

Bronze Wilt of Cotton

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Bronze wilt is a newly recognized disease of cotton characterized by bronze or red discoloration and wilting of leaves. Because of these symptoms, it also has been called "copper top," "sudden wilt" and "phloem wilt" in the U.S. and "red leaf," "red wilt" and "anthocyanosis" in other countries. The disease occurs on short-season varieties of Upland and Pima cotton.

Bronze wilt was first recognized as a problem in Mississippi and Louisiana in 1995, and in Texas, Arkansas, Tennessee and North Carolina in 1996. In 1997, the disease was noted for the first time in Georgia and California. Devastating losses from bronze wilt occurred in 1998 in the upper Mississippi River Delta and in the Gulf Coast States. The disease was especially severe on 'Stoneville 373' in Missouri and on 'Paymaster 1220 BG/RR' in Georgia and was associated with unusually high temperatures and dry conditions in May and June. Sporadic outbreaks have occurred each year, resulting in substantial reductions in yield, fiber quality and seed quality for some producers.

Losses from bronze wilt are difficult to estimate, in part because its symptoms are not easily distinguished from those of drought, nutrient deficiencies, and several common soilborne diseases. Also, bronze wilt symptoms may result from a disease complex rather than a single cause.

Symptoms

Symptoms most often occur during fruit development and may become progressively more severe as bolls mature. Symptoms usually go through a series of predictable stages (Table 1).

In most cases, the tops of diseased plants first become chlorotic (Fig. 1), then leaves turn bronze or red (Figs. 2, 3, 4) and may begin to droop and wilt (Figs. 5, 6). The bronze or red leaves on diseased plants are warmer to the touch than the green leaves on plants without symptoms. The first symptoms may be transient and disappear. If the disease progresses, the upper leaf and stem tissue may turn red and many squares and bolls may shed abnormally (Figs. 7, 8). However, after fruit shed, leaf color can revert to green or reddish green. If the disease is particularly

Table 1. Stages of development, or levels of severity, of Bronze Wilt.

Stage or severity	Above-ground symptoms
Early or slight	Bronze leaf tint, lower leaf angle (wilting), and higher leaf temperature in upper canopy than in normal plants.*
Mid-stage or moderate	Evidence of some early symptoms, plus reddening of upper canopy (stem or leaf) and abnormal shedding of fruit.**
Late stage or severe	Evidence of some mid-stage symptoms, plus necrosis of stem tissue or whole plants.

* Early symptoms may sometimes disappear or not progress.

** Mid-stage symptoms may not progress, and leaf color may revert to green or reddish green after fruit shed.

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severe, all the foliage may rapidly wilt and collapse within a few days of the first symptoms (Fig. 6). Then leaf and stem tissue of the upper canopy may turn dark and necrotic (Figs. 9, 10).

The phloem and bark tissues of petioles, peduncles and stems sometimes collapse and become discolored in plants affected by bronze wilt. Boll peduncles, leaves subtending bolls, fruiting branches, and the main stem near fruiting branches are most often affected.

The darkened lesions vary from a few millimeters to many centimeters in length. As the bolls mature, the entire terminal end of a branch or stem may become black and all leaves die or abscise (Figs. 9, 10). Young bolls often abscise or fail to develop, showing blackening or splitting of the carpel sutures before they are mature (Fig. 7). Bracts may die prematurely (Fig. 8) and leaves subtending the boll and the fruiting branch may develop necrotic margins and drop off.

In most cotton-growing areas the root systems of diseased plants are stunted, with few if any secondary roots in addition to the taproot. Both the wood and bark of the taproot appear healthy except for small dark scars or pustules left from the death of secondary roots.

Distinguishing Bronze Wilt from Other Diseases

The above-ground symptoms of bronze wilt may resemble those of *Fusarium* and *Verticillium* wilts; *Macrophomina* and *Phymatotrichum* root rots; damage from root knot, reniform, stunt or lance nematodes; potassium, sulfur and phosphorus deficiencies; drought; and extended periods of high temperatures. **Bronze wilt can be distinguished from other disease by the condition of the lower stem and upper taproot and the spatial pattern of diseased plants in the field.**

The pith, wood and bark of the lower stem and upper taproot remain light colored and appear healthy with bronze wilt (Fig.11, left). In contrast, yellow or brown streaks develop in and around xylem vessels in the wood of plants with *Fusarium* or *Verticillium* wilt (Fig.11, right). Fungal root rots cause discoloration and rotting, first of the bark and then of the entire root. *Rhizoctonia* causes girdling of the stem at the soil line and black discoloration of the pith in both the stem and the taproot. **If the upper taproot and lower stem appear healthy, leaf symptoms are caused by bronze wilt. Bronze wilt often appears first and most severely on plants at the ends of rows (Fig. 12) or along the sides of fields, or in single, isolated plants. It often causes more distinct symptoms in low- than in high-density stands. Symptomatic plants within rows occur randomly.** The opposite of this pattern is seen with nutrient deficiencies, drought and nematode damage; these problems occur in sizable areas or clusters in the field where similar damage occurs to all plants.

Cause and Epidemiology

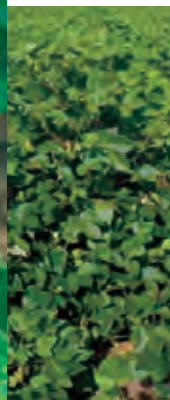
The cause of bronze wilt is not certain. Both biotic and abiotic factors have been proposed as possible



Figure 1. Chlorosis of foliage with bronze wilt.



Figures 2, 3 and 4. Dening of foliage with bronze wilt.



Figures 5 and 6. Dening of foliage with bronze wilt.



Figures 7 and 8. Bract and boll necrosis with bronze wilt.



ronzing and red-bronze wilt.



6. Wilt of foliage with bronze wilt.



rosis associated with bronze wilt.

causative agents. Brown scars left on taproots from the death of secondary roots are consistently infected with high concentrations of a unique strain of *Agrobacterium tumefaciens*. However, the bacterium is ubiquitous and can be found in roots and seeds of nearly all cotton plants regardless of symptoms.

Conditions that favor bronze wilt include high soil temperatures (above 86 degrees F); high light intensity; high rates of nitrogen fertilizer; deficiencies of phosphorus, sulfur and/or potassium; and high soil pH (above 7). Drought followed by rain or irrigation may accentuate symptoms. Severe bronze wilt has occurred when moisture levels were high early in the growing season, followed by high temperatures and drought.

Bronze wilt is most severe in short-season varieties, especially when they are grown in production systems that set and mature fruit in a brief time. Several of the varieties that are most susceptible to bronze wilt are derived from crosses involving 'Tamcot SP-37' or its progeny 'Miscot T8-27'.

Control Recommendations

Avoid Susceptible Varieties. Planting varieties that have no known history of bronze wilt is the easiest way to reduce losses from this disease. Many varieties susceptible to bronze wilt have been removed from the market (Table 2). Most seed companies now include information about bronze wilt susceptibility in their product guides. Varieties known to be affected by bronze wilt are listed in Table 2.

Cultural Practices. If susceptible varieties are planted, the following cultural practices may make the disease less severe:

- Plant as early as possible to avoid high soil temperatures during fruiting.
- Use no more nitrogen fertilizer than is appropriate to achieve desired yields.
- When soil tests indicate deficiencies, fertilize with phosphorus, potassium and sulfur before planting.
- Prevent water stress by irrigating sufficiently.

Susceptible cultivars can still suffer considerable losses in spite of good cultural practices if climatic conditions favor the disease.

Table 2. Varieties in which Bronze Wilt has been observed.

Dyna-Gro 205
Fibermax 963 *
Hartz (H) 1210, * H 1215, * H 1220, * H 1244, * H 1266 *
Paymaster (PM) 1215 BG, * PM 1215 BG/RR, *
PM 1220 RR, * PM 1220 BG/RR, * PM 1218 BG/RR,
PM 1244 RR, * PM 1330 BG, * PM 1560 BG, **
PM 1560 BG/RR**
SureGrow (SG) 125 R, ** SG 125 B/R**
Stoneville (STV) 132, * STV 373, * STV BXN 16
Texas 141

* Varieties are no longer commercially available in the U. S.

** Most plants in these cultivars do not show symptoms.



Figures 9 and 10. Stem and foliage necrosis and defoliation associated with bronze wilt.



Figure 11. Comparison of lower stem wood in plant with bronze wilt (left) and one with Verticillium wilt (right).



Figure 12. Plants at the end of a row affected by bronze wilt.

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