

Sustainable Agriculture

Looking forward for this generation
and the next...

at **UGA**



Winter 2015

Well, it is a new year. Those of us that grow and work with living things are acutely aware of the years' seasons - the cycle from the long hot days of summer to an enveloping winter dark. We often hear this cycle described as a circle, and there is a kind of groundedness that comes from knowing the circle and the season will come round again. But recently, I saw a wonderful graphic of our solar system moving through space – the sun with all the planets spiraling around it. It made me realize that we really should visualize our lives as a spiral instead of a circle; that we are always moving as well as circling through the seasons. Hopefully, this means we are moving forward, making things better as we turn through the years.

This really is the essence of sustainable farming, trying to take a step at a time to reduce our environmental impact, use resources more wisely, improve our profitability, and improve our lives and the lives of others around us. So at this beginning of a new year, I wish you all well, and hope that some of the information in this newsletter will give you ideas that you can use in your spiral towards sustainability. All the best.

Julia Gaskin
Sustainable Agriculture Coordinator
Crop and Soil Sciences Department
University of Georgia

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Upcoming Events

Organic Certification Workshop:

January 29, 2015: Sound and Sensible Organic Certification in the Gulf States
Fort Valley, GA

February 5, 2015: Sound and Sensible Organic Certification in the Gulf States
Athens, GA

These workshops take you step by step through the National Organic Certification process.

January 30, 2015: Vegetable Grower Workshop
Griffin, GA

Great for new growers and veterans in both organic and conventional production.

February 20-21, 2015 GA Organics Conference
Athens, GA

Check out the UGA farm tour and workshops!

Find more information on these events at
www.SustainAgGa.org

Also find basic principles of sustainable agriculture, Extension bulletins, research publications as well as archived copies of this newsletter.

Grower's Corner

Bees, Beneficials, and the Smoking Gun in the Decline of the Good Guys!



Bee on Tall Goldenrod.

When the most recent and well-publicized phenomenon of honey bee disappearance, termed Colony Collapse Disorder (CCD), began, it gave rise to serious concerns, not only among those in the commercial beekeeping industry, but also among environmentalists, academics, the mainstream media and even the general public.

Bees were dying at alarming rates. Large commercial beekeeping operations, having sustained crippling losses, were on the brink of bankruptcy. And, thousands of acres of pollinator-dependant crops were in jeopardy. Theories and rumors quickly arose as to why colonies were dying. In response, researchers raced across affected areas to collect samples and begin their investigations. The initial, knee-jerk accusations, blaming everything from cellular emissions and high-voltage power lines to UFOs and solar flares, began to fill the airwaves. However, cooler heads prevailed and the Coordinated Agricultural Project (CAP) was started to actually examine the facts and just the facts, ma'am. The project attracted 17 institutions, including UGA, from across the U.S. to study why bees were dying, and, hopefully, find a cure. For four years, miticides, habitat loss, along with other potential culprits have been investigated. The conclusion: while there is no single "smoking gun," the causation of the syndrome seems to be a combination of

stresses on the bees, contributed chiefly by varroa mites (an exotic ectoparasite)

For decades now - even before CCD - honey bees and other pollinators have been in decline. Reasons for their disappearance include the stresses mentioned above. So, how does this decline affect each and every one of us?

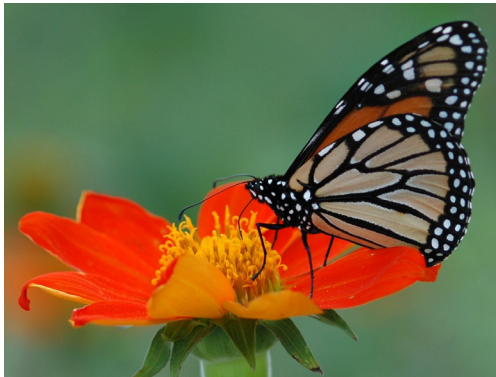
One-third of the food we eat is made available by the hard work of bees, butterflies, ants, beetles, wasps, moths, hummingbirds, bats and other small animals as pollination vectors. Approximately 1,000 agricultural plants grown for food, beverages, fibers, spices and medicines depend on physical pollination (i.e., by an active agent or vector, as opposed to self-pollinated or passively wind or water pollinated). For example, most of the fruits, nuts and vegetables found in grocery stores would no longer be available if honey bees and other pollinators were to become extinct. Instead of the flavorful and colorful meals that we take for granted every day, we'd be forced to eat gruel: a bland diet of base starches, such as corn, barley, wheat and rice. So, in essence, the human race wouldn't starve without pollinators, but we would have to say goodbye to fun and exciting experiences like fruit smoothies and salad bars, to name a couple. Correspondingly, our landscapes and yards would also become drab since 75% of all flowering plants rely on pollinators for reproduction.



Praying Mantis on Celosia flower.

Along with pollinators, there are also other "beneficial" insects that are important. Beetles (lady bugs), praying mantises, green and brown lacewings,

parasitoid wasps, and many spiders can consume or parasitize large amounts of agriculturally destructive species. So, what can we do to help protect these pollinators and other beneficials? To begin with, plant a wide variety of native flowering plants, shrubs and trees to provide habitat and resources (nectar and pollen). Plants such as hyssop, salvia, milkweed, coneflower, bee balm, and sunflower are just a few excellent examples. Another important thing we can do is eliminate or reduce the use of pesticides, which can bring harm not only to the bad bugs (the ones we want to get rid of), but also the pollinators and other beneficials. Before reaching for that can of pesticide, try non-chemical approaches first. For example, spray plants with water to remove unwanted pests.

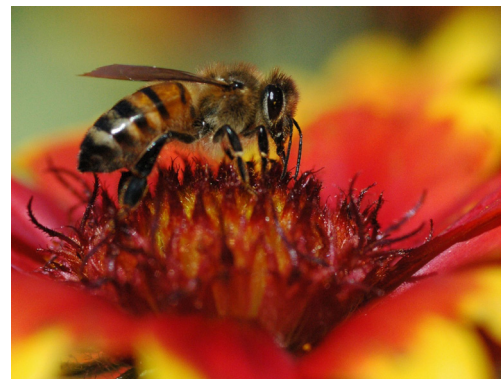


Monarch butterfly on Mexican Sunflower.

Another thing to consider is whether or not there are actually any true pests at hand. Do you see damage? If so, use such clues to try to identify the specific pest(s) before automatically reaching for a broad-spectrum pesticide. Extension agents, nursery workers, and certain botanical and entomological websites are excellent sources for guidance. And, even when an identified pest is doing damage, it may still pay off to have patience. Plants and animals can tolerate a certain amount of infestation or infection. The tomato plant, for instance, can tolerate a given level of whiteflies or aphids before its productivity and viability are compromised. This may be due in part to natural resistance and regenerative abilities of the particular plant species as well as the environmental presence of beneficials preying on the destructives. If the pest populations never reach truly damaging levels, then insecticides

would not be necessary. The point here is that reacting with a pesticide application should be neither an immediate nor automatic response. Yet, there are clearly times when chemicals can serve as a last resort.

When the latter is the case, you can still reduce exposure to pollinators and other beneficials by incorporating the following tips: Timing is of the utmost importance when using pesticides where beneficials, including pollinators, reside. The best time to apply pesticides is in low-wind conditions and after the sun has set. And, try not to contaminate the blooms. Instead of broadcasting a chemical across large areas, apply it directly to where the damage is occurring (spot applications); this not only reduces unintended impact, but saves money - i.e., chemicals are expensive! Choose pesticides that break down rapidly and are the least toxic. The larger box stores, along with local nurseries, now offer “safer” products such as insecticidal oils, soaps, and some pyrethrins. *Bacillus thuringiensis* (Bt) is an excellent biological pesticide that controls caterpillars with little to no risk to beneficials.



Bee on Blanket flower.

Another helpful tip is to be aware of the chemical formulation. Dusts such as Sevin® and wettable powders can wreak havoc on beneficials, especially ones that rely on pollen as a food source. Bees, for instance, collect pollen and take it back to the nest to store and eventually feed to their young. Pollen is the protein source for brood development. If the bees come into contact with toxic dust or dried powder, it is collected as pollen, taken back to the nest (as long as the forager survives the exposure), kills both adults and brood, and saturates the wax comb to affect future generations and new colonies to come.



Bee on a blueberry flower.

These simple tips can reduce the impact of environmental toxicity on pollinators and other beneficials in our backyards, gardens and farms, which will help us all in the short and long term. To learn more about beneficial insects, as well as topics on honey bees and beekeeping, please go to our website: www.ent.uga.edu/bees

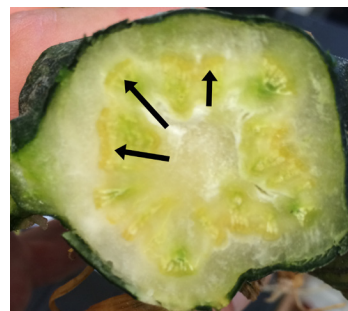
*Jennifer Berry
UGA Honey Bee Program
Entomology Department
University of Georgia*

Floating Row Covers to Prevent Cucurbit Yellow Vine Disease

Summer and winter squash are high value fresh market crops for organic vegetable growers in Georgia. Squash is a seasonal favorite for consumers but the crop is often a challenge to grow in Georgia due to high disease and pest pressure. Common diseases of squash include downy and powdery mildew that affect the foliage and decrease photosynthesis. Several viruses commonly infect summer cucurbit plantings and lead to yield reductions and fruit abnormalities. Squash plants are also plagued by a multitude of insect pests, including squash bugs, cucumber beetles, squash vine borers, and pickleworms.

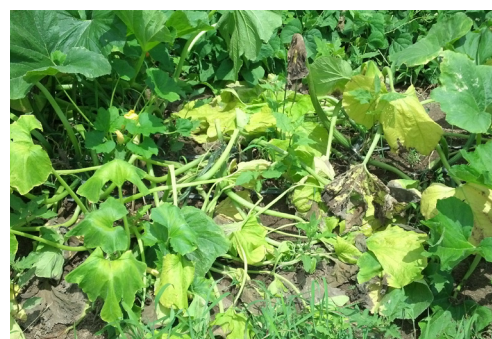
Over the past few years a new disease has emerged in Georgia that has caused substantial losses in organic squash production. Cucurbit yellow vine disease (CYVD) is a disease of winter and summer squash, and to a lesser extent watermelon and

cantaloupe. Initial symptoms occur at the time of flowering and include a yellowing and wilting of leaves. As the disease progresses the entire plant will wilt and collapse. A distinctive symptom of this disease is a honey-brown discoloration of the phloem tissue in the lower stem. In a particular location losses can range from a few plants to almost 100%.



Phloem tissue in the stem is discolored honey-brown.

CYVD is caused by the bacterium *Serratia marcescens* and is spread from plant to plant by the squash bug, *Anasa tristis*. We have found that the bacterium overwinters inside the adult squash bug at frequencies of up to 50% in some areas. The squash bugs become active in May and seek out nearby squash plantings to lay eggs and feed. The squash bug injects the bacterium into the squash phloem while feeding. The squash bug offspring acquire the bacterium while feeding on the infected plants and as adults they move to later cucurbit plantings and spread the disease.



Cucurbit yellow vine disease is caused by a bacterium and vectored by the squash bug.

On conventional farms management of squash bugs is accomplished with synthetic insecticides that are systemic, or taken up by the plant and part of the plant tissue. Organic management of squash bugs, and other pests and diseases, involves an integrated approach. Early planting of squash will avoid many problems but pest and disease pressure will start to increase by June and July.

The targeted use of organic insecticides may help to reduce early population increases but organic options often have limited effectiveness against squash bugs and are detrimental to pollinators.

We have been investigating methods to reduce squash bug feeding and the impact of CYVD. Research has indicated that plants are much more likely to develop CYVD if the bacterium is acquired during the early growth stages before flowering. During the 2013 and 2014 growing seasons experiments were conducted on the use of row covers to protect summer squash during the vulnerable early growth stages and prevent CYVD.

Results indicate that protecting the plants for the first three to four weeks after transplanting or direct seeding but before flowering begins will significantly reduce and usually eliminate the incidence of CYVD with no reduction in yield. Since row covers have the additional benefit of excluding virtually all insect pests, this strategy is particularly beneficial during the summer months when pest pressure is high.



The benefits of row covers must be weighed against the cost of installation, but they may be the best option for mid to late season squash production during years with high pest pressure.

Photos: Row covers were used to exclude the squash bug vector for two, three, four, or five weeks after plant emergence (A). The experiment was repeated three times. Plants that were protected from squash bugs for more than three weeks (B, left row) had significantly less CYVD when compared to plants that were not protected at all (B, right row) or for two weeks. In addition, the row covers protected plants against other pests such as white flies (B) resulting in a marked increase in plant health and yield.

*Kevin Besler and Dr. Elizabeth Little
Plant Pathology Department
University of Georgia*

Shading Nets Affect Fruit Yield and Quality and Extend Growing Season in Bell Pepper

Bell pepper (*Capsicum annum L.*) is an important crop in the southeast U.S. In Georgia, spring bell pepper (for mature green fruit) production is valued at \$130 million. Most conventional bell peppers are grown in open field on plastic film mulch. Many organic growers also use plastic mulches for bell pepper production to control weeds. The spring crop is typically planted from March to April and harvested from May to early July. High average daily temperatures during late spring and early summer reduce bell pepper yields and increase problems with sunscald and blossom-end rot, causing significant yield loss.

In tropical and subtropical countries, shade nets are used for vegetable production to help with these problems. Studies in Israel report that shading increases plant growth and yield, reduces water requirements, and increases irrigation water use efficiency in bell pepper. Shading has also been shown to extend the season in bell pepper grown in tunnels in Florida, allowing for fruit production during the summer.



Commercial shade house zucchini production in Israel.

There is limited information on the use of shade nets for vegetable production in the U.S., so we conducted a study to determine the effects of shade level on fruit yield, quality, and postharvest attributes. A three-year trial was carried out in Tifton, GA under conventional conditions, including use of drip tape and plastic film mulch.



Structures and nets (30%, 47%, 63% and 80% shade) used for the experimental trial. Tifton, GA.

Results showed that shade had a number of beneficial effects. Bell pepper total marketable (Fancy and US1) fruit yield increased with increasing shade level up to 35% shade. The yields then decreased as shade levels increased. Relative to unshaded plants, marketable yields of shaded plants improved by 43% to 119%, depending on the season. Fruit sunscald decreased as the shade level increased. Interestingly, the incidence of

Phytophthora blight was also reduced with increased shade level. We need to conduct further research to confirm that shade can reduce this disease.



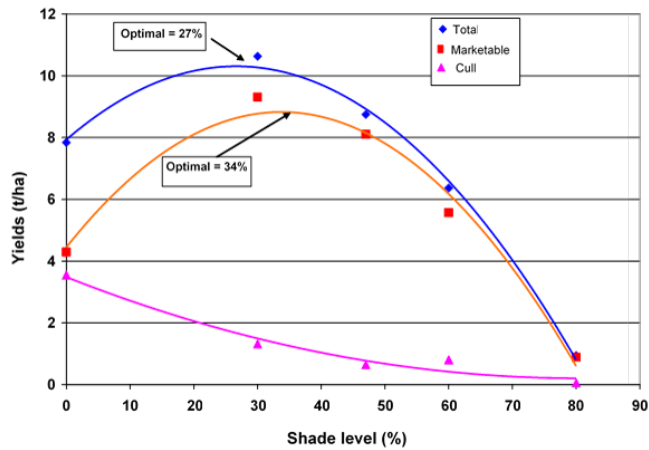
Shade nets reduce incidence of sunscald in bell pepper.

Shade level also influenced fruit nutrient concentrations and quality. Fruit nitrogen, phosphorus, and potassium concentrations increased and aluminum, molybdenum, and nickel decreased with increasing shade level. Fruit soluble solids ('Brix scale') and percent of fruit dry weight decreased with increasing shade level. Generally, you would like the fruit soluble solids that measure sugars and other flavor compounds to be high.

The benefits seen in the study were basically due to reduced heat stress on the bell pepper plants. Shade reduced the amount of radiation from the sun, which reduced both the air and soil temperature. Use of shading nets allowed production of pepper fruit later in the season. The study indicates that best shade level for maximum yields was around 27% to 34%. These shading levels are able to maximize the cooling effect due to reduction of infrared radiation and minimize the decrease in net photosynthesis due to that reduction.

Results indicate that shade nets may be a tool to produce high quality bell pepper, reduce heat stress, and extend the growing season in bell pepper and, probably, in other vegetable crops. Although this study was done under conventional production conditions, shading may likely provide

similar benefits to organic and sustainable bell pepper growers. Before growers adopt this technology in a large scale, however, it is recommended that they test shade nets in a small section of their field or high tunnel.



Bell pepper yields as affected by shade level. Tifton, GA.

Juan Carlos Díaz Pérez
 Department of Horticulture
 University of Georgia
 Tifton, GA

Research

Using automated systems for water conservation

Drought often reduces yields dramatically and can lower the overall quality of a crop. Drought stress has become an issue that is increasingly worrying many growers. It is an important issue for sustainability because as the human population increases, we will need to grow more food more efficiently with the limited resources available. Sustainable water management will require multiple approaches from rebuilding soil organic matter to better store water, increasing onsite water storage, and more efficient irrigation. We have been researching how technology may help farmers increase water conservation.

One way to do this is with an automated control of irrigation, based on sensors relaying information on moisture and environmental parameters. This has been proven to help reduce water use by minimizing excessive irrigations. Automation provides

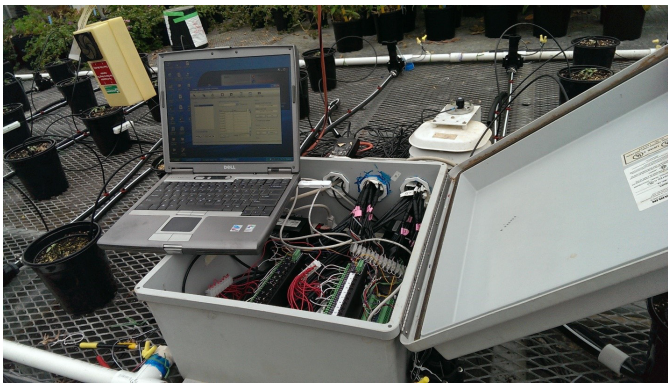
a way to increase irrigation efficiency by setting a set moisture level for a given crop, and allowing a computer to manage the frequency of irrigations needed to maintain that moisture.

Dataloggers can now completely automate and record the irrigation cycles simultaneously across several crops, individually watering each to their corresponding optimal soil moisture levels. Automated irrigation through dataloggers allows growers the ability to irrigate based on need rather than schedule. As moisture levels in the field drop below threshold levels, valves are able to open specific plots on a farm. Valves are used to control the selection of blocks allowing it to only irrigate the plots where it is needed. Irrigation based on need reduces the amount of water used, the wear and tear on pumps, and the amount of energy needed to supply the water.



A new tomato experiment becomes automated with irrigation and logging of environmental data.

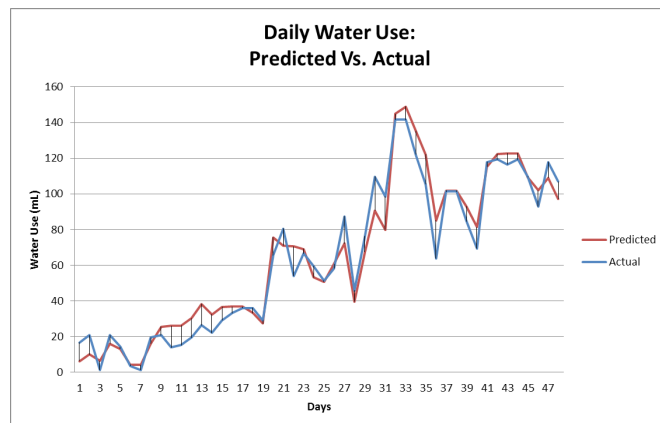
Another advantage of automated systems is that by using sensors to monitor environmental data along with moisture levels for each crop, the data collected can be used not only to reduce water on a given day, but also to create a water budget to forecast water needs for the next week. In Dr. van Iersel's plant pathology laboratory at UGA, we measured the daily water uptake of young 'Moneymaker' tomatoes and the environmental conditions in the fall of 2013 to quantify their effects on daily water use. Plants were grown in pots in a greenhouse for 53 days. Irrigation was controlled by a datalogger to keep the substrate at an ideal moisture (35% v/v). The datalogger recorded how much water was applied each day, the temperature and humidity in the air (vapor pressure deficit), along with light intensity.



Sensor information was fed to a datalogger with an attached computer to view real time data. Threshold triggers would activate solenoid valves for irrigation.

The daily water use by tomato plants generally increased over time, and peaked at 425mL of water per plant (just under 2 cups). As you might expect, daily water use increases as the plants grow since larger plants need more water. But environmental conditions, such as daily total light and the vapor pressure deficit, can also affect water use. We saw fluctuations of over 200mL per plant (about $\frac{3}{4}$ of a cup) in daily water use during the last 20 days of the study. These fluctuations were correlated with changes in the vapor pressure deficit, emphasizing the impact of environmental conditions on plant water use. Our findings describe how fluctuations in environmental conditions affect daily water use by plants through their lifecycle.

We applied the model of daily water use created from the greenhouse study to a newly sowed block, and checked the model predictions against the actual plant use. As you can see in the graph below, the model did well in predicting water use. This indicates it can be used to budget water resources over the course of a week. Calibrated for a particular crop, it can help growers plan their water use, particularly during shortages. It will also help them estimate the impact on their reservoirs. Currently, ongoing studies aim to optimize this forecasting model to better predict daily water use across a wider array of crops and offer higher precision.



Graph: Actual water use per tomato plant as recorded by a datalogger compared to the predicted amount from the model.

The use of this technology with sensors offers a greater control over the health and lifecycles of crops. In many cases, this increased control can enhance the sustainability of a farm, because water conservationism can thrive without decreasing yield. The benefits of automation may increase by adding a remote monitoring capability. Remote monitoring is currently used in a broad range of growing conditions from laboratory settings to remote farmlands. All the data during a season can be recorded and sent to either a control station for easy observation or sent directly to a grower in the form of an email or text message, reducing the time required to manually gather the data. Wi-Fi networks are able to group several systems together, broadcasting their information to a local web server for easy viewing and adjustments. In remote farmlands, cellular modems can substitute for a lack of a Wi-Fi signal. This approach has shown great promise in mitigating not only water shortages as experienced during a drought, but have had a positive effect on reducing the overall carbon footprint of an operation.

*Alexander Litvin
M.S. Horticulture Candidate
University of Georgia*

Mark your calendars for following conferences:

Georgia Organics Conference

February 20-21, 2015 Athens, GA

Website: conference.georgiaorganics.org

Check out the UGA farm tour and workshops!

