The Cause of Bronze Wilt of Cotton

A mysterious cotton disease known as bronze wilt appeared in the Midsouth and Southeast during the hot summers of 1995, 1996, and 1998. Similar disease symptoms were seen in peanuts and soybeans.

Bronze wilt flourishes when daytime temperatures are above 95°F for 2 to 3 weeks. In 1996, this occurred in late June and early July.

"We first saw the dramatic evidence of this disease around the 4th of July, causing me to think of it as the 'Fourth of July disease,'" says ARS plant pathologist Alois A. Bell in College Station, Texas. "That isn't necessarily the case every year, but there is a significant relationship between high, sustained temperatures and outbreak of the disease."

In 1996, several commercial seed companies asked Bell to determine the cause of bronze wilt. The disease, which causes death of feeder roots and deficiencies of phosphorus and potassium in tissues, took its toll on cotton grown in Arkansas, Georgia, Louisiana, Mississippi, South Carolina, and Texas.

In 1998, cotton losses in Georgia were valued at nearly $25 million. Even Pima varieties of cotton grown in Arizona and California showed yield losses that year.

Bacterial Suspect

Last summer, Texas and South Carolina had relatively cool temperatures during June and early July, but temperatures exceeded 95 °F during late July and most of August. High temperatures during this stage of cotton development caused excessive abortion of bolls and seed embryos.

Bell found two species of bacteria in seed from 24 farms in the upper coastal area of Texas. Greenhouse studies confirmed that heat stress and the bacterial species contributed to reduced yields of between 20 and 50 percent and led to poor fiber and seed quality.

Wilted leaves of affected plants turn reddish to copper just before the plants collapse. Diseased plant stems turn deep red to maroon. "During the day, I've placed my hands on the leaves of affected plants and found them warmer than comparable leaves of healthy plants. The higher leaf temperature is probably caused by the limited ability of damaged feeder roots to take up water from the soil," says Bell.

Bell discovered that a new strain of the bacterium *Agrobacterium tumefaciens* is associated with bronze wilt and is present in the seed of all U.S. cotton varieties. He was the first scientist to isolate the newly discovered strain, called biovar 1, from both seeds and roots of affected cotton, peanuts, soybeans, and dry beans.

Though this doesn't prove that the bacterium causes bronze wilt, there is a high correlation between the presence of the bacterium and disease symptoms. More research is needed to pin down the precise relationships between the organism and bronze wilt.

Searching the "B Genes"

Bell believes he's on the track of revealing important genetic reasons why some plants are more susceptible than others to bronze wilt. In several areas of the Cotton Belt, popular cotton varieties are bred with specific genes that convey bacterial blight resistance and early fruiting, explains Bell.

The resistance genes used in traditional breeding programs are generally referred to as "B genes." Three genes—B2, B3, and B7—are in the genetic background of Tamcot SP37, a Texas cotton variety that has been used in many breeding programs worldwide. This variety provides the desired early fruiting, which permits farmers to save on insecticides.

"Breeders who used Tamcot SP37 as a parent for earliness could have inadvertently separated the B genes from each other. Greenhouse studies showed that varieties with B7 alone are very susceptible to bronze wilt and develop high *Agrobacterium* populations in roots.

"Cystic fibrosis in humans is a good parallel for explaining what may be happening genetically in cotton," says Bell. "Plants with one dominant and one recessive gene remain healthy, but when they have two recessive genes they develop bronze wilt. It's the same in people carrying one recessive gene and one dominant gene for cystic fibrosis—they are only carriers for the disease. But if two carriers have children, one-fourth of their offspring will likely have two recessive genes and be stricken with the disease," explains Bell.

A genetic test—like the ones available for sickle cell anemia or cystic fibrosis—will need to be developed to further confirm these speculations. Bell is looking for genetic markers to use in tests for identifying seed stocks that may carry the genes for susceptibility to bronze wilt.

For now, there is no cure for bronze wilt. Avoiding use of highly susceptible varieties and minimizing heat stress may be the best means of prevention. One study suggests that farmers should avoid using nitrogen fertilizer alone without other nutrients.

Other researchers in the Southern Plains Agricultural Research Center in College Station, Texas, are collaborating with Bell to look for fungal and bacterial biocontrols. Such biocontrols may, at best, reduce the severity of disease, as will attempts to correct phosphorus deficiencies in the plant.—By **Linda McGraw,** ARS.

This research is part of Plant Diseases, an ARS National Program (#303) described on the World Wide Web at http://www.nps.ars.usda.gov.

Alois A. Bell is in the USDA-ARS Cotton Pathology Research Unit, Southern Plains Agricultural Research Center, 2765 F&B Rd., College Station, TX 77845; phone (409) 260- 9518, fax (409) 260-9470, e-mail abell@acs.tamu.edu. ◆