UGA Cotton Team Newsletter

August 6, 2020

Articles in this month's issue include:

Causes of Shedding in Cotton (John Snider, Cotton Physiologist and Gurpreet Virk, Graduate Student):
<u>Squaring, flowering, and boll development:</u> To understand the causes of square and boll shed it is first important to have a basic understanding of flower and fruit development in cotton. The first reproductive structures that are visible on the plant are floral buds called squares. Squaring happens about five weeks after planting, once 425-475 DD60s have accumulated after emergence. The square can be classified into different developmental stages based on the shape and size of the bud. For example, a pinhead square will have a floral bud roughly the size of a pinhead once the bracts are removed to make the floral bud visible; a match-head square will have a floral bud roughly the size of a match-head. Figure 1 from Ritchie et al. (2007) provides an overview of the different stages of floral development from pinhead square to flowering.

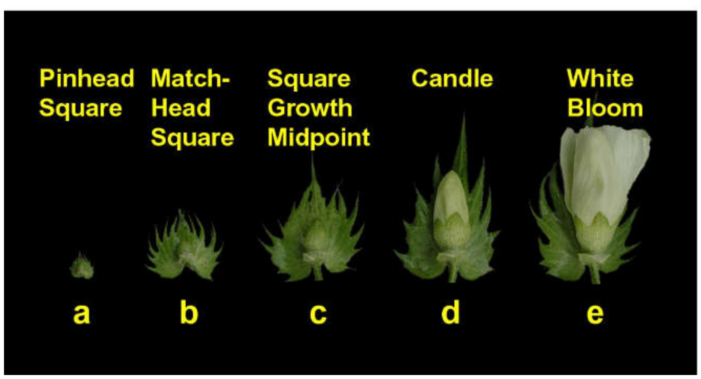


Figure 1: Different developmental stages of floral development (from Ritchie et al., 2007).

The first open cotton flower (white in color) is observed about 3 weeks after the first square is visible. The flower opens and pollination occurs in the morning on the day of anthesis, but the timing of these events depends on relative humidity and temperature. Fertilization of the ovules inside the ovary of the flower is essential for seed and boll development. This occurs between 12 and 24 h after pollination. The white flower will transition from a white to a pink/red color as floral structures other than the ovary (developing boll) begin to die. The pink flower usually dries out and falls off approximately 5 to 7 days after flowering, which exposes the developing boll.

In the first three weeks of boll development, the capsule wall will reach its final size and dry weight, the fiber will reach its final length, and the embryo inside the developing seed will reach its final volume. However, the majority of the boll's final dry weight will be accumulated after this point as seed filling and fiber thickening continue to occur until ~38 days after flowering.

The shedding process: Shedding (abscission) of squares or bolls can be observed in any cotton field, and can be influenced by a number of factors. Leaves and fruit contain a layer of cells at the base of the petiole (leaves) or peduncle (fruit stalk) called the abscission zone. Abscission takes place due to softening and weakening of the cells in this zone because of two main digestive enzymes: pectinase and cellulase. High levels of the naturally occurring plant hormone IAA in a square or boll will inhibit the production of these enzymes. A decline in IAA or a decrease in the ratio of IAA to ABA in the fruit will stimulate ethylene production, which increases the production of these degradative enzymes and promotes the abscission process. Factors driving square and fruit shed will be discussed next.

Age and position on the plant: Insect injury to developing squares and bolls has long been known to cause abscission at a wide range of developmental stages because injury stimulates ethylene production which promotes shedding. However, a certain amount of shedding occurs naturally in the absence of biotic stresses. Under normal conditions, the cotton plant will naturally shed nearly 60% of all squares it produces. Young squares are far more likely to shed than squares at or beyond the mid-point. Open flowers typically will not shed in the absence of direct injury. Bolls are most likely to shed during the early stages of development (5 to 7 days after flowering). Once the cotton boll has made it beyond two weeks after flowering, it is unlikely to shed. This makes a lot of sense from an energetic perspective. Early during development, the plant hasn't invested much in the developing boll. As the boll continues to develop, it accumulates more dry matter and it would be energetically costly to lose the boll past a certain stage (two weeks in this instance).

Along with fruit age, crop development and position on the plant affect fruit abscission. Since young bolls are the most likely to shed, the highest rates of shedding are commonly observed one week following peak bloom (give or take a few days). So, if a grower has large cotton plants with a high number of fruiting sites, one can expect to start seeing plenty of young bolls on the ground during this period. This is not automatically cause for concern.

The position of a square or boll on the plant also influences abscission rate. As a general rule, squares produced at fruiting branch positions farther away from the main stem have a lower probability of being retained than those closer to the main stem. Specifically, first position squares have a 74% percent probability of being retained until boll maturity. Probability of retention decreases to 24% for the second position, and 2% for the third position. This is likely because bolls closer to the mainstem get a larger portion of the carbohydrates produced by mainstem leaves and because subtending leaves tend to be larger for first position fruit than for second and third position fruit.

<u>Environmental factors:</u> Square and boll shedding can be influenced by light intensity, temperature and water. It has long been recognized that cloudy weather negatively impacts fruit retention, and some of the earliest research on fruit abscission addressed the impact of low light on the shedding process. Figure 2 summarizes the effect of fruit age and shading on shedding in cotton and is derived from Guinn et al. (1982). It shows that low light intensity for three consecutive days caused nearly 100% fruit shed if the low light conditions were initiated during the first week after flowering. Sensitivity to low light declines substantially with increases in fruit age; short term low-light conditions had no effect on fruit retention for > 2 week-old bolls.

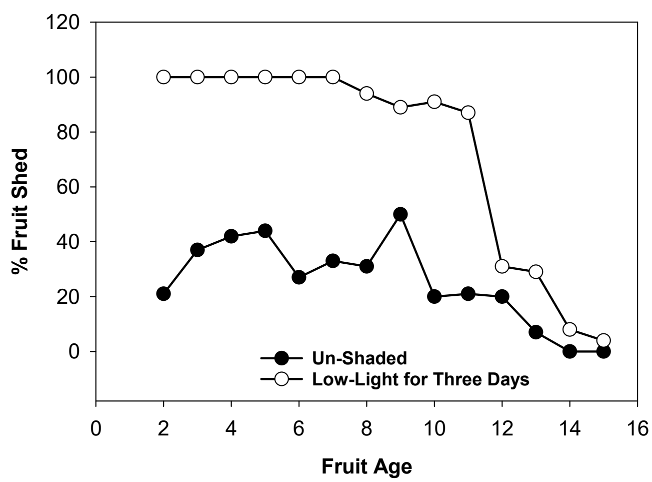


Figure 2: The effect of low light intensity and fruit age on fruit shed (Guinn et al., 1982).

High temperatures more negatively impact reproductive development than vegetative development. For example, work by Hodges et al. (1993) showed that day/night temperatures in excess of 95/81°F (day/night temperature) positively impacted overall plant growth and fruiting site production, but substantially increased boll abscission, negatively impacting productivity. This can be explained by the fact that a certain percentage of the ovules in a developing boll must be fertilized for the boll to be retained. Heat stress that occurs during pollen formation (during squaring) or after pollination can limit fertilization efficiency and increase fruit shed.

Shedding can be increased by too little or too much water. It has been well documented that drought conditions can increase the rate of boll abscission. Drought causes reductions in leaf area and photosynthetic efficiency that limit the number of fruit the crop is able to support. The crop is particularly sensitive to drought from early flowering to peak bloom, with two-bail reductions in yield observed previously in Georgia (Chastain et al., 2016) for dryland cotton when compared with a well-watered control. Although typically less of a concern, too much water can also decrease fruit retention. For example, pollen is sensitive to water and will burst soon after it comes into direct contact with water droplets. Timing and volume of water applied to a flower will influence percent seed set and abscission rates. Sprinkler induced fruit shed and yield loss has been documented in the Texas high plains, provided that irrigation was received at a time during the day after pollination had already occurred (Burke, 2003). Over-irrigation can also limit fruit retention by producing excess vegetative growth, which shades lower leaves and fruiting sites.

References

Burke, J.J., 2003. Sprinkler-Induced Flower Losses and Yield Reductions in Cotton (*Gossypium hirsutum* L.). Agron. J. 95:709-714.

Chastain, D.R., J.L. Snider, G.D. Collins, C.D. Perry, J. Whitaker, S.A. Byrd, and W.M. Porter, and D.M. Oosterhuis. 2016a. Irrigation scheduling using predawn leaf water potential improves water productivity in drip irrigated cotton. Crop Sci. 56:3185-3195.

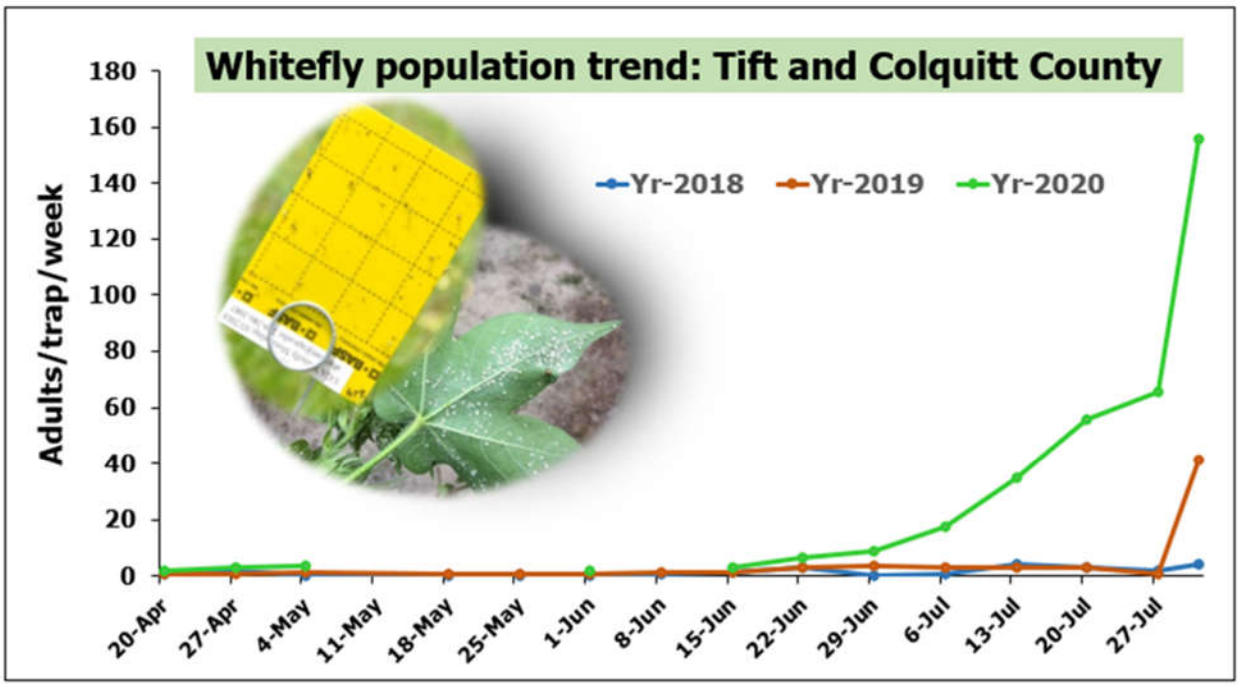
Guinn, G. 1982. Causes of square and boll shedding in cotton. United States deap-rtment of Agriculture. Agricultural Research Service. Technical Bulletin 1672.

Hodges, H.F., K.R. Reddy, J.M. McKinion, V.R. Reddy. 1993. Temperature effects on cotton. Mississippi Agricultural and Forestry Experiment Station, Bulletin 990.

Ritchie, G.L., C.W. Bednarz, P.H. Jost, and S.M. Brown. 2007. Cotton growth and development. The University of Georgia, College of Agricultural and Environmental Sciences, Athens, GA. Bulletin 1252.

Oosterhuis, D.M. 1990. Growth and development of the cotton plant. In: W.N. Miley and D.M. Oosterhuis (eds) Nitrogen Nutrition in Cotton: Practical Issues. Proceedings of the Southern Branch Workshop for Practicing Agronomists. American Society of Agronomy, Madison, WI. pp. 1-24.

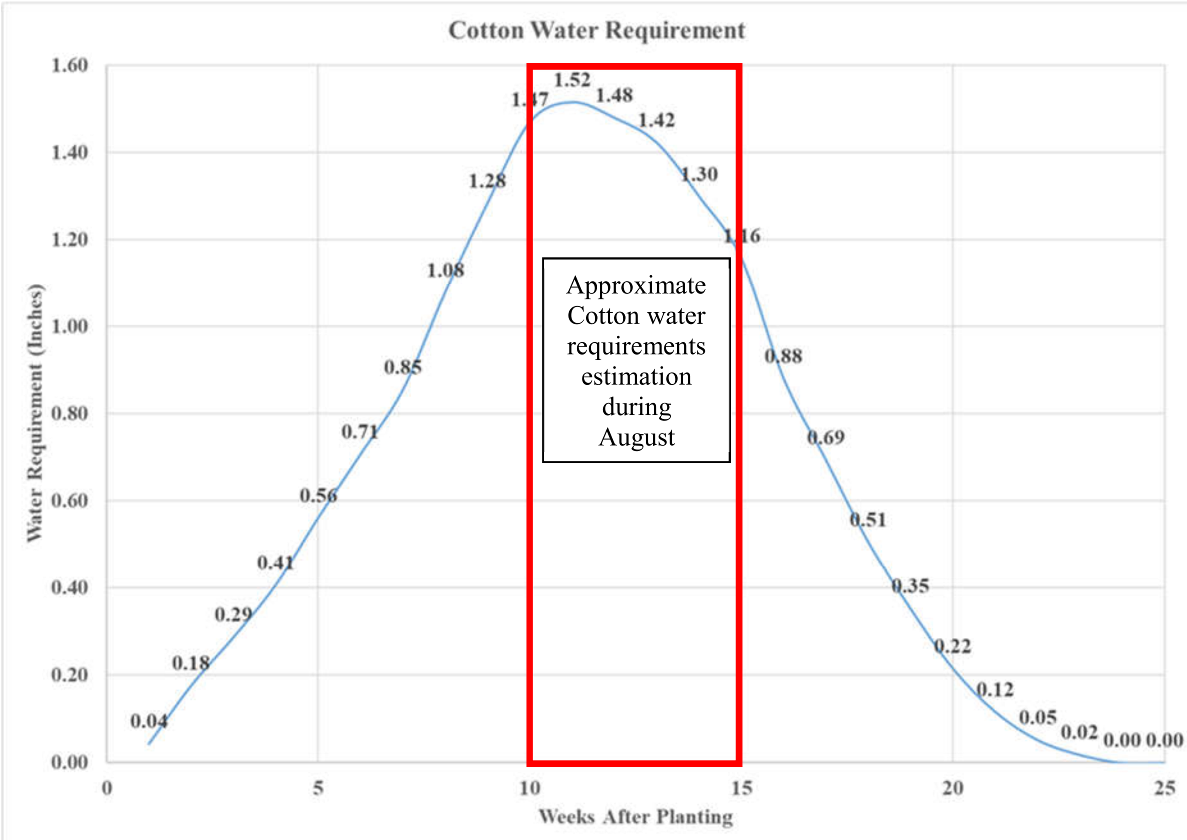
Whitefly Update (Apurba Barman, Entomology Postdoctoral Researcher): Whitefly population is increasing at faster pace as you can see in the graph based on the average trap captures across Tift and Colquitt county. Although the average tarp capture is much higher during this time of the year (July), variability from location to location is tremendous. Therefore, all fields are not equally infested and need to be accessed individually for best management practices. Fields with younger cotton and close to produce fields seem to have significantly higher whiteflies than in mature cotton. Dryland cotton is already stressed due to lack of rainfall in critical crop growth period and likely to suffer even more from increased whitefly pressure. Beneficial insects such as lady beetle, lacewing, big-eyed bug and minute pirate bug are well present in our cotton fields, but alone they are not sufficient to bring down whitefly populations that is growing at increasing pace. Our trapping results clearly show that this year (2020), we are experiencing whitefly infestation in cotton couple weeks earlier than seen in any typical year. Please plan accordingly based on the crop conditions and consider timely insecticide applications following Extension recommendations and scout data. Once population is out of control, it is difficult to manage and could turn out to more expensive.



Cotton Irrigation Considerations for August (David Hall, Extension Water Educator, Cale Cloud, Extension Water Agent, and Wesley Porter, Extension Precision Ag and Irrigation Specialist): Up to the end of July the environmental conditions across the state have been brutal the past couple of weeks due to heat and dry weather. Unfortunately, if your crop was planted in May, the stress of adverse weather could not have occurred at a worse time because most cotton planted during May is in peak Bloom right now. This means the crop is somewhere between 8 to 12 weeks after planting (assuming a May 1 to June 1 planting date). This is during the peak water use period. Hopefully, you were able to meet the water needs of your cotton fields during that critical peak water demand time frame.

As mentioned in last month's newsletter, we have been ramping up water demand to this year's peak demand in cotton. Even though perhaps peak water demand may be past if the crop was planted during late April or early May, we cannot get behind on irrigation during bloom. 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 If your 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 to go on, 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 more water than recommended 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 evaporation rate is very low. Plus, with a good canopy closure the ground is shaded well. 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. 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. Chemigation through pivots may not be for everyone but with possible insect pressure and many acres to cover, this practice may prove timesaving and effective. Remember, read the label to ensure the pesticide is approved for chemigation. Also, run the pivot at 100 percent to apply the least amount of water while chemigating. If your system can not apply .1 of an inch or less per revolution, chemigation is out of the question. Remember the goal of chemigation is to apply chemical to the foliage of the plant, not the soil. This also means that a chemigation event cannot accurately and validly be counted as an irrigation application.

If you are considering fertigation using the pivot that is perfectly fine. However, keep in mind that the goal in fertigation is to get the fertilizer to the soil and into the top few inches of the soil. Ensure that you are applying the water at a rate to accomplish this, not to leave water and fertilizer on the crop canopy, and not to cause runoff or leaching of the nutrients.



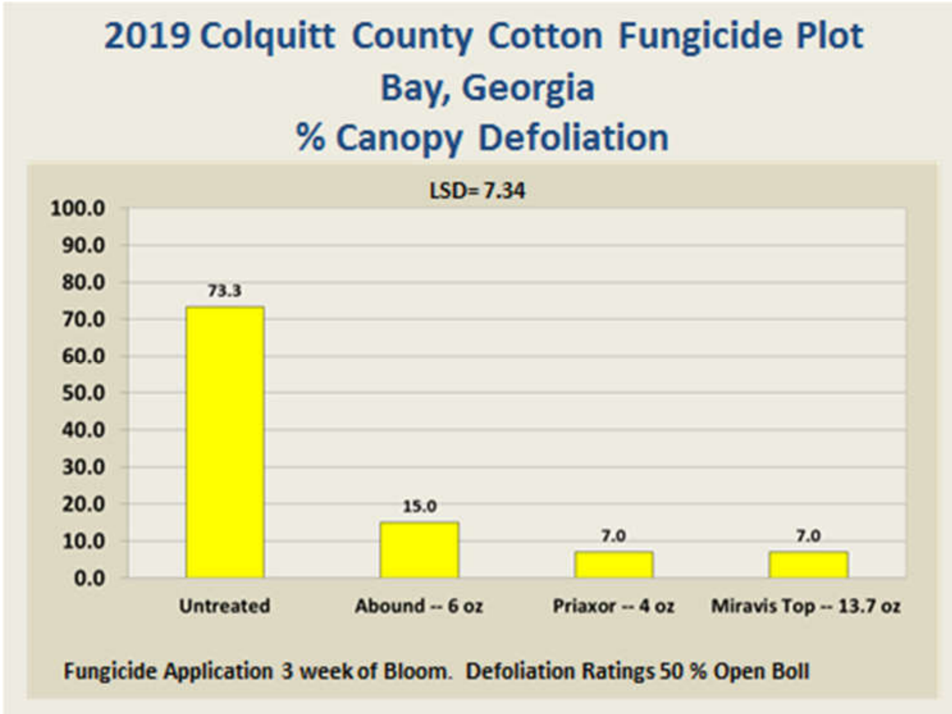
Managing Target Spot and Areolate Mildew (Bob Kemerait, Extension Plant Pathologist): Target spot and areolate mildew are the two most important diseases affecting cotton in Georgia later in the growing season and judicious use of fungicides not only protects the crop, but can increase profitability as well. Stemphylium leaf spot is perhaps the most common disease in Georgia's cotton crop late in the season, but at this time we do not have a fungicide to protect the crop from a disease whose underlying cause is a deficiency of potassium within the plant.

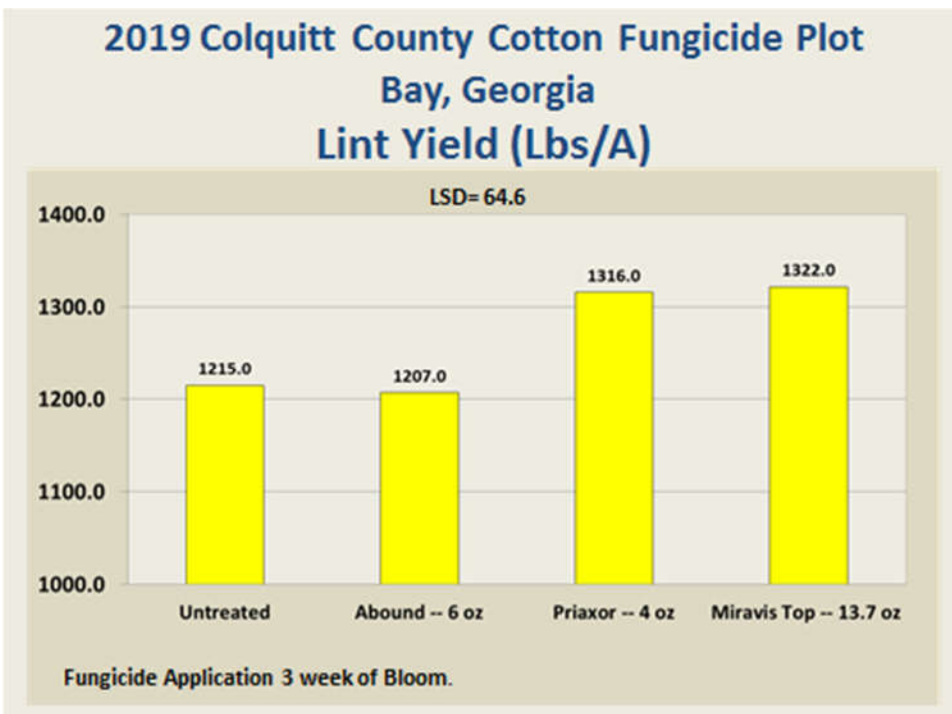
Images of target spot are presented below, as are the fungicides currently labeled for management of this disease and results from recent on-farm trials conducted in Colquitt County with UGA Extension agent Jeremy Kichler. Growers should consider protecting their cotton crop from target spot between the 1st and 6th weeks of bloom IF the disease is present, or is likely to develop, and conditions are favorable for development and spread, and IF the crop has good yield potential. Judicious use of fungicides can protect as much as 250 lb of lint where target spot is problematic. Where the crop is suffering from drought or poor growth from other causes, protection against target spot with a fungicide may not be warranted.

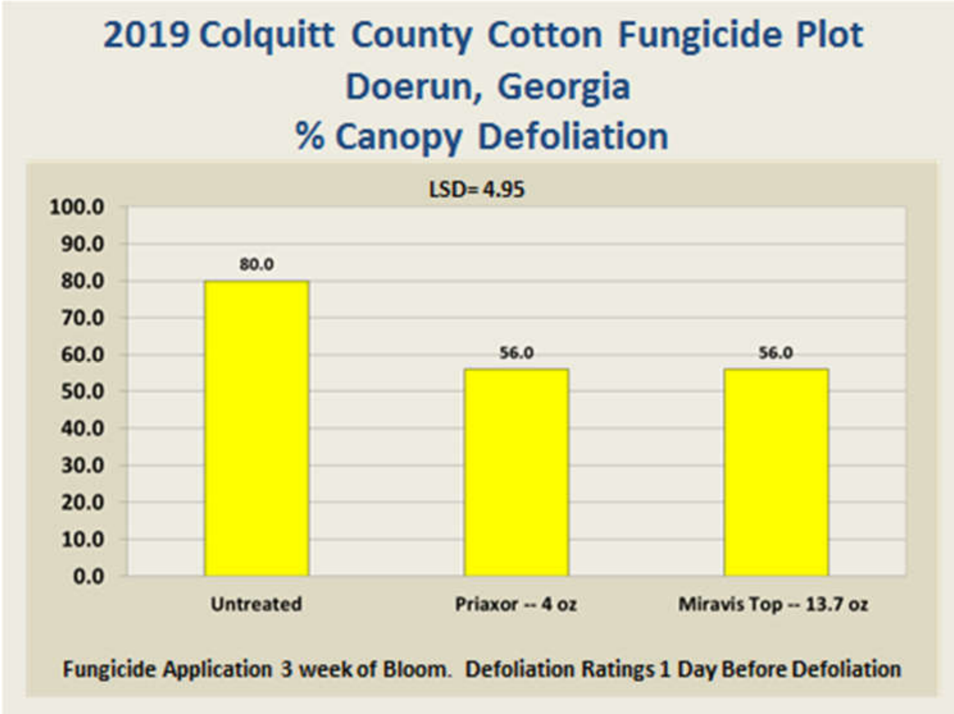
COTTON and TARGET SPOT

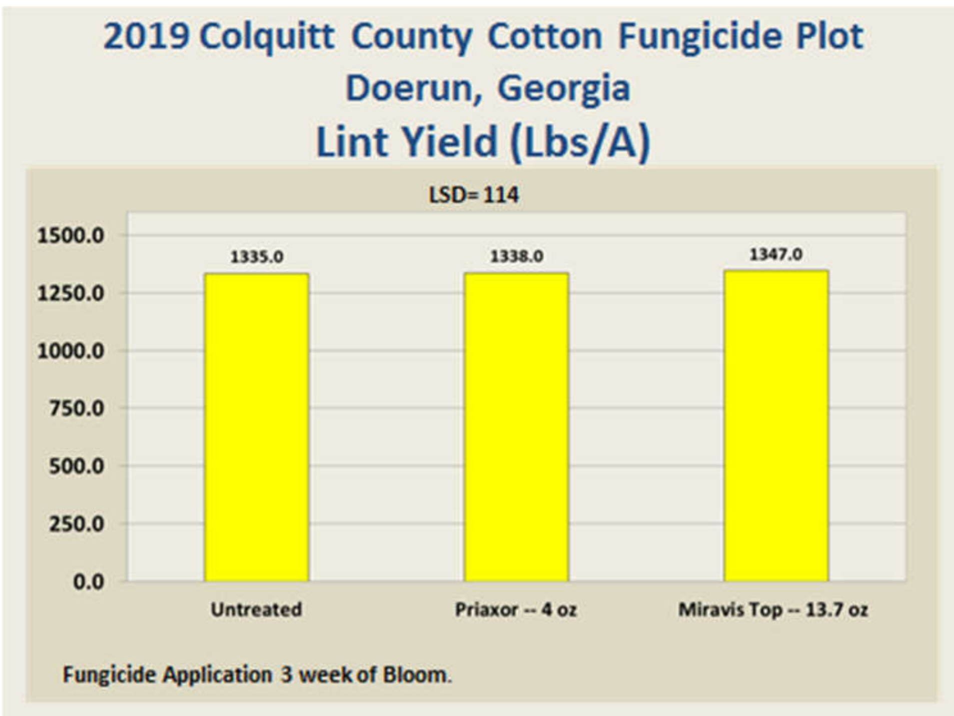
Fungicides for Foliar Diseases of Cotton

- Headline (pyraclostrobin) (6 fl oz/A)
- Twinline (pyraclostrobin + metconazole) (7-8.5 fl oz
- Quadris (azoxystrobin) (6 or 9 fl oz/A)
- AzoxyStar (azoxystrobin)) (6 or 9 fl oz/A)
- Tebuzol 3.6F (tebuconazol) (6-8 fl oz/A)
  - Labeled for control of southwestern cotton rust
  - *Puccinia cacabata*
- PROLINE (prothioconazole)) (5.0-5.7 fl oz/A)
- PRIAXOR (4.0-6.0 fl oz/A)
- MIRAVIS TOP (13.6 fl oz)
- Elatus
- TOPGUARD (flutriafol)


2019 Colquitt County Cotton Fungicide Plot
Bay, Georgia
% Canopy Defoliation
LSD= 7.34
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
73.3
15.0
7.0
7.0
Untreated
Abound -- 6 oz
Priaxor -- 4 oz
Miravis Top -- 13.7 oz
Fungicide Application 3 week of Bloom. Defoliation Ratings 50 % Open Boll


2019 Colquitt County Cotton Fungicide Plot
Bay, Georgia
Lint Yield (Lbs/A)
LSD= 64.6
1400.0
1300.0
1200.0
1100.0
1000.0
1215.0
1207.0
1316.0
1322.0
Untreated
Abound -- 6 oz
Priaxor -- 4 oz
Miravis Top -- 13.7 oz
Fungicide Application 3 week of Bloom.


2019 Colquitt County Cotton Fungicide Plot
Doerun, Georgia
% Canopy Defoliation
LSD= 4.95
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
80.0
56.0
56.0
Untreated
Priaxor -- 4 oz
Miravis Top -- 13.7 oz
Fungicide Application 3 week of Bloom. Defoliation Ratings 1 Day Before Defoliation


2019 Colquitt County Cotton Fungicide Plot
Doerun, Georgia
Lint Yield (Lbs/A)
LSD= 114
1500.0
1250.0
1000.0
750.0
500.0
250.0
0.0
1335.0
1338.0
1347.0
Untreated
Priaxor -- 4 oz
Miravis Top -- 13.7 oz
Fungicide Application 3 week of Bloom.

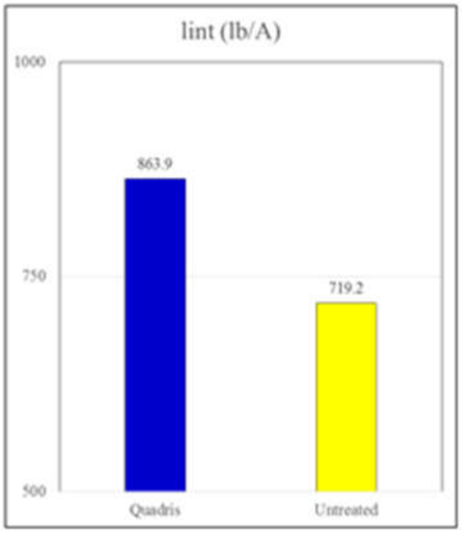
Areolate mildew may, or may not be a problem for Georgia's cotton in 2020. Prior to 2017, this disease was usually restricted to the southeastern part of our cotton production region and often occurred so late in the season as to be inconsequential. However, since 2017 areolate mildew has been found over a wider area earlier in the season. Areolate mildew that occurs with four weeks of when a grower intends to defoliate a cotton crop will likely have minimal effect on yield. Areolate mildew occurring earlier can affect yield and profit.

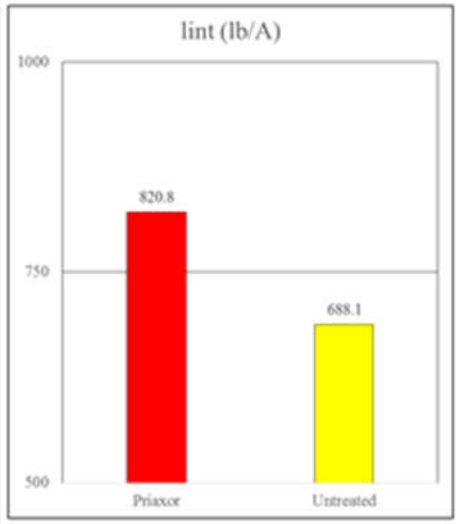
Areolate mildew is easier to control than is target spot, because the disease is more exposed on the cotton plant than is target spot, which develops deep in the canopy. The same fungicides that protect the cotton crop against target spot also protect against areolate mildew. However, while azoxystrobin is less effective against target spot than are Priaxor or Miravis Top, azoxystrobin has been effective against areolate mildew. Growers are CAUTIONED that azoxystrobin is a single-site mode of action fungicide and that multiple applications of this fungicide alone in a season will hasten development of fungicide resistance.

Presented below are images of areolate mildew as well as results from field trials in Colquitt County (Jeremy Kichler) and Brooks County (Stephanie Hollifield).

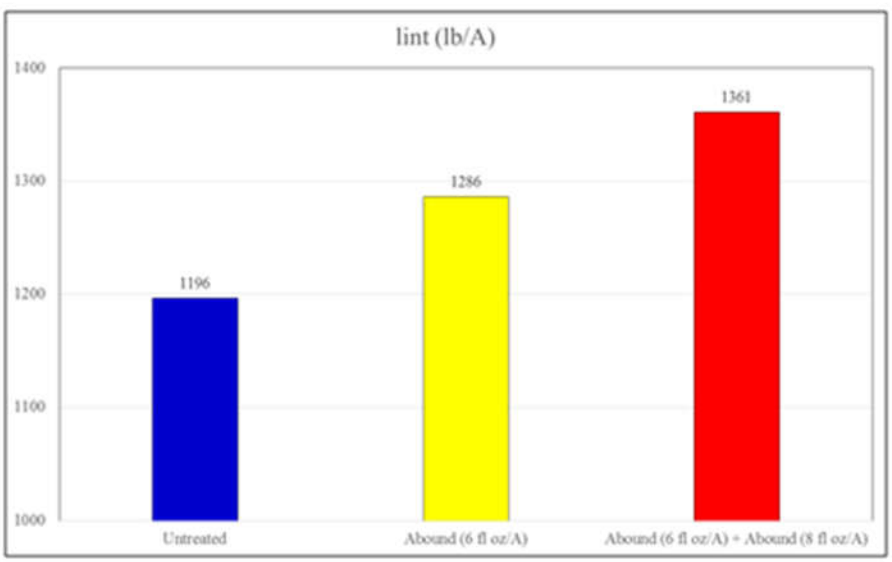
Areolate Mildew

2018 Colquitt County Areolate Mildew





2018 Brooks County Areolate Mildew



Late Season Potassium Deficiency in Cotton (Henry Sintim and Glen Harris, Department of Crop and Soil Sciences): We had several calls from cotton growers last year (2019), and the major nutrient-related issue identified was late season potassium (K) deficiency. K is an essential nutrient in cotton, playing critical roles in tissue strength, yield, and fiber development. Therefore, it is important to ensure K levels are always adequate to avoid undue consequences. Moreover, cotton is highly sensitive to K deficiency. The sensitivity of cotton to K deficiency is actually greater than in the other major row crops cultivated in Georgia such as peanut, corn, and soybean. K deficiency in cotton can also lead to secondary issues such as leafspot disease, as noted in Harris (1997).

K deficiency in cotton can be attributed to several factors including, (a) low soil K levels, especially in deep sandy soils with limited underlying clay layer, (b) inadequate K fertilization, (c) poorly established root system, (d) inadequate soil moisture to solubilize K for uptake, and (e) high boll load. Late season K deficiency in cotton typically coincides with a period of high K demand and reduced root establishment as a result of developing bolls. The developing bolls serves as major sink for K, and cotton K uptake can reach about 3-4 lbs K_2O/ac during boll development.

K is mobile in plants, and thus, pre-bloom K deficiency affects older leaves first, which appear as light green to gold mottling between leaf veins (Fig. 1A). It can progress to yellowing and then browning and necrosis of the leaf margins (Fig. 1B). However, under severe K deficiency, cotton can exhibit symptoms in younger leaves before bloom (Fig. 2). According to the International Plant Nutrition Institute, late season K deficiency in cotton appear on younger leaves (in the upper third of the canopy), which can lead to premature defoliation, early cut-out, poorly formed bolls, reduced yield, and poor-quality lint. The sensitivity of cotton tissues to K deficiency varies, and it is in the order of stems > roots > bolls > leaves and leaf petioles (Rosolem and Mikkelsen, 1991; Abaye, 2009). Thus, by the time deficiency symptoms are observed on the leaves, the other plant parts would have already been stressed or undergone what can be termed as “hidden hunger.”

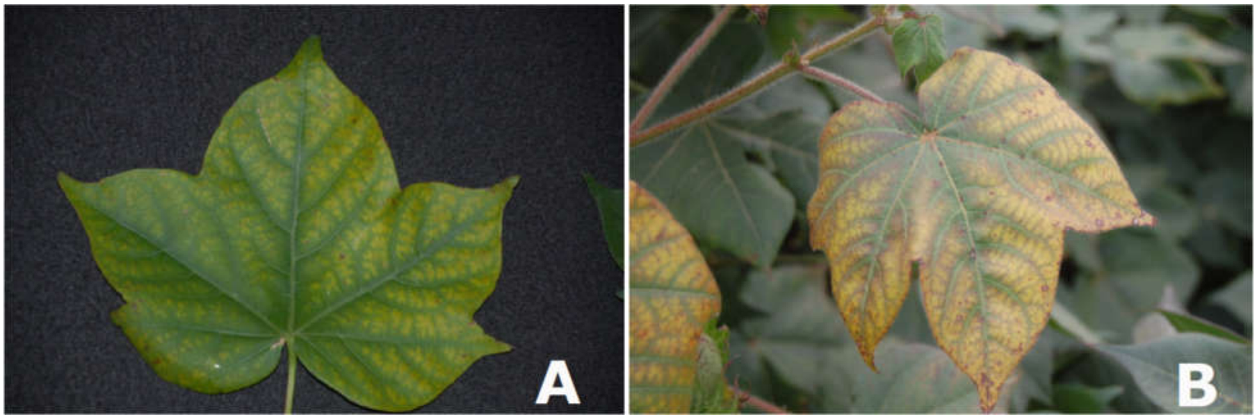


Fig. 1: Early (A) and severe (B) K deficiency symptoms in cotton (Source: Dodds, 2016).


Fig. 2: Cotton at pre-bloom stage showing K deficiency symptoms in young leaves. Photo credit to Glendon Harris, University of Georgia.

To better diagnose K deficiency in cotton, we recommend that tissue analyses be performed in conjunction with soil test. UGA Agricultural & Environmental Services Laboratories (AESL) recommend sampling 30 to 40 youngest fully mature leaves on the main stem, which is typically the fourth or fifth leaf from the main stem terminal. The current UGA-AESL sufficiency range for cotton is 1.5 to 3%, but we recommend that you shoot for a minimum K level above 2% at peak bloom. Also, the UGA-AESL soil K classifications for the Coastal Plains and Piedmont areas in Georgia are shown in Table 1. If tissue and soil tests confirm K deficiency then K fertilization is needed. Apply the recommended K rates as side-dress. If side-dress is not feasible for obvious reasons, then foliar apply K at two weeks interval at 5 lbs K_2O/ac per application.

Classification	Coastal Plain	Piedmont
Low K	0-70 lbs/ac	0-120 lbs/ac
Medium K	71-170 lbs/ac	121-250 lbs/ac
High K	171-275 lbs/ac	251-400 lbs/ac
Very high K	>275 lbs/ac	>400 lbs/ac

NB: Levels are based on Melich I extraction.

References:

Abaye, A.O., 2009. Potassium fertilization of cotton. Publication 418-025, Virginia Cooperative Extension, Blacksburg, VA.

Dodd, D., 2016. Potassium deficiency in cotton. Mississippi State University Extension, Mississippi State, MS.

Harris, G., 1997. Potassium deficiency in cotton linked to leafspot disease. Better Crops, Volume 81 No. 2. International Plant Nutrition Institute, Peachtree Corners, GA.

Rosolem, C.A., Mikkelsen, D.S., 1991. Potassium absorption and partitioning in cotton as affected by periods of potassium deficiency. J. Plant Nutr. 14:1001-1016.

Important Dates:

Georgia Cotton Commission Annual Meeting and UGA Cotton Production Workshop – January 2021