As the females emerge from the vegetation, males immediately swoop down and grasp a female. At times, males will grasp a female that is already mating with a male in an attempt to disrupt mating. As many as 10 males have been observed holding onto a female, each attempting to copulate. After finding a match, the pair will come to a rest on the vegetation below and finish their mating process, during which the male faces the opposite direction of the female.

Lovebugs Hinder Motorists

Lovebugs are a considerable nuisance to motorists. They congregate in unbelievable numbers along highways, and the insects spatter on the windshields and grills of moving vehicles. Windshields become covered with the fatty remains, and vision is obstructed. During flights, the flies clog radiator fins, causing cars to overheat. They also get into refrigeration equipment on trucks, causing them to malfunction. The fatty tissue will cause pitting of the car's finish if it is not removed within a few days. Flies enter cars and sometimes are crushed by drivers and passengers, causing stains on clothing. They are also a considerable nuisance to fresh paint. The flies enter houses under construction in such numbers that carpenters refuse to work. Beekeepers complain because worker bees do not visit flowers that have been infested with the flies.
A number of insecticides have been evaluated for effectiveness in controlling lovebug larvae and adults. Most of them kill lovebugs but are impractical because high populations of the insects occur over vast areas of the state. A vacuum cleaner can be used to remove adults from confined areas, such as in buildings and vehicles.

Predators Reduce Lovebug Flights

During the past several years, both the April–May and August–September lovebug flights have been substantially reduced in North Central Florida. This reduction in the population is partly attributed to predators. Larvae aggregate in extremely high numbers in pastures and other grassy habitats. This makes them vulnerable to foraging birds. Lovebug larvae have been found in the gizzards of robins and quail. Although examinations of the stomach contents of armadillos have been negative, observations suggest that they, too, may be excellent predators of the larvae.
Some natural enemies of lovebugs are fungi. Although more time and research is needed, nine different species of fungi are known to affect lovebug larvae. However, available data indicate that only the fungus *Beauveria bassiana* causes significant mortality levels (27 to 33%) in adults and immatures. Laboratory studies using invertebrate predators found in lovebug-infested pastures indicated that these predators included earwigs, two species of beetle larvae, and a centipede.
There are several things that can be done to lessen the problem facing motorists. By traveling at night motorists can avoid the insects; lovebugs reach peak activity at 10 am and stop flying at dusk. Traveling at slower speeds will reduce the number of bugs that will be spattered. A large screen placed in the front of the grill will keep the radiator fins from clogging, and will protect the finish on the front of the car. If a large screen is not used in front of the grill, a small screen can be placed behind the grill in front of the radiator.
Spattered bugs should be washed off the car as soon as possible. Lovebugs are more easily removed, and the chance of damaging the car's finish is lessened, if the car has been waxed recently. When the remains are left on an unwaxed car for several days, the finish will often be permanently damaged. Soaking splattered lovebugs for several minutes with water aids in their removal. When lovebugs are numerous, motorists may choose to spread a light film of baby oil over the front of the hood, above the windshield, and on the grill and bumper. This practice will make lovebug removal a simpler task.

Living with Lovebugs

Norman C. Leppla
UF IFAS Extension

Lovebug Myths

MYTH: Lovebugs Escaped after University of Florida Researchers Brought them into Florida

Lovebugs are not native to most of the southern United States (Hardy 1945). According to Buschman (1976), since 1940 *P. nearctica* has extended its range from Louisiana and Mississippi across the Gulf States, reaching Florida in 1949. In the late 1960s, it became established entirely across north Florida. During the 1970s explosive populations occurred progressively southward nearly to the end of peninsular Florida and northward into South Carolina (Figure 4). Its movement may have been accelerated by prevailing winds, vehicle traffic, sod transport, increased habitat along highways, and expansion of pastures, but not by UF researchers.

MYTH: University of Florida Researchers Genetically Engineered Lovebugs to Kill Mosquitoes

Lovebugs are small, slow herbivorous insects that feed on the pollen and nectar found in flowers. Thus, they lack the mandibles (jaws), grasping legs, speed, and other characteristics of predaceous insects, such as dragonflies. Lovebugs are active during the day, whereas most mosquitoes are crepuscular (active at twilight) or nocturnal, and they are only adults for a few weeks each year. For these and many other reasons, the lovebug would be a poor candidate to genetically engineer as a mosquito predator, even if it were possible.

MYTH: Lovebugs are Attracted to Automobiles

After mating, lovebugs disperse as coupled pairs, presumably flying in search of nectar on which to feed and suitable oviposition sites. Mated females are attracted to sandy sites with adequate moisture, dead leaves, grass clippings, cow manure, and other decomposing organic debris. Cherry (1998) found that lovebugs are attracted to anethole, an essential oil found in plants that also attracts bees. Both sexes of adults also are attracted to the floral odorant, phenylacetaldehyde (Arthurs et al. 2012 & 2015). Additionally, female lovebugs are attracted to UV irradiated aldehydes, a major component of automobile exhaust fumes (Callahan and Denmark 1973, Callahan et al. 1985). They may confuse these chemicals with the odors emitted from decaying organic matter at typical oviposition sites. Heat has also been shown to attract lovebugs (Whitesell 1974) and contribute to their abundance on highways. Additionally, lovebugs seem to collect on light-colored buildings, especially when freshly painted (Callahan 1985). Many kinds of flies are attracted to light-colored and shiny surfaces, although the physiological or behavioral mechanisms are unknown. Thus, lovebugs apparently accumulate in relatively warm, humid, sunny areas with food and chemicals in the atmosphere that mimic oviposition sites.

MYTH: Dispersing Lovebugs Move Great Distances and are Attracted to Homes

Lovebug pairs are not strong fliers, so tend to remain within a few hundred yards of emergence sites when there is little or no wind (Thornhill 1976b). They are able to move across the wind when it is 5–7 mph and search for sources of nectar and suitable oviposition sites. Stronger winds blow them as high as 1500 ft in the air and concentrate them against down-wind objects. Coupled females initiate and control flight but males assist if they are able to obtain food (Sharp et al. 1974). Locations within 20–30 miles can have quite different levels of lovebug emergence and dispersal (Cherry and Raid 2000), and this variable distribution can lead to naturally occurring "hotspots" in different places from year to year. Lovebugs are most abundant in moist grassy habitats. People who live near these habitats, or are exposed to winds that deposit the insects at their homes, can perceive erroneously that they are attracting these pests.

MYTH: Lovebugs Mate the Entire Time they are Coupled

The general pattern of mating in lovebugs begins with males forming swarms above emergence areas each day in the morning and afternoon (Leppla et al 1974; Thornhill 1976c). Individual males also may fly just above these areas. Females emerge from the soil later than males, crawl onto vegetation, and fly into the swarms. A male may grasp a female before or after she flies into a swarm. In either case, the pair lands on vegetation where the male transfers sperm to the female. Sperm transfer requires an average of 12.5, hours but the pair can remain coupled for several days during which they feed and disperse (Thornhill 1976c). The male ejects a depleted spermatophore after separating from the female (Leppla et al. 1975), and both sexes may mate again. Pairs formed during the morning hours begin dispersal flights, whereas those that couple in the evening remain on vegetation until taking flight the following day.

MYTH: The Body Fluids of Lovebugs are Acidic and Immediately Dissolve Automobile Paint

When numerous lovebugs are smashed on the front of a vehicle, the contents of their bodies, especially eggs, coat the painted surface. No permanent damage is caused, however, if the surface is cleaned before the coating is baked by the sun for a day or two. Marisa and Jeffrey Gedney (personnel communication) determined that macerated lovebugs are about neutral with a pH of 6.5 but become acidic at 4.25 within 24 hours. Yet, automobile paint was not damaged after being coated with macerated lovebugs and held in a humid indoor environment for 21 days. A lovebug-coated surface exposed to the sun for an extended period of time, however, may be damaged by the insects and their removal (Denmark and Mead 2001). The front of a vehicle can be protected by coating it with “car wax” and removing the lovebugs within 24 hours.

MYTH: Lovebugs have no Significant Natural Enemies

No parasites have emerged from lovebug larvae or adults held in the laboratory, and few cases of predation have been observed in nature over the years (Hetrick 1970; Mousseau 2004). Apparently lovebugs adults are avoided by red imported fire ants, *Solenopsis invicta* Buren (=*S. wagneri* Santschi), and other predators but one periodically eaten by spiders, dragonflies, and birds. They have aposematic coloration that implies defensive mimicry but have not been chemically analyzed or tested as food for predators (Dunford et al. 2008). Bee keepers report anecdotally that honeybees do not visit flowers infested with lovebugs. Fungal pathogens, identified by screening larvae and adults, could be limiting lovebug populations (Kish et al. 1974, 1977). These fungi include the well-known insect pathogenic genera, *Metarhizium*, *Beauveria, Conidiobolus*, and *Tolypocladium*. Although not yet studied, lovebug eggs may be subjected to predation or parasitism.

MYTH: Insecticides are Effective in Controlling Lovebugs

Insecticides available to the public for controlling houseflies, mosquitoes, and other flies will also kill lovebug adults. However, there are risks associated with using these products around humans and pets, and the lovebugs will return almost immediately. Other insects are often misidentified as being lovebugs, some of which are innocuous or beneficial, and therefore, should not be killed. It is important to preserve lady beetles, lacewings, honeybees, and other insects that help to protect or pollinate plants. Thus, insecticides are expensive, potentially harmful, and of no value in controlling lovebugs. It is best just to avoid lovebugs if they become a nuisance during their brief appearances each year.

MYTH: University of Florida Scientists are Working to Control Lovebugs

The University of Florida research programs in urban and public health entomology are among the strongest in the U.S. Priority is placed on destructive or dangerous pests that threaten human health and resources. These pests include mosquitoes that transmit West Nile virus, equine encephalitis, and other diseases; those that infest people, livestock and pets; and urban insects, such as cockroaches, ants, and termites. Nuisance pests like lovebugs and blind mosquitoes are important but much less damaging and costly. The Florida Legislature funded research on lovebugs at the University of Florida during the outbreak that swept through the state in the early 1970s. Additional resources were contributed by the USDA and Florida Department of Agriculture and Consumer Services, Division of Plant Industry. Even though this support is no longer available, the University of Florida continues to provide information to help educate Florida residents and tourists about lovebugs.

Lovebugs and People

It is possible but usually not necessary to avoid lovebugs and the problems they cause. Unlike some of their close relatives, lovebugs do not bite, sting, or transmit diseases and are not poisonous. Lovebugs are only active in the daylight and are much less mobile during the early and late daytime hours. Typically, the pairs fly across the wind during their dispersal flights and are blown against obstacles, especially vehicles traveling at high speeds. Their remains can be removed from surfaces easily if not left to bake in the sun. Lovebugs are poor fliers that can be kept out of a building by creating positive pressure with an air-conditioning fan. If a few lovebugs enter, a vacuum cleaner can be used to remove them. Screens can be added to windows and doors, particularly on the prevailing windward side of a building, and placed over decks and swimming pools. A fan can be used outside near work or recreational areas to keep lovebugs away. Due to their abundance and mobility, lovebugs cannot be controlled effectively with poisons or repellents.

Some people consider the lovebug to be among the peskiest alien invasive species to become established in the Gulf States. On the contrary, these potentially annoying flies are actually beneficial as larvae because they help to decompose dead plant material. People would also appreciate esthetic aspects of the adults, if these insects were not such a nuisance. Like cute little migratory birds, lovebugs signal changes in the seasons from spring to summer and again from summer to fall. Moreover, if they were larger, people could easily see and admire their delicate features, particularly the big round eyes of the males. Wilhelm Rudolph Wiedemann named the lovebug genus *Plecia* in 1828, so his concept for the term may never be known. A reasonable guess, however, is that he applied the Greek verb "pleo" intending to mean "to sail" (Jaeger, E. C. 1955). Lovebugs sail from flower to flower much like butterflies and in smaller numbers could be perceived as beautiful. They have become less abundant over the past 30 years, and people living in the Gulf States are beginning to accept them as a normal part of nature. However, newcomers are much less tolerant of lovebugs until they learn that these insects are not dangerous. Since lovebug populations tend to rebound unpredictably, we are fortunate that these creatures create inconveniences and tickle, rather than threaten human health and the environment.

A few important slides from Dr. Brian Boman (Professor Emeritus, UF-IFAS) presentation

Bicarbonates

- Soil pH and bicarbonates affect nutrient availability and root uptake.
- Bicarbonate induced chlorosis is caused by transport of bicarbonate into the plant leading to reduced nutrient uptake.
- Reduction of plant biomass
  - reduced root growth leading to a lower photosynthesis rate
  - reduced leaf area per tree
  - reduced chlorophyll concentration under Fe stress conditions.

Ammonium fertilizers

- Urea, ammonium nitrate, **ammonium sulfate, & sulfur coated urea.**
- Bacteria in the soil convert the ammonium into acidic compounds
- Ammonium sulfate has 2-3 times more acid forming per pound of nitrogen than other commonly used ammonium fertilizers.

Sulfur Fertilization

Sulfate sulfur (SO_4)

- Often contained in mixed fertilizers
- Will not acidify soils

Elemental Sulfur (S)

- Used for soil acidification
- Not available to plants until oxidized by soil bacteria to sulfate form
- Takes several months

Water quality (meq/L or ppm $CaCO_3$)	Approximate pounds of pure $CaCO_3$ added per acre by 15 ac-in of water	Approximate amount of acid-producing materials per *wetted* acre to neutralize 100% of the bases from the water				
		46% Sulfuric acid (gallons)	Elemental sulfur (pounds)	Tiger 90 (lbs)	Ammonium sulfate (pounds)	Ammonium nitrate (pounds)
1 (61)	169	23	56	63	150	281
2 (122)	338	45	113	125	300	563
3 (182)	506	69	169	188	450	844
4 (244)	675	93	225	250	600	1125
5 (305)	844	116	281	313	750	1406
6 (366)	1013	138	338	375	900	1688
7 (417)	1181	162	394	438	1050	1969
8 (488)	1350	185	450	500	1200	2250
9 (549)	1519	207	506	563	1350	2531
10 (610)	1688	231	563	625	1500	2813

150 tree/ac x 25 gal/day x 110 days = 15 ac-in
(21,154 gal/ac-in)

bicarbonate in meq/l $CaCO_3$ x 61 = ppm

Adapted from: Kidder and Hanlon, UF/IFAS Exten. Pub. SL142

Lbs elemental S needed to lower soil pH of a sandy soil to a depth of 6 in.

Existing soil pH	Desired soil pH			
	6.5	6.0	5.5	5.0
8.0	876	1167	1459	1751
7.5	584	876	1167	1459
7.0	292	584	876	1167

adapted from: http://www.ipm.iastate.edu/ipm/hortnews/1994/4-6-1994/ph.html

For pH of 7.8, S needed to reduce soil to pH of 6.5

= 292 + 8*(876-292)/10 = 759 lb

Only wetted area needs to acidified, so assume 50% of area

759 lb S/ac x 50% = 380 lb/ac S

Summary

- Bicarbonates form salts with Ca, Mg, Na, and K.
- Higher calcium carbonate in soils increases pH making many nutrients less available.
- Bicarbonates have a physiological affect on roots reducing nutrient absorption.
- Standard water treatment is to lower pH by adding acid. Lowering the pH to 6.5 neutralizes about half the bicarbonate in the water.
- Soil treatments:
  - calcium or gypsum (calcium sulfate) to increase calcium availability to plants and soil,
  - elemental sulfur can be used to reduce soil pH,
  - applications of acidified water or acidic fertilizer.

Flatwoods Citrus

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Hendry County Extension Office
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Racial-Ethnic Background

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

Gender

__Female

__Male