University of California Cooperative Extension August 10, 2012

Cotton Field Check

A Cotton Management Update from UC Cooperative Extension

High Temperatures, Fruit Shed in SJV Cotton – August 2012

Bob Hutmacher, Steve Wright, Dan Munk, Brian Marsh (University of CA Cooperative Extension)

Boll and Square Shed in Pima and Acala Cotton. For most of the time growers and researchers have been closely observing the growth habit and structure of cotton plants, it has been recognized that: (1) the likelihood of retention of squares, flowers and young bolls is a variable controlled by multiple factors; and (2) that retention of at least some is vital if fields are to produce adequate amounts of a saleable product. Particularly in California, there has been a considerable amount of research implicating plant bugs such as *Lygus hesperus* as having potential to reduce square or young boll survival and yield potential in cotton. However, as more efforts were directed also to close and careful plant observations, we have also observed that square and young fruit shed can be caused by a number of reasons other than insect pests. Particularly as the plant ages and squares become flowers and young bolls, there is a shift in how the cotton plant allocates its resources, and plant growth dynamics change. Many observations have been made over the years that implicate "physiologic shed" as a primary cause for fruit abscission once there is at least some fruit load on plants. In this brief note, we will try to describe some of the primary issues related to physiological shed as well as attempt to clarify its relationship to plant type, water stress and heat stress during the key fruit setting period.

Many research trials in Acala and Pima cotton have shown that as plants enter the later part of the fruiting period (plants with >18 to 20 total nodes), the likelihood of continuing high fruit retention in upper canopy positions in general declines significantly, even without major insect pressure, heat, water or nutrient stresses. The concept of the "95 percent zone" was established for California Acala cotton and later expanded to include California Pima cotton. This approach basically acknowledges and sets a number of fruiting branches that goes to make up 95 percent of the total bolls produced and likely to be harvested. This concept was and continues to be useful as it helps establish a timing at which we want to terminate the crop and allows us to make economically-sensible decisions that balance the desire to continue to set fruit with the fact that a rapid decline in productivity of late-set fruit is expected and natural under most situations. Guidelines developed by UC Cooperative Extension have established approximate cutout values at about 4 to 5 nodes above the uppermost 1st fruiting position white flower for Acala and non-Acala Upland cotton and about 3 nodes above the uppermost 1st fruiting position yellow flower for Pima cotton. Protecting the crop that is set on or before this date will help ensure yield and fiber quality will be maintained at high levels.

Physiological Fruit Losses – Potential for High Temperature and Related Stress Impacts. Although the weather has generally been favorable for a long stretch of June and July, more recently the cotton plants and those of us working with them have been feeling the effects of persistent heat. The timing of this persistent hot spell for most of this year's cotton plants is after peak bloom, so we may expect that the effects on fruit set and retention will not be as bad as if this had happened perhaps a month ago. However, we are still trying to get many plants to continue to set fruit and continue with development of young bolls at this stage. Based on a variety of research trials in California and other states, the temperatures we are now experiencing (daytime temps generally less than 110F but close to those levels) and nighttime temperatures below 85F after midnight) are generally not assumed to be high enough to directly cause pollen sterility problems. Peak temperatures of about 110 to 112F and above, and nighttime minimum temperatures that remain above 82 to 85F for significant durations (repeat periods, multiple days) have been associated with loss of pollen viability in controlled research done in greenhouse or growth chambers, and there also have been good correlations with field fruit loss in some, but not all situations. When temperatures are high enough to damage pollen, the direct heat damage is done mostly when flower buds are very small, and is not seen right away. Typically, damage is seen as aborted positions about 2 to 2 ½ weeks or so after the first high temperature events.

However …. life in the fields for plants is never quite as simple to explain as results from greenhouse or growth chamber research. Plants in the field are exposed to more complex combinations of multiple stresses. In addition, we have multiple types of cotton grown here in the SJV, each with potentially different characteristics affecting relative heat tolerance:

- non-Acala Uplands with origins outside of CA (likely more heat-tolerant since a lot of the selection work on these varieties is done in higher humidity, high heat load areas where there is less evaporative cooling than in our drier western climate)
- Acala varieties with SJV origins (generally considered more heat-sensitive, but little new work has been done to compare newer-introduced Acalas more widely grown in recent years)
- Pima (generally considered more heat-tolerant, improved tolerance likely associated with screening and variety development work in Arizona – heat tolerance less known for more recently-developed varieties, particularly since many of our newer commercial varieties have California origins or were selected here in California)

High daytime temperatures not only impact leaf net photosynthetic rates but also plant respiration rates and utilization of stored carbohydrates. High night-time temperatures that contribute to high respiration rates also have potential negative impacts, and these combination effects are typically most detrimental to plants that have a relatively large fruit load to support relative to the size of the photosynthetic leaf area and root system (smaller, lower leaf area plants with a big fruit load). For plants fitting this type of description, the developing fruit require carbohydrates and nutrient uptake to fully develop, and these requirements represent direct competition for the same materials needed to support continued shoot and root growth and maintenance. As we get further into the months of August or even September, plant carbohydrate and nitrogen reserves are progressively being directed mostly to developing fruit (to mature out seed), and this results in fewer plant resources available to sustain older, declining roots or new replacement leaves. For instance, leaves on plants are physiologically mature (full size in terms of expansive growth, full capacity in terms of photosynthetic capability) within about 3 weeks after they first become big enough to see. After that, if they are not seriously damaged by nutrient limits, stress or insects, the photosynthetic capabilities of the leaves will continue at a relatively high level for about another three weeks and then start to significantly decline. In the later season, as plants go into vegetative cutout and largely stop producing new leaves, you can see that the combination of few new leaves and aging existing leaves results in declining photosynthetic productivity, even if you maintain adequate soil moisture to keep the plants from being severely stressed. High temperature periods in this late season period just add one more stress and another reason for plants to put some upper limits on the number of fruit that can be retained and supported.

Most years in the SJV we are lucky enough to have either a limited number of these periods of temperatures high enough (over 110 to 112 F) to cause these direct injuries or to experience them late in fruiting when most of the boll load is set. In prior years with incidents of prolonged high temperatures (such as late-July, 2006), some of the worst-affected plants observed have been where a combination of high air temperatures occurred in conjunction with aeration/anoxia stress brought about with irrigation / standing water on low intake rate soils. This combination can result in near closure of the stomata during the worst of the aeration stress, causing elevated plant canopy temperatures and more stress on transpiring and non-transpiring plant tissues. Withholding irrigation water under these conditions would reduce aeration stresses, but for long-lasting hot spells would eventually lead to more direct water stress. If lighter irrigations are possible in order to reduce the duration of the aeration stress during hot spells, that might help. At any location, however, indirect effects of long-lasting hot spells on plants can be similar to what long term high temperature exposure does to people around here – a cumulative stress associated with hot daytime temperatures combined with nighttime temperatures that in some cases remained at 85 to 90F well toward midnight. Day and night temperatures reaching the high temperature ranges mentioned above are generally less conducive to good, high photosynthetic rates, and favor higher daytime and nighttime respiration rates in plants. This reduces available carbohydrates needed for maintenance of developing fruit and continued growth. If this continues for long, without relief, it certainly represents another stress for beleaguered plants already dealing with fruit losses and perhaps water or aeration stresses. With this in mind, when you see fruit loss in years with very high temperature periods lasting a few days or more during fruiting, keep in mind that some fruit losses can be heat-related rather than just pest-related – so, identify the presence of pests prior to deciding on fruit loss causes and making control decisions.