UNIVERSITY OF GEORGIA EXTENSION

UGA Cotton Team Newsletter
August 2023

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Cotton Insect Pest Update (*Phillip Roberts*): 2023 has been a learning year for many in terms of cotton pests. We experienced high tarnished plant bug populations in some areas during June and July, even in areas where growers have never treated for this pest. Now growers are dealing with spider mites which historically is an occasional pest with relatively few acres requiring treatment in most years. August is considered the stink bug month which we are very familiar with and we are seeing silverleaf whiteflies build in areas we would expect to see them.

Spider mite infestations are unusually common in many areas of Georgia. Although still a relatively small percent of acres, we will likely treat more acres for spider mites in 2023 than any year of my career at UGA. So why are mites more common this year? I am not sure we know the exact answer to the question but we should consider a couple of things. First and foremost, we treated a significant acreage for plant bugs in June and July. Many of the insecticides we use for plant bug control also reduce beneficial insects, so we disrupted the "system" with plant bug treatments and this increased our risk of spider mite infestations. For several years we have noticed that low levels of mites are present in most fields in the state and perhaps disruption allowed these populations to reach more noticeable and sometimes damaging populations. It also appears to me that rainfall events do not suppress spider mite populations like they once did. The threshold for mites is "apply when 50% of plants are symptomatic and populations are increasing". So, what is a symptomatic plant? Spider mites are very small and feed on the underside of leaves, often in the folds of the leaf or near the base of the leaf where it is attached to the petiole. Early symptoms include yellow spots or stippling on the upper leaf surface, especially on the folds of the leaf. These early symptoms are what we should be scouting for. In time areas of leaves which are damaged will turn reddish and if populations are high and the mites are not controlled, damaged leaves may defoliate. When scouting it is important that you confirm the presence of mites on damaged leaves which will require magnification with a hand lens. Severely damaged leaves (reddish symptoms) may no longer have mites so be sure to check leaves with mild symptoms of injury.

Stink bug populations have been low to moderate as a whole but reports from agents, scouts, and consultants suggest that internal boll damage is increasing. It is important that we scout and use thresholds for stink bugs and other boll feeding bugs such as tarnished and clouded plant bugs and leaffooted bugs. When sampling for internal damage select bolls approximately the diameter of a quarter. This size boll is what stink bugs prefer to feed on. Bolls are considered damaged if warts or callous growths are present on the inner boll wall and/or stained lint is present. The dynamic threshold varies by week of bloom. The 3rd, 4th, and 5th weeks of bloom is a critical window for stink bug management, during this time we have the greatest number of susceptible bolls on the plant to protect so our threshold is lower. When selecting insecticides for stink bug control consideration must be given to other pests present.

Silverleaf whitefly (SLWF) infestations are building in areas prone to be infested with SLWF. A couple of weeks of hot and dry weather were favorable for this increase in populations. A few fields have been recently treated for SLWF. It is imperative that we are VERY TIMELY with insecticide applications when and if needed. The presence of SLWF in a field should influence every decision you make. Conserve beneficial insects to the greatest extent possible. Only spray other pests if thresholds are exceeded and avoid insecticides known to increase the risk of SLWF. How the remainder of the year goes will depend on our management decisions and weather conditions. Poor decisions and hot, dry weather are favorable for SLWF populations. Below are two Extension publications with additional information on SLWF. The first provides detailed instructions on how to scout whiteflies and use thresholds. The second explains the biology of SLWF and describes environments which are at greatest risk of whitefly infestation.

1. Sampling and Managing Whiteflies in Georgia Cotton
   https://extension.uga.edu/publications/detail.html?number=C1184
2. Cross-Commodity Management of Silverleaf Whitefly in Georgia
   https://extension.uga.edu/publications/detail.html?number=C1141

Current Thoughts on the Crop, and Helping Us Collect Data this Winter (*Camp Hand*): About two weeks ago I saw my first open bolls in Tifton, which means we are approaching the finish line on this season. There are three main points I want to discuss in this article:

1. What has changed in the last few weeks? Two to four weeks ago, many people were doom and gloom on our cotton crop – between severe weather, plant bug problems galore, and deer damage, it had been a tough go at it. Plus add to the equation our crop was behind due to cool weather, we were hoping and praying for a long, warm fall to try and finish this crop out. Overall, the attitude has changed on this crop. Depending on where you are in the state, in mid to late July the crop turned a corner and looks really good. We have great yield potential out there, and my hope for this season is that we can get it all in the basket and to the gin. The last week of July and first week of August did a lot of good for our crop, as we are now caught up according to growing degree days, and I think most folks would agree with that. While we need to keep in mind some of

the early season issues we had (they may impact decisions later), overall the mood on the crop is optimistic. My hope for the rest of the season is great conditions to finish it out.

2. Planning for next season… wait, what? Already? Yes, already. This time of year, many people are still making trips across the field, and you can see a lot from a sprayer cab that you can't see from ground level. Take note of problem areas in fields. Weak spots – what is causing it? Are samples necessary (nematode or soil)? Can we do anything to correct it? What about rank areas in fields? Should we try less aggressively growing varieties? Was it over-fertilization? Or was it a timeliness issue with PGRs? If you're a sports fan, any good coach takes note of what the opponent is doing and makes adjustments. Take note of what happened this year and adjust accordingly for next year.

3. Last thing – help me get a number on paper. This year I have gotten more calls about deer from county agents, growers, industry personnel, and consultants that I have since I started. We have begun kicking the can down the road of seeing what can be done, but the first and most important step in acting on this issue is generating a number that we can associate with losses due to deer damage in cotton. I will be preparing a survey to distribute at county production meetings this winter to try and capture this number. So as we approach winter meeting season, I need everyone to attempt to take note of losses due to deer in cotton. This will not only include direct lint yield losses, but also cost of repellent products, labor costs if you or your farm labor are taking advantage of the DNR pest program, costs to replant the crop, and other necessary losses as well. This will go a long way in getting the attention of the people involved in this issue and trying to come to a sensible solution to help farmers with this issue.

As always, if you have questions about this or anything else, please don't hesitate to reach out to your local UGA County Extension Agent. They, along with the rest of the cotton team, are here to help!

August Climate and Weather Outlook (*Pam Knox*): As I am sure you all know, the weather this year has been quite variable, although at the moment we are in fairly rainy conditions after a mostly warm and dry July. Growing degree days have been above normal across southern parts of Georgia, especially the southeast quadrant, leading to more rapid growth. With more rainy conditions returning, we can expect the temperatures and solar radiation to drop somewhat in August, leading to a little slower growth. The outlook for the rest of August shows wetter conditions are likely to continue through at least the first two weeks of the month, but after that there is not much indication of what we will get.

The tropics have shown some signs of life, but so far nothing is threatening for the next couple of weeks. There are tropical waves coming off of Africa, as we expect this time of year. But nothing is developing due to the combination of Saharan dust keeping the atmosphere stable and the El Nino's wind shear, which is blowing the top off of anything that shows signs of growing, especially in the Caribbean and western Atlantic. However, Atlantic Ocean and Gulf of Mexico surface water temperatures are much

warmer than normal, so if anything does break through the wind shear, it could intensify rapidly. If that happens in the Gulf, you may only have a day or two to prepare, so keep watching forecasts carefully for any signs of storms approaching as we enter the peak Atlantic hurricane season from mid-August to the end of October.

With the El Nino firmly in place through next spring, we can expect a cloudier, cooler, and wetter winter than normal. That could start to occur by late fall, so you will not want to let your crops sit out in the field for long once they are ready to harvest. It does bode well for the soil moisture next spring, which is usually in good condition (sometimes too wet for field work, though) for next planting season.

Rainfastness of PGR Products (*Wade Parker*): This season in East Georgia has been a roller coaster ride. The latter part of May and first part of June was very wet and cool, followed by a drier late-June and July. However, the rain came back in earnest mid/late-July and has not let up. Each storm passing through has been delivering 1.5"-3" per round. We are actually having to rearrange our field day stops at Midville due to heavy rain. A common question during these conditions always includes the rainfastness of various plant growth regulator (PGR) products.

The majority of our cotton in East Georgia is in the 2nd and maybe 3rd week of bloom with the remainder in the mid-squaring range. With the conditions described in the aforementioned text, cotton will continue to grow aggressively as the daytime heat has not let up. Unfortunately, sometimes the PGR applications do not stay on long enough to do us any good and may need reapplying if plants do not show any node length reduction.

Below is a description of our basic growth regulator products relative to rainfastness according to the product label. As always, read the label carefully to fully understand the effects of precipitation. All surfactants used need to be high-quality EPA-exempt (per label). Hopefully, the information below will give you a quick reference for the main PGRs used in our area.

Mepiquat Chloride (MC) products (0.35 lbs a.i./gal – several tradenames)

- Applied Alone: 8 hours
- With Surfactant: 4 hours

Gin Out Plant Growth Regulator (4.2% Mepiquat chloride – 0.0025% Kinetin)

- Applied Alone: 4 hours
- With Surfactant: 1-2 hours

Pentia Plant Growth Regulator (9.2% Mepiquat Pentaborate)

- Applied Alone: 2 hours
- With Surfactant: 1 hour

Stance Plant Regulator (2.1% Cyclanilide + 8.4% Mepiquat Chloride)

- Applied Alone: 4-8 hours
- With Surfactant: 2 hours

Potenza (4.2% Mepiquat Choride + 0.065% Kinetin)
- Applied Alone: 2 hours
- With Surfactant: 1 hour

Compact 6x (23% Mepiquat Chloride)
- Applied Alone: 4 hours
- With Surfactant: 1-2 hours

Familiarity with each one of these products is important as they come up in conversation. The majority of acres are treated with mepiquat chloride products only under various trade names. Some of the other products contain other chemical compounds and require different application rates. The Compact 6x is a mepiquat chloride stand alone product, but has approximately 6x the amount of A.I., therefore 1 ounce of Compact is equivalent to 6 ounces of a mepiquat chloride product. Subtle differences such as these make a big difference when giving a recommendation to a client.

Previous research conducted at UGA has indicated that mepiquat chloride applications that are washed from the surface of the leaf 2 hours after application still reduce plant height, but reapplication intervals may need to be sooner than originally planned. In the same study, 4 hour rainfree periods were as effective as 8 hours in reducing plant height. However, fields should always be evaluated to ensure the PGR is working as intended and adjustments in reapplication interval or rate should be made accordingly.

August is a Critical Month for Management of Target Spot and Areolate Mildew (*Bob Kemerait*): A critical component of any disease or nematode management program in cotton is “timeliness”. “Timeliness” means deploying the best management tactic to fight diseases and nematodes before they become well-established or while there is still opportunity to use a tactic. August is an important time in the cotton season to both be timely for possible fungicide applications and for preparation for the 2024 cotton crop.

Foliar Diseases. As of August 2023, there are four foliar diseases active in some, but not all, cotton fields in Georgia. These include bacterial blight, caused by *Xanthomonas citri* pv. *malvacearum*, Stemphylium leaf spot, caused by the fungus *Stemphylium solani*, target spot, caused by the fungus *Corynespora cassiicola*, and areolate mildew, caused by the fungus *Ramulariopsis gossypii*.

Though not widespread at this point, bacterial blight is being reported from more fields than it has in past few years. All reports of bacterial blight are from varieties known to be susceptible to this disease. There is little that can be done to manage bacterial blight at this time, other than to note if it has occurred in your fields and which varieties have been affected. Now is the time that growers should note the level of

bacterial blight in their crop and begin to make decisions as to variety selection for 2024. Growers have an increasing number of "bacterial blight resistant" varieties from which to choose.

Bacterial Blight. Photo by Bob Kemerait

Stemphylium leaf spot is characterized by numerous small spots with dark purple/brown margins and often times gray, papery centers. These spots often show up first in the top of the leaf canopy, but can be found throughout. This disease is widespread and will become even more so as the season progresses. Stemphylium leaf spot occurs when the cotton plant is deficient in potassium; potassium deficiencies may exist because of poor soil fertility, perhaps from leaching, or during periods of drought where potassium is not taken up into the plant. Stemphylium leaf spot is also commonly observed in plants affected by plant parasitic nematodes. Stemphylium leaf spot is managed by insuring proper levels of potassium in the plant; fungicides are NOT an effective management tool.

Stemphylium leaf spot. Photo Greg Slaughter

Target spot is likely present in many fields across the Coastal Plain of the state, though there have not be any reports, yet, of severe premature defoliation. Target spot can develop quickly when there is high humidity and frequent rainfall. This disease is most common in good-growing cotton with high yield potential. Extended periods of leaf wetness, where the foliage in the interior of the canopy remains wet well into the later morning hours, create perfect conditions for rapid development of target spot and premature defoliation from it. Fungicides are an important management tool for target spot, though use does not always result in increased yields. From our research, effective use of fungicides should be considered between the first and sixth week of bloom where the third week of bloom is typically the most critical time of management. Scouting before use of fungicides to determine if the disease is present help to ensure that an application is warranted. Priaxor and Miravis Top are currently the most effective fungicides for control of target spot, though Headline, Quadris and other formulations of azoxystrobin are also effective.

Target spot. Photo Jason Brock

Areolate mildew has been especially severe in Georgia since 2017 and there are reports that this disease was present by the end of July in a few fields. It is expected that this disease will quickly spread as we move into August. Areolate mildew has historically been confined to southeastern Georgia east of I-75; however, it can now be a problem for cotton growers across the Coastal Plain. Until 2017 this disease typically arrived too late in the season to cause any damage (in fact, late-season defoliation may be a benefit), use of fungicides had often not been warranted. Based upon data from recent field trials, judicious use of the same fungicides used to control target spot is warranted in the management of areolate mildew. Growers within four weeks of defoliating their cotton need not worry about managing areolate mildew. Where areolate mildew occurs in a crop with anticipated defoliation a month or more away, and weather is favorable for continued development and spread of the disease, use of a fungicide may be beneficial to protect yield. Timely use of a fungicide has protected between 100 and 250 lb/lint per acre.

Areolate mildew. Photo by Jeremy Kichler.

It is too late to protect our 2023 cotton crop from plant-parasitic nematodes or Fusarium wilt; however now is the time that symptoms become very evident in the field. Where stunting, poor growth and even dying plants are found in areas of a field, growers should take measures to determine 1) is it caused by nematodes? 2) if so, what kind of nematodes, and 3) is Fusarium wilt also involved. Detection and identification now will help growers to make best variety selection and possible use of nematicides in 2024. Distinctive interveinal chlorosis (I call it "tiger striping") is often associated with both nutrient deficiencies and with damage from plant parasitic nematodes on a cotton crop. Finding such in a field should encourage growers to check further for the presence of root-knot, reniform, or sting nematodes with appropriate soil sampling.

Photo of interveinal chlorosis by Glen Harris.

Cotton Irrigation Considerations for August (*David Hall, Jason Mallard, Phillip Edwards, Daniel Lyon, and Wes Porter*): As I've travelled around the state over the summer and up until now, it's hard to really quantify where our cotton's "average" water requirements are across the state. I see fields that are basically ankle high around the 4 to 8 leaf stage and then I see fields with a lot of white blooms moving up through the canopy. When I get questions about how much we need to be irrigating cotton right now, it's a very much, "it depends" answer. When was your cotton planted, what stage is it at right now, how much rain have you gotten or missed, have you irrigated up to this point, how much, when was the last application? There may be as many questions as answers. This year like all years has had it challenges. It started off very cool and wet, early plantings occurred and then it turned cool and wet, preventing a lot of farmers from getting in the field during most of June and delaying a lot of planting. Additionally, during most of June it was much cooler and wetter than normal. This let much of our crop to not having to search for moisture and potentially slowing or hindering root growth, keeping a majority of our roots in the shallower profile. We have had some very hot weather over the month of July and a majority of our crop should be in peak water usage now, if not moving on through it, as shown in Figure 1.

Even though perhaps peak water demand may be past if the crop was planted during late April or early May, it is critical not to fall behind on irrigation during bloom. It is critical that we continue to monitor the weather and make smart irrigation decisions. Even though water requirements are starting to move out of the peak demand, don't get too comfortable, it's always difficult to catch up with irrigation alone. Over the next month, keeping up with the water requirements is very important. The water demand will be lowering as we move on into the season, but it is still critical to have adequate soil moisture during the entire period of bloom. Based on planting date, the weekly water requirement of the crop can range between about 1.0 to 1.5 inches per week based on the UGA Extension checkbook method for cotton. Please keep in mind the weather conditions and how much of an impact they can have on water requirements. In other words, the checkbook method is there to give you a reference as a guide, but should not be used for the final decision. We are entering the tropical storm season and have opportunities for large rain events and even some hit or miss showers. Some days can be of intense heat with low humidity, leading to high evapotranspiration rates and cause the need for higher than recommended water requirements for that week. Conversely, we can receive hot days with very high humidity and overcast conditions which will mean the plant is still using water but the evapotranspiration rate is very low. Plus, with a good canopy closure the ground is well shaded. It's really amazing to see crop water use through moisture sensors. The graphical representations of plant water demand and environmental conditions can be an eye-opening experience to witness throughout a growing season. It's human nature at times to question sensor readings when it comes to irrigation scheduling. It's true that moisture sensors do not last forever and can fail to give accurate data. With most Watermark sensors, accuracy can be simply checked by attaching a meter to the individual sensor probe wires to verify the current readings. The old school method of drilling down with a 1-3-inch auger near the probe, monitoring soil moisture as you drill down, can assist to determine if the sensor is faulty, or giving erroneous readings. If you don't have access to moisture sensors, walking your fields with a shovel or soil probe to investigate available moisture is highly recommended. Again, the checkbook method is just one tool of many tools that can be used to assist in scheduling irrigation.

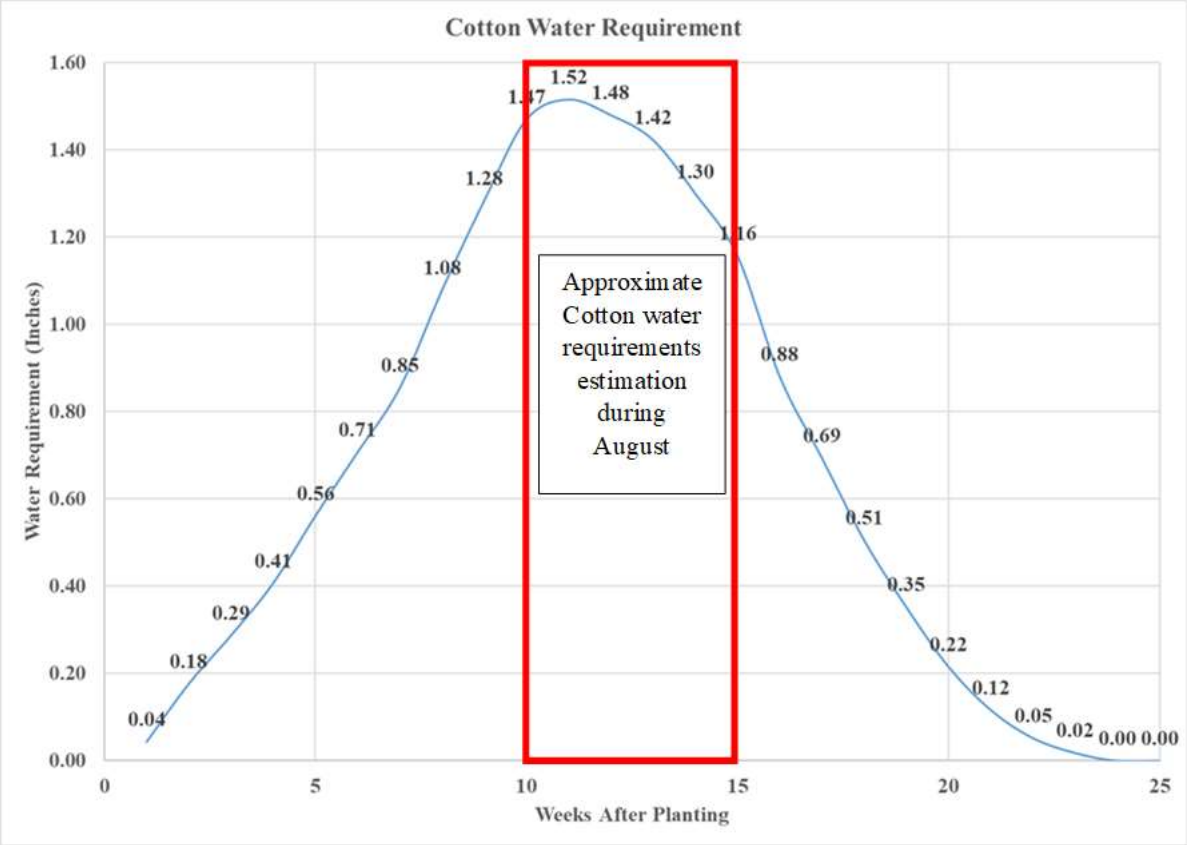


Figure 1. UGA Cotton Checkbook, with the estimated water use period highlighted.

While the hot weather and sporadic periods of no rain has many of us feeling like we need to irrigate, it may surprise you, but I have only triggered one irrigation event (as of 7/31/2023) on my cotton research plots near Camilla, GA. Figure 2 may reinforce this for many of you as all of our state is listed in the none category for drought as of the end of July. While, this can change rapidly, and there are places throughout the state that have missed many of these rainfall events, overall, we have had adequate rainfall this season and may not have needed as much irrigation as we initially thought.

I am not saying we should not have irrigated cotton across the state, just overall, we have had a more wet season than we have in the past. However, if you have missed many of these rain events, or even some of them it is critical that you have stayed on top of your irrigation requirements. In years with adequate or excessive rainfall it is very critical to have an irrigation scheduling method that you have confidence in, which will help you determine when to apply those few critical applications to ensure you maximize yield and water use efficiency without wasting water or reducing yield.

Though some areas have received adequate rainfall, there are areas where rainfall was seriously diminished in the month of July. When we have very wet conditions during plant development plant roots sometimes do not enter those deeper depths. It is important to maintain adequate moisture within the active root zone. Through monitoring soil moisture sensors in certain areas, we are noticing, a majority of

moisture is being utilized from the shallower depth sensors. In this situation if you aren't seeing moisture being utilized from the deeper depths be sure to maintain good moisture where the plants are utilizing moisture.

It seems this season as we have received rainfall several times it has been in large rain events. When these heavy downpours happen, we need to keep in mind two things which impact how much of that rainfall we capture and are able to utilize for our crops. They are the water intake rate and water holding capacity of our soils. When we receive those 3" rainfall events we may only "bank" 0.75" or 1" of it according to rainfall intensity and soil conditions.

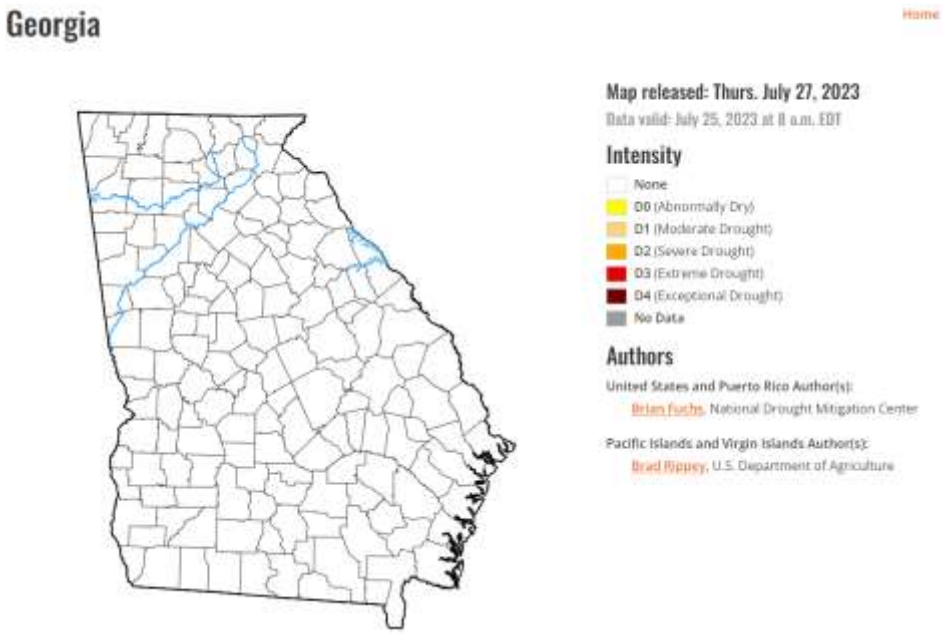


Figure 2. The current drought conditions in Georgia as of the end of July.

If you have further questions about irrigation requirements, irrigation scheduling or current water requirements for cotton reach out to your local UGA County Extension Agent.

Variable Rate PGR Application Considerations (*Simer Virk*): Variable-Rate (VR) application of plant growth regulators (PGRs) is gaining interest every year among cotton growers in order to better manage plant growth variability within the fields. While there is a steeper learning curve to fully understand and put this application into practice, several consultants and cotton growers across the state have been utilizing it with much success over the last few years in Georgia. Considering the amount of variability in our cotton fields, the VR application of PGRs definitely has its benefits over traditional single-rate applications; however, there are some important considerations to understand and utilize for effective VR PGR applications in cotton. The points listed below are based on the research conducted in large-scale fields and from previous experience with technology during other VR applications. Also, similar to any

other VR application, it is important to understand that the whole point behind VR PGR application is to manage plant growth variability within the field whereas an inadequate VR job can actually create more variability in the field than before it. Thus, attention to some of the considerations related to aerial imagery, prescription map and spray technology are important.

- Currently, most VR PGR applications are based on in-season satellite imagery which is available through many commonly-used ag data management platforms (such as John Deere Ops Center, Climate FieldView or Granular AgStudio/Insights) throughout the season and provides a good indication of crop health/biomass variability within the field. The frequency and resolution of the imagery can vary depending on the provider and the subscription. One of the most important considerations when utilizing aerial imagery is to geo-reference it, which means the field boundary and zones would need to be aligned correctly for application equipment to accurately change the rates within the desired areas in the field.
- Another important consideration is to take the downloaded aerial imagery and/or VR prescription (Rx) map on a GPS-enabled handheld device such as iPad/tablet or field computer, and ground truth it to verify the actual plant growth within different zones as well as the transition areas between the different zones. A good practice is to edit or adjust these areas as well as assign the PGR rates based on what you actually see within each zone in the field and not base it solely on the crop health (NDVI) values from the imagery.
- When creating VR PGR prescription maps, keeping the number of zones between two and four is a good strategy as it helps keep the math (converting from oz/ac of PGR product to gallons/ac of spray volume) and the logistics of VR application simple and easier to implement. While most data management software's today will let users create multiple zones and assign rates to each, that doesn't mean we should always go with the most rates possible in the field. That not only makes the process overwhelming and complex but also impractical most of the time, especially when considering the nozzle selection and spray equipment capabilities in achieving the different rates in the field. Remember again that our goal is to address variability and not create more than what we started with.
- Spray technology has advanced considerably over the years with pulse width modulation (PWM) and individual nozzle control becoming standard option on most new application equipment. While newer sprayers and sprayers equipped with rate-controllers have multiple boom sections and faster response times but the rate changes during VR applications are not super-fast and instantaneous. Both rate-control and PWM technology requires some time (which corresponds to various distances at different speeds) to attain and stabilize the application rate. Therefore, the size of the application zones should be considered properly so the sprayer (or each boom section) has enough time to achieve and maintain the target rate instead of continuously chasing different Rx rates. It is always a good practice to merge smaller zones with adjacent larger zones to avoid such application errors due to equipment/technology limitations.
- There is also some interest recently in using spray drones for VR PGR applications. Currently, we do not know enough about the rate-control technology and its capabilities on spray drones so the accuracy and reliability of the system is achieving different target rates is not clear. My personal opinion is that the VR technology on spray drones is not as good as ground application technology

which would require operators to even use more caution when implementing VR applications with spray drones. There is research underway this year to understand the efficacy or benefits of PGR applications with spray drones compared to ground applications so hopefully we will have more information on that as well as VR capabilities of spray drones by later this year.

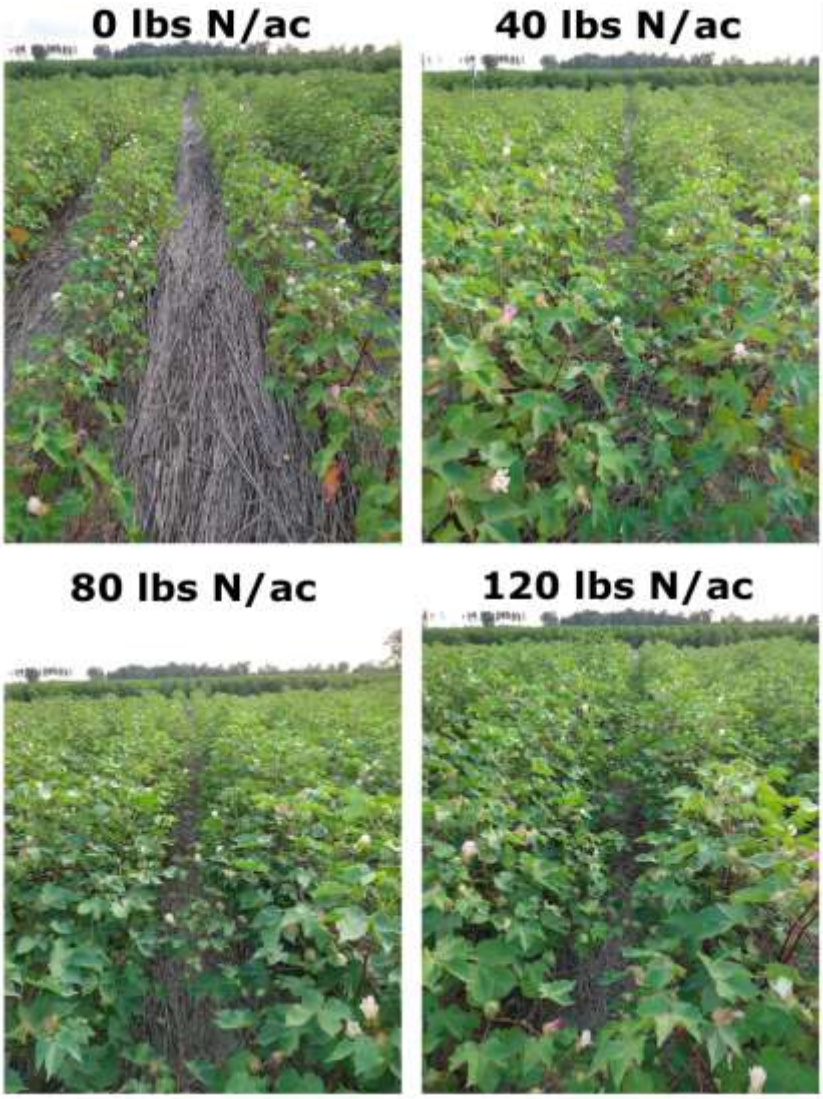
Visual Nutrient Deficiency Symptoms in Cotton (*Henry Sintim and Glen Harris*): Essential nutrients are indispensable for plant growth because they support critical metabolic functions. Their deficiencies oftentimes cause plants to exhibit visual symptoms. This could be used as an initial diagnosis of plant nutrients, especially when management practices are taken into consideration. Soil and plant tissue analyses are, however, required to confirm the nutrient deficiency of a crop. Nutrient management should not be exclusively based on visual symptoms because some of the nutrients have overlapping deficiency symptoms. Knowing visual nutrient deficiency symptoms is still valuable, especially, when scouting a field. Here we provide common visual nutrient deficiency symptoms in cotton to help with initial assessments of a nutrient deficiency problem.

Nitrogen Deficiency

If nitrogen deficiency occurs during the early season, you will observe stunted cotton plants showing yellowish-green leaf colors that are small in size. Because nitrogen is mobile and can be moved to developing tissues, the nitrogen deficiency will first appear on older leaves as yellowing. Know that if nitrogen deficiency starts occurring during the later stage of the growing season, the lower leaves that were already formed will only show yellowing and will not necessarily be small in size. The new leaves that are being formed will be smaller even though the yellowing will not be very obvious in the initial stages. As the nitrogen deficiency gets severe, then eventually all the newer tissues will also start yellowing, and in very severe cases, there will be reddening of the leaf blade. In general, cotton plants deficient in nitrogen mature prematurely, have poor boll retention, and ultimately yield lower.

Photo showing a healthy cotton leaf (left) and a cotton leaf deficient in nitrogen (right). Source: North Carolina State University Extension.

Photo showing a healthy cotton plant (left) and a cotton plant deficient in nitrogen (right). Source: Yara North America.



Side-by-side comparison of the plots of nitrogen studies in Midville, GA that received different rates of nitrogen.

Phosphorus Deficiency

Phosphorus is mobile in plants so deficiency appears first on older leaves. The leaves become dark green with purplish reddening. The tips of leaves and leaf margins become necrotic (dead tissue) as symptoms persist. The plants can also show reduced root systems, stunted growth, delayed flowering, and poor boll retention. While the obvious symptom of phosphorus deficiency is the purplish reddening of the leaves, it is important to note that sometimes stunted growth may be the only evidence of phosphorus deficiency. This can easily be overlooked or wrongly attributed to other factors. Periodic soil and tissue analyses may be necessary because phosphorus deficiency can sometimes be quite difficult to spot in the field.

Photo showing the lower leaf of a cotton plant turning dark green and purplish red color due to phosphorus deficiency. Source: California Department of Food and Agriculture

Photo showing advanced phosphorus deficiency in a cotton plant with dark green and purplish red color. Source: Yara North America.

Photo showing a healthy cotton plant (left) and a plant deficient in phosphorus (right). The phosphorus-deficient plant does not show obvious purplish-red color. Also, the leaves are not dark green but yellowish. Source: Yara North America.

Potassium Deficiency

In the early season, potassium deficiency shows first in the lower canopy and then later spreads throughout the plant. The plants show a light green to gold mottling between leaf veins, which progresses to yellowing and then browning and necrosis (dead tissue) of the leaf margins. Mottling is a pattern of irregular marks or spots of different shades or colors. In the late season, deficiency symptoms appear first on the younger leaves, typically, in the upper third of the canopy. Ultimately, this can lead to premature leaf shedding, early cut-out, poorly formed bolls, inferior lint quality, and reduced yield. The entire leaves of young cotton plants can show symptoms under very severe potassium deficiency conditions. Also, the level of expression of potassium deficiency symptoms could vary by the variety and environmental conditions.

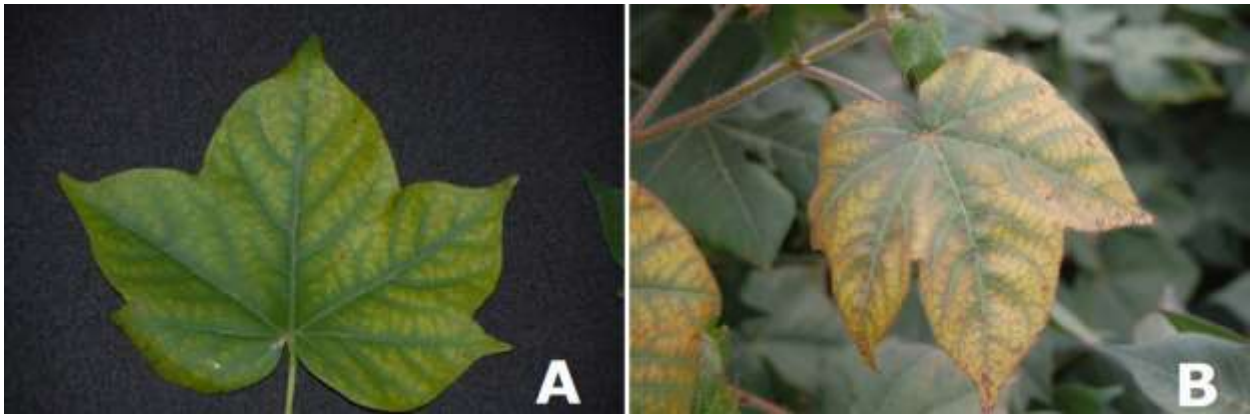


Photo of cotton at pre-bloom stage showing potassium deficiency symptoms.

Magnesium Deficiency

Magnesium is a component of chlorophyll, which gives plants a green color and is required for photosynthesis. Early symptoms of magnesium deficiency manifest as interveinal chlorosis (yellowing), where the vein remains green. As magnesium deficiency progresses, cotton leaves turn purple-red, and the veins of the leaves remain green. The affected leaves may age prematurely.

Photo of a cotton plant showing early symptoms of magnesium deficiency. The leaves show interveinal chlorosis (yellowing), where the vein remains green. Source: North Carolina State University Extension.

Photo of a cotton leaf showing advanced magnesium deficiency. The leaves turn purple-red, but the veins remain green. Source: International Plant Nutrition Institute.

Photo of a healthy cotton plant (left) and a cotton plant with magnesium deficiency (right). Source: Yara North America.

Sulfur Deficiency

Sulfur is not very mobile in the plant so deficiency symptoms appear first on younger or upper leaves and leaf veins. The leaves become pale green or yellowish. This is different from nitrogen deficiency where the symptoms are observed on lower or mature leaves. Sulfur deficiency causes newly formed leaves to be smaller, and it also reduces vegetative branches and boll size.

Photo showing symptoms of sulfur deficiency in a cotton plant. Source: Yara North America.

Photo of cotton plants showing symptoms of sulfur deficiency. Source: The University of Florida Institute of Food and Agricultural Sciences.

Boron Deficiency

Boron deficiency in cotton causes a distorted and stunted terminal (dwarfed plants), as well as abnormal growth of the uppermost leaves. Boron deficiency may also cause the formation of dark concentric rings on the leaf petiole. The leaf petioles are also shortened and thicker than those in healthy plants. Flower

abortion and boll shedding may occur in some conditions, contributing to excessive stalk growth. Note that the damage from lygus (*Lygus hesperus*) may appear similar to boron deficiency symptoms.

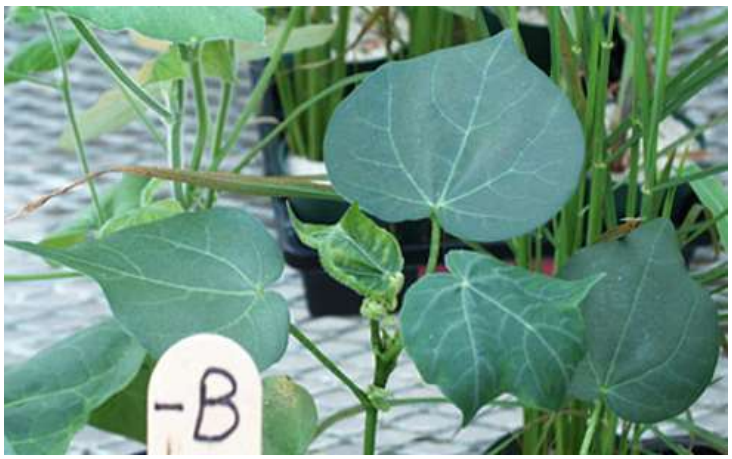


Photo of a boron-deficient cotton plant showing distorted growth of the uppermost leaf. Source: North Carolina State University Extension.

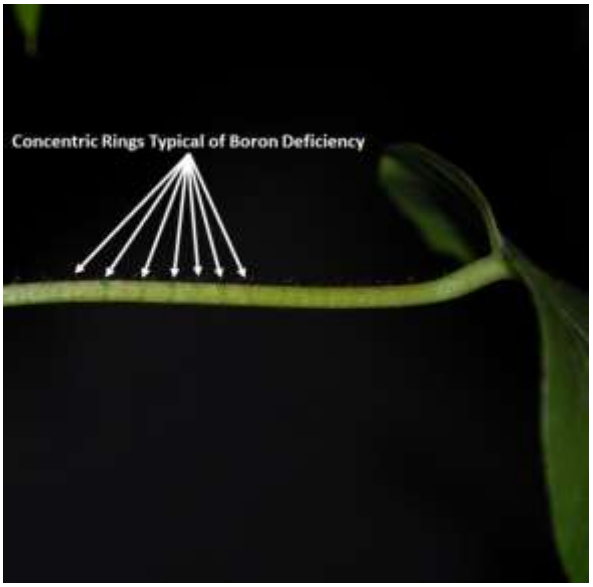


Photo of a boron-deficient cotton leaf petiole showing dark concentric rings. Source: Mississippi State University Extension.

Zinc Deficiency

The initial symptoms of zinc deficiency in cotton are interveinal chlorosis (yellowing) of young leaves that start from the leaf margin. This is because zinc is not very mobile in plants. As zinc deficiency progresses, the leaves appear leathery and upturned. Other symptoms of zinc deficiency may include rosetting (short internodes), as well as stunted leaves that are bronzed in appearance. The brown spots extend from the leaf tips to the base and later dry.

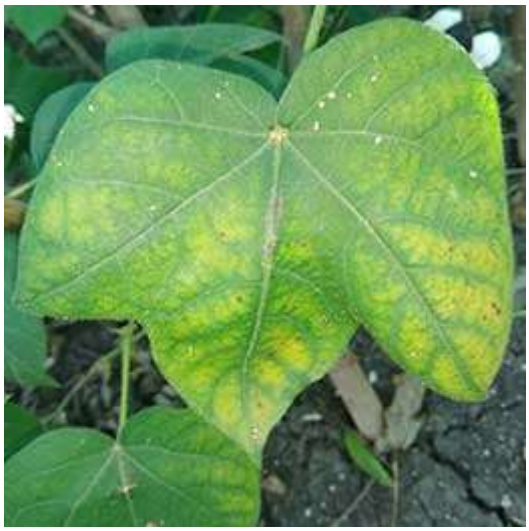


Photo of a zinc-deficient cotton leaf showing interveinal chlorosis (yellowing). *Source: Aries Agro Limited.*

Photo of a cotton leaf showing advanced deficiency in zinc. Source: International Plant Nutrition Institute.

Iron and Manganese Deficiency

Just like zinc, both iron and manganese are not very mobile in plants so the deficiency symptoms first appear on the topmost or young leaves. The leaf veins remain somewhat green while the uppermost leaves become chlorotic and bleached. As deficiency advances, the leaf blade becomes completely bleached. Symptoms of iron and manganese deficiency are difficult to distinguish so soil and tissue tests from healthy and deficient areas may be needed.

Photo showing early symptoms of manganese deficiency in cotton. Virtually, all the leaf veins are still fairly green while the leaves are chlorotic. *Source: Yara North America.*

Photo showing severe symptoms of manganese deficiency in cotton. The leaf veins of some leaves are totally bleached. *Source: Yara North America.*

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Want to learn more about the H.SINTIM LAB visit **https://sintim.uga.edu/**

Important Dates:

Southwest Research and Education Center Field Day – Plains, GA – August 16, 2023
Cotton and Peanut Research Field Day – Tifton, GA – September 6, 2023
J. Phil Campbell Sr. Research and Education Center Cotton Field Day – September 27, 2023
Georgia Cotton Commission Annual Meeting and UGA Cotton Production Workshop - Tifton, GA – January 31, 2024