Scientists seek useful traits in wild cottons

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Mark Arnold, Experiment Station research associate, looks for thrips damage on young cotton plants. Identifying resistant and non-resistant cotton lines (top right) will help breeders develop varieties that can withstand thrips feeding damage to the first four true seedling leaves. Credit: Texas Cooperative Extension photos by Tim W. McAlavy

If you have Mom's smile, Dad's eyes and Grandpa's laugh, you might wonder what other traits you picked up from the genealogic fabric of the ol' family tree. Scientists at the Texas A&M University System Agricultural Research and Extension at Lubbock are studying the family tree of cotton for much the same reason.

"Cotton genetic diversity has narrowed in recent years," said Dr. John Gannaway, Texas Agricultural Experiment Station cotton breeder. "Many of today's successful commercial varieties share common parents and grandparents.

"Many scientists believe today's varieties are flexible enough genetically to handle minor changes but lack enough diversity for really spectacular change. Aside from limiting fiber quality and yield potential, narrow genetics makes them more susceptible to insects and disease."

Gannaway and other scientists believe future progress in cotton breeding can only be achieved if sufficient genetic variability remains in global breeding stocks.

The mission of the center's Crops Genetic Research Facility is to investigate the potential of useful traits lying undiscovered in the gene pool or germplasm of obsolete and wild cottons contained in U.S., Russian and French cotton collections. These traits could help diversify the gene pool from which breeders draw new varieties in the future.

The U.S. Department of Agriculture's Agricultural Research Service facilities in College Station house one of three international collections of cottons. Another resides in France and another in Uzbekistan, in the former Soviet Union. Breeders worldwide are evaluating specimens from these collections and exchanging germplasm in their efforts to improve the cotton genome.

"These collections contain a wealth of genetic material," Gannaway said, "especially when you compare them to today's varieties. We are screening obsolete and wild cottons for useful traits such as insect and disease resistance, and drought, salt and cold tolerance.

Scientists at Lubbock obtain seed from global cotton collections in small lots, sometimes as few as 10 seeds per lot. Before their work advances, they must turn a few seeds into more by growing plants in an environmentally-controlled greenhouse.

Greenhouse manager and Experiment Station research assistant Leslie

Wells supervises seed stocks from planting through harvest. His skill in making difficult cross pollinations is critical in developing new cotton lines, Gannaway said.

"Many of the cottons we grow for more seed are photoperiodic," Gannaway said. "They will only produce fruit and seed during the short days of temperate winter."

As these cottons grow and mature, scientists keep a log of their physical, or phenotypic, characteristics. Remember Mom's smile, Dad's eyes and Grandpa's laugh"

The lint, or fiber, these cottons produce is also measured, analyzed and recorded. The lint is hand-, saw- and roller-ginned, and then characterized using high volume instrumentation and the advanced fiber information analysis system.

The Lubbock scientists enter this information into a genetic database which they share with other scientists and the public. This database will complement the Texas A&M University System's cotton breeding program, Gannaway said. An overview of that program is online at lubbock.tamu.edu/news/2007/LScapesWinter06.pdf .

Under Gannaway's guidance as lead researcher, Experiment Station research associate Jimmy Mabry and others conduct the greenhouse screening to make the database a reality.

Mabry grows cotton plants in PVC tubes, measuring the characteristics of their roots, shoots and leaves and comparing them to a group of control cottons. The data from these comparisons could help scientists discover which physical traits help impart drought resistance and make more accurate trait selections in the future.

Natalia Castillo, Experiment Station research assistant, screens cotton grown hydroponically – without soil – for salt tolerance. Seedlings are incrementally subjected to different concentrations of salt, which can reach 30,000 parts per million.

If cotton breeders can impart more salt tolerance to commercial varieties, farmers on the Texas High Plains could one day irrigate their crop from the Santa Rosa Aquifer – which lies underneath the heavily-tapped Ogallala Aquifer, Gannaway said.

"The Santa Rosa Aquifer is estimated to be 100 times larger than the Ogallala Aquifer, but it has a much higher concentration of dissolved salts," Gannaway said. "Salt tolerance could open up the Santa Rosa as an irrigation source."

Other Lubbock scientists are examining natural insect and disease resistance in obsolete and wild cottons. This resistance could lead to more "environmentally friendly" varieties that do not require harsh insecticides and fungicides to thrive in adverse conditions. Fiber from "greener" varieties may be more desirable with environmentally-savvy consumers, and help farmers reduce production costs without sacrificing yield or lint quality, Gannaway said.

Mark Arnold, Experiment Station research associate, and Monica Sheehan, Experiment Station research assistant, are screening cottons grown at Lubbock for thrips and Lygus bug resistance.

"Thrips are a serious cotton pest," Arnold said. "Thrips are very small. They can cause severe crop damage resulting in yield loss by feeding on the emerging leaves of cotton seedlings. Those leaves nurture the plant while it is establishing roots and gaining strength."

Treated seed and insecticides applied in the furrow at planting help farmers combat thrips, but these methods are expensive and often only provide a three-week window of protection against this hungry pest, Arnold said.

Arnold raises thrips on wheat, a favorite host plant, and forces them to move to neighboring cotton plants by killing the wheat with herbicide. "This produces massive thrips pressure on the cotton plants, and results in a lot of damage to those first four true seedling leaves," he said. "We measure the leaf damage, identify cottons that show thrips resistance and subject those to further tests."

Sheehan raises Lygus bugs, a secondary pest of cotton, and confines their feeding to certain parts of cotton plants using bug cages. The amount of damage they inflict on cotton fruit and their ability to lay eggs for another generation are good indicators of Lygus resistance, said Sheehan, who hopes to intensify her experiment in 2007.

Raina King, a Texas Tech University graduate student, is working to develop 'cleaner' cottons that shed the small leaves (bracts) at the base of each boll a few days after flower blooms open.

Determining whether this trait is dominant, co-dominant or recessive and finding its DNA location could help breeders develop upland cottons that require less lint cleaning – producing cleaner fiber with less ginning costs, Gannaway said.

Scientists at the Crops Genetic Research Facility at Lubbock have been conducting their cotton research since 2004. The facility was completed and came on-line in 2003.

"We have developed several reliable methods for screening obsolete and wild cottons for several positive, heritable traits," Gannaway said. "The data from these experiments should give molecular breeders more tools to work with as they look for ways to diversify, improve and expand our cotton gene pool. That will benefit global breeding stocks and lead to varieties that are more flexible and productive."

Source: Texas A&M University - Agricultural Communications