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COTTON WILT SYNDROME HITS CALIFORNIA COTTON INDUSTRY?

Robert B. Hutmacher
Univ. CA Shafter REC
Herman Meister
Univ. CA Coop. Ext.
Holtville, CA
Michael Rethwisch
Univ. CA Coop. Ext.
Blythe, CA
Steve Wright
Univ. CA Coop. Ext.
Tulare, CA
Ron Vargas
Univ. CA Coop. Ext.
Madera, CA
Bruce Roberts
Univ. CA Coop. Ext.
Hanford, CA
R. Michael Davis
Univ. CA Davis
Mark Keeley and Raul Delgado
Univ. CA Shafter REC

Abstract

Acala cotton fields in several production regions of California in 2002 experienced a range of symptoms, including early cessation of main stem and sympodial branch growth, foliar red or bronze coloration followed often by leaf necrosis, and in some limited cases, observable leaf wilting. Most University of CA Advisors and private consultants we met with felt the range and severity of these occurrences were considerably worse than experienced in the same areas in any recent years in Upland / Acala cotton. Variations on these symptoms were observed in widespread locations in several San Joaquin Valley counties in 2002, and field symptoms that were similar in some respects and different in other respects were also observed in the Imperial Valley region in southern California. In most fields, the first observations of problems began about mid-bloom, with the first observable symptoms differing somewhat across locations. In many cases, more severe than normal red and purple coloration in upper canopy stem and petiole tissue, or dark red or bronze coloration in upper canopy leaf blades were among the first plant symptoms observed. In most cases analyzed, plants developed moderate to severe nutrient deficiencies after mid- to late-fruiting. Soil and plant tissue tests available from many, but not all affected fields indicate that although plant tissue levels were low in several nutrients, including nitrogen and potassium, corresponding soil nutrient levels were generally within University of CA recommended levels. The worst-affected fields in the San Joaquin Valley generally had low to moderate yields, but the fruit loads were quite high given the smaller size and reduced vigor of the plants. Observations and soil and plant tissue tests available indicate that this problem was noted in numerous varieties, but foliar symptoms developed earlier and were worse in some varieties than in others. Yield data in these fields is inadequate to determine clearly if varietal differences in timing of symptoms resulted in yield differences. Although definitive causes of observed problems have not been identified based on these field observations, some generalizations are described that may prove useful if problems recur in other years,

Introduction

As in many cotton production areas, there is a long history in California of problems with late-season foliar damage and other factors with potential to limit growth and yields in the middle and later parts of the growing season. The fungal pathogens *Verticillium* and *Fusarium* have long been recognized as organisms that in certain situations can build up in the soil to levels where they can be a significant cause of reduced plant vigor or even early leaf loss and death. Changes in production areas, crop rotation, and efforts to screen new varieties for improved resistance to pathogens such as *Verticillium* have resulted in reduced sensitivity to this pathogen and fewer cases of significant yield loss in most years. There also has been a large amount of research done over the past 15 years or more on the symptoms of potassium deficiency in cotton in California and other production areas (Miller et al (1997; Marsh et al (2003). Potassium deficiency, if severe enough and developing mid-season, can cause leaf foliar discoloration and late-season reductions in growth and partial leaf loss that can result in significant yield reductions. Work described by Miller et al (1997) identified that K-deficiency problems are much more likely to occur under conditions of a heavy fruit load developing on plants of moderate or low vigor. The research also has provided

information on recommended plant tissue potassium levels, soil K testing procedures, precautions and recommendations for testing soils for exchangeable-K and soil K-fixation capacity, and K fertilizer recommendations. Other research has defined situations in which severe root knot nematode damage, mid- to late-season water stress, nitrogen deficiencies, other foliar or root zone fungal pathogens, or pollution such as ozone damage can cause reductions in late-season growth rates and some types of nutrient deficiencies or direct foliar damage.

Materials and Methods

Field evaluations were initiated in 2002 to observe problems with mid and late-season foliar damage and early reductions in plant growth rates in some San Joaquin Valley and Imperial Valley fields. Following identification of problem fields by grower or consultant contacts or direct observation, affected parts of fields were identified. Field observations were made, and plant tissue and soil samples collected where possible to begin evaluation of potential causal factors for foliar symptoms, growth and yield limitations. Where possible, efforts were made to collect samples in worst-affected and least-affected parts of fields, or in adjacent fields to compare degree of plant damage, and soil and plant tissue nutrient levels. At the time of preparation of this report, only a limited number of soil and plant tissue samples have been analyzed. Comments in this report are based on analyses completed at the time the report was prepared (late-January 2003).

Results and Discussion

In the least affected fields, these symptoms developed in the late season, well into boll maturation, and caused little impact on fruit yields, particularly because most fields had good early fruit set and late bolls did not represent a major part of the total crop. In more severely affected fields, plants were affected much earlier in fruit development, and there were multiple negative impacts on crop yield. In the moderate to severely-affected fields, main stem internodes shortened and terminal growth slowed or stopped and sympodial branch development ceased earlier than normal. This resulted in fewer new leaves to sustain photosynthate production. Starting in the upper canopy, existing leaves developed the discoloration and necrotic areas mentioned previously, and this was often followed by development of what we believe were secondary leaf foliar damage caused by fungal pathogens including *Alternaria* and *Aschochyta.* In most cases, the order of occurrence of the foliar and plant symptoms does not support the idea that leaf fungal pathogens are the primary cause of the plant breakdown. Much of the discussion that follows recounts field observations and circumstantial evidence that was accumulated that may in part explain some problems seen in 2002.

Some characteristics of the 2002 Acala cotton production year in the San Joaquin Valley included high fruit loads in many fields, with unusually high early and mid-season fruit retention in many fields, including many of those affected with the described symptoms. Whether or not they realized those high yields in many cases depended upon if the fruiting period and growing season were terminated too early due to the foliar damage and growth limitations. The 2002 growing season in the San Joaquin Valley was fairly moderate in terms of weather, with no prolonged cool or hot periods in comparison to normal conditions. Air pollution levels, including ozone concentrations, were unusually high during periods of July and August, which has led to some speculation about potential for the symptoms to be ozone damage, a well-researched problem known to cause foliar damage and yield losses in cotton under some situations. While this could not be ruled out as a complicating factor based on levels observed in San Joaquin Valley sampling stations, not all cotton fields (even within any given variety) in the higher ozone concentration areas of the Valley developed symptoms, and conversely, symptoms were noted in some fields even in the areas of the San Joaquin Valley with lower average ozone levels during these July and August periods.

Evaluations done on plant stem samples collected across many locations indicated little stem vascular staining, and most samples submitted for pathology evaluations for Verticillium or Fusarium came back negative. In the Imperial Valley fields where wilt and foliar discoloration problems were noted, Verticillium, Fusarium and Texas Root Rot were ruled out as primary causes of the symptoms in evaluated fields. In about one-third of the San Joaquin Valley fields where moderate to severe symptoms of the type described were noted, there is some prior history of root knot nematode problems which could impact root distribution and damage, but root knot nematode populations were not evaluated except in several “worst-case” fields. The plants with some of these symptoms in the Imperial Valley generally were more likely to develop observable leaf wilting than seen in most fields evaluated in the San Joaquin Valley. One possible reason for this considered, but unproven is that air temperatures and heat loads during mid fruit-set in the Imperial Valley are much more severe than in the San Joaquin Valley, and could lead to limits in the ability of a restricted or damaged root and vascular system to meet plant water requirements.

Limited late-season plant tissue samples and soil samples were collected in many fields, both those showing symptoms and adjacent fields without symptoms, and limited results were available at the time this report was prepared. In limited data available at this time, plant tissue samples collected starting in the last week of July through early September in fields with moderate to severe symptoms in almost all cases indicated low tissue N, NO_3-, P, K, Ca, Mg, S, while soil samples indicated soil nutrient levels that were generally within University of CA guidelines, except in exchangeable-K in about ¼ of the locations evaluated to date. At those sites, exchangeable-K values were near University of CA soil threshold values of 100-110 ppm exchangeable-K. Similar observations of moderately low plant tissue N and K were made in some Imperial Valley

fields where some foliar damage and wilt symptoms were seen in 2002, even when soil N and K levels were near or above recommended levels. An obvious question in these fields with low plant nutrient levels is "what can a grower do to reduce the problems?" Even though most observed problem field sites in which soil nutrient analyses are available to date have been in the "adequate" or higher range in nutrients such as potassium or nitrogen, this does not necessarily suggest that plants would not benefit from moderate supplemental potassium or nitrogen supplied either from water-run or foliar applications. A weak or damaged root system means less ability to extract soil nutrients, and if combined with high demand from a moderate to high fruit load, could lead to mid-season nutrient deficiencies even when soil nutrient levels would otherwise be considered adequate.

The worst-affected fields in the San Joaquin Valley generally had low to moderate yields, but the fruit loads were quite high given the smaller size and reduced vigor of the plants. Field observations were that this problem occurred in numerous varieties, but foliar symptoms developed earlier and were worse in some varieties than in others. Lint yield data collected from affected fields was inadequate to clearly identify if varietal differences in timing and severity of symptoms were positively correlated with lower yields. Final plant mapping data, however, did indicate reduced node number and lower boll counts in comparisons of varieties differing in timing of symptom development, implying potentially lower yields.

In many ways, plant symptoms observed in Acala fields in 2002 were similar to problems observed and studied in late-season foliar decline in previous years in Pima. It was surprising to note, however, that in general, incidence of these late-season foliar problems were lower in 2002 than in most recent years. In previous investigations of similar symptoms in many Pima cotton fields over the past five years, we have noted varietal differences in the timing of occurrence (how late in the growing season) and severity of symptoms. Among Pima varieties evaluated, sensitivity to these late-season foliar decline problems has been related to several factors, including late-season tissue nutrient levels such as nitrogen and potassium, fruit load, determinancy characteristics and plant root system vigor. Observations in Pima fields with somewhat similar symptoms have led us to the supposition that late-season foliar decline can be caused by a combination of stresses, such as high fruit load on a low to moderate vigor plant, weakened or damaged root system, and problems of water stress, air pollution, or mechanical or fungal disease impacts on plant root or vascular tissue. These stresses differ in occurrence with location and year, so that may explain why some of these problems are not repeated in the same fields in subsequent years, or why they are seen even when soil nutrients are at levels not considered deficient. Varieties differ in fruit load patterns, determinancy, and in proportion of nutrients and photosynthate directed to maintenance of root systems, and that may explain some of the differences in symptom development observed across varieties.

Additional analyses are underway on plant and soil samples collected in 2002 from Acala cotton fields, and will be evaluated when available. If the problems are seen again in coming years, the focus will be on looking for ways to identify fields at risk of similar problems and what remedial actions (changes in irrigation or supplemental fertilization practices) might reduce impacts on yields.

References

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