Development of a Thrips Resistant, Adapted Cotton Cultivar for The Texas High Plains: Screening, Crossing and Field Trials

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Introduction

Thrips are a serious pest of seedling cotton in the Texas High Plains, feeding on the cotyledons and first true leaves as they emerge. Severe infestations can destroy the first 4-5 true leaves and even reduce stands. Serious economic losses can be caused by thrips damage through yield loss plus control and monitoring costs.

The predominant thrips species attacking seedling cotton in the Texas High Plains is the western flower thrips, *Frankliniella occidentalis* (Pergande), which moves into cotton in large numbers, purportedly from senescing wheat.

In the Texas High Plains, a period of cool, wet weather often occurs in late May after cotton has emerged. Seedlings grow slowly while thrips damage accumulates, resulting in severe injury. Insecticidal seed treatments often do not function as planned due to dry soil or degradation over time. In furrow, systemic insecticides are expensive on a light thrips year and often growers choose not to spend the money. Once thrips injury is visible the damage has usually been done, making all but automatic foliar treatments marginally effective.

Natural host plant resistance (HPR) is a an environmentally friendly control method that can also be highly effective.

Modern cotton cultivars have become progressively inbred, and many believe lack the genetic diversity for significant change. By contrast, the wild cotton accessions from the collections around the world have a very broad genetic base. It is possible that these accessions harbor genes that can convey thrips resistance.

Objectives

To screen accessions from the USA (USDA), French and Russian collections for resistance as seedlings to pest thrips, identify the mechanism of any resistance found, and develop thrips resistant cultivars and multiple trait germplasm releases.

Screening - methods

STEP 1: Large "tray" style free-choice tests to quickly eliminate susceptible accessions

Test cottons are placed next to wheat that has been sprayed with herbicide. Thrips move to the test cottons, and place massive feeding pressure on cotton seedlings.

A RCBD design with 5 blocks is used. The same susceptible control cotton is used in all experiments.

Evaluation: at the fourth true leaf stage, leaves are:

1) Washed for thrips (Burris 1989)
2) Measured for surface area (Quisenberry and Rummel 1979)

STEP 2: No-choice testing on promising candidates to verify and identify the mechanism of resistance

Plants showing resistance in the initial screening are caged with herbicide treated wheat. Antixenosis is removed as a mechanism of resistance.

Evaluation is similar to the initial testing, with the exception that body length or weight, or instar of immature thrips is determined and used to create the thrips health indicator.

Plant and insect health indicators are plotted against one another, using a standard method that indicates the mechanism of resistance.

Screening results

After 52 experiments, comparison of leaf surface area reductions versus the susceptible control, All-Tex Atlas (Figure 1), has revealed strong resistance in several accessions, strains and cultivars, and moderate resistance in many others . The 16 best performing cottons are shown in Figure 2. Among the best performing cottons are TX110, TX502, Gb663, DP353 and AD5-14, all of the two species *G. barbadense* or *G. Darwinii* (similar species). It has been known since the 1920's that *G. barbadense* is resistant to thrips injury. It has been theorized that this may be due to a thicker epidermal cell layer on the undersides of leaves which prevents deep penetration of the thrips mandible into the soft parenchymal cell layer, resulting in less injury.

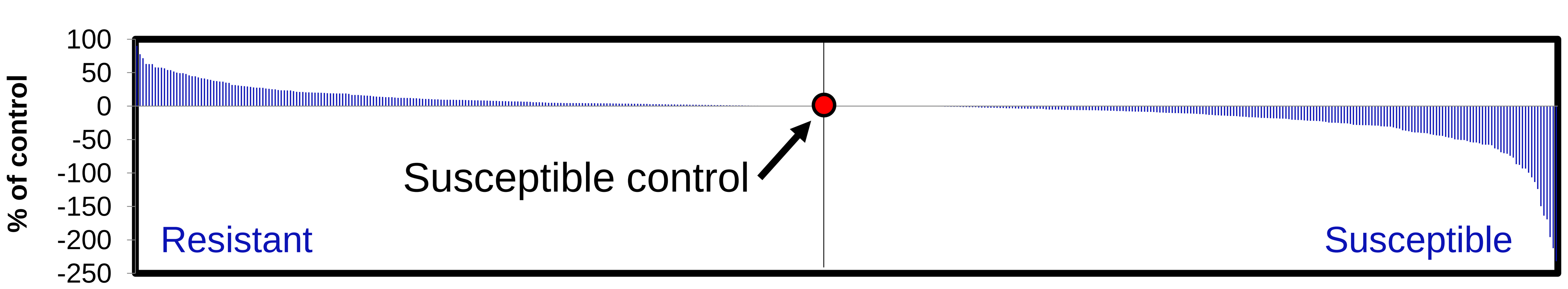

Figure 1. Results of applying Abbott's formula to leaf surface area reduction from cottons tested in 52 host plant resistance screening experiments testing 464 accessions, cold tolerant lines, and various other cottons of interest.

Screening results (cont'd)

Figure 3 contains a plot of thrips health versus plant health from a no-choice study testing TX110 against Atlas (susceptible control). Thrips health was generally lower on TX110 and plant health was generally higher. This indicates some degree of tolerance and antibiosis in TX110 when compared to Atlas. Points for Atlas are clustered in the top right of the chart, indicating less resistance by both mechanisms.

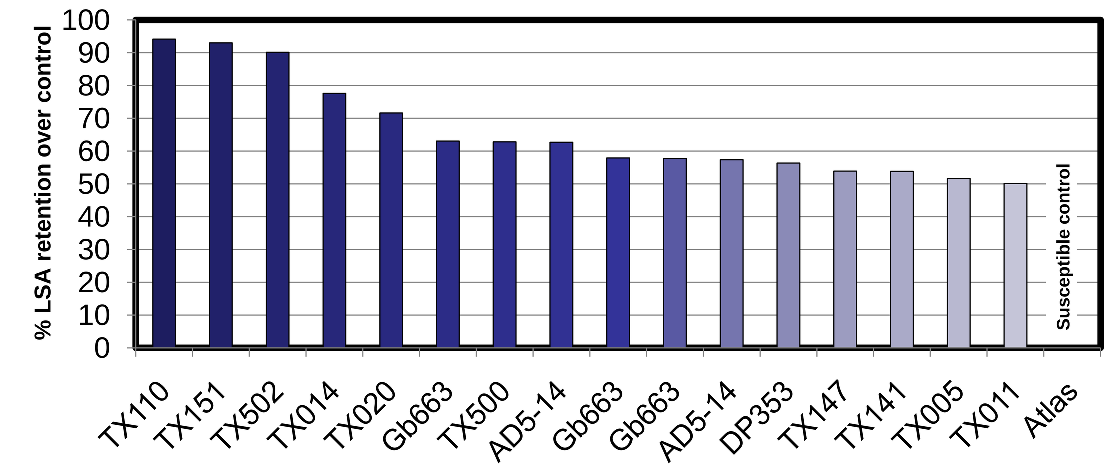

Figure 2. Plot of Abbott's statistic for all wild accessions and cultivars showing significantly lower leaf surface area reduction (of at least 50%) compared to the control cultivar, Atlas.

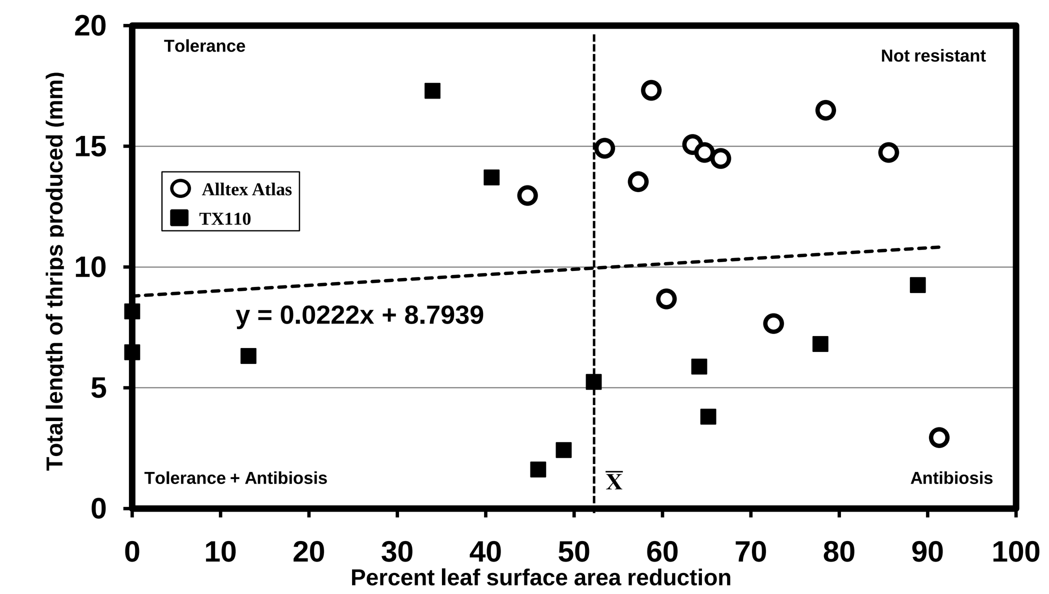

Figure 3. Plant and thrips health indicators for TX110 and Atlas obtained in a no-choice HPR study.

Crossing and field trial - methods

It was decided to attempt to move the resistance trait to a *G. hirsutum* background using an interspecific cross, then a combination of both the pedigree and backcross plant breeding methods. TX110 was crossed to two breeding program elites. F_1 seed was sent to winter nursery in Mexico for selfing to produce F_2 seed.

Crosses were also made between TX110 and cold tolerant strains that exhibited resistance in screening trials.

The F_2s, their parents and a susceptible cultivar were planted into a replicated field trial designed to allow for both verification of resistance in the field and individual plant selection for resistance. Counts were made for all traits of interest to use in a heritability study. Plots treated with aldicarb were used to calculate variable leaf surface area reduction.

Field trial - results

Analysis of this experiment is still in progress. Partial results are as follows:

Seedling populations in F_2 plots segregated cleanly for thrips resistance and photoperiodicity. Selection of resistant individuals was easily accomplished. Varying levels of thrips injury in the crosses and their parents are shown in Figure 4.

Analysis of leaf surface area reduction data also indicates that resistance was inherited, with high levels of injury in the susceptible parent lines and susceptible control, less injury in the progeny and still less injury in the resistant parent (Figure 5).

The final condition for a successful experiment was met. Several plants selected for thrips resistance fruited early enough to produce viable seed.

Figure 4. Thrips injury on parents, progeny and a susceptible control (Atlas) at Halfway, Texas, 2009.

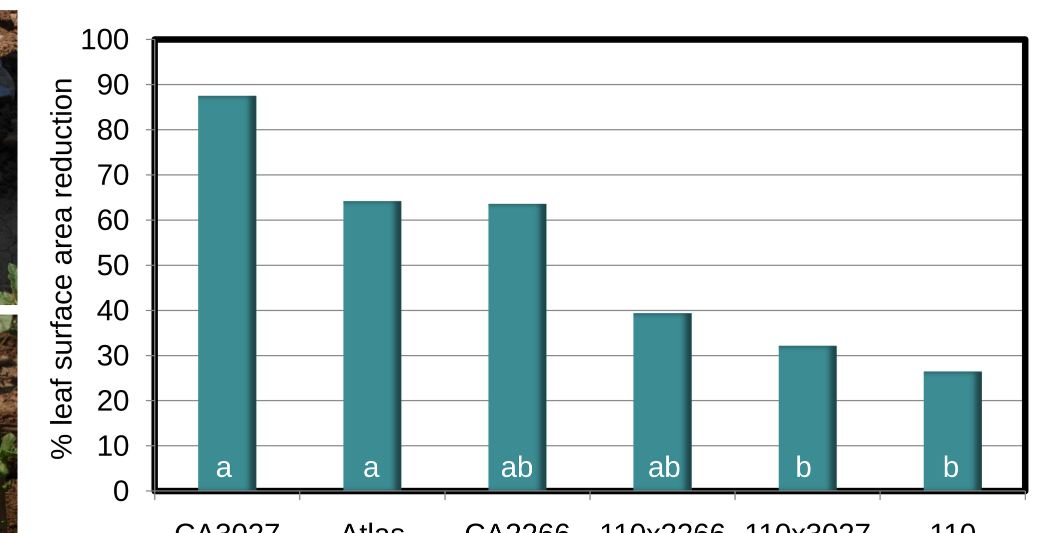

Figure 5. Leaf surface area reductions in parents, progeny and a susceptible control (Atlas) at Halfway, Texas 2009.

Summary

The method of using wheat to rear and move thrips continues to produce successful experiments. At this point 52 screening tests have been conducted without a failure caused by low thrips pressure. The heavy thrips pressure produced is very similar to actual field conditions in a severe thrips year.

To date, 464 accessions have been screened successfully. Resistance has been found in many accessions. That a good deal of resistance has been detected after such a small foray into the large collections indicates there is likely a large amount of germplasm that can be used to produce thrips resistant cultivars.

Conclusions in the literature reporting resistance of *G. barbadense* as a species have been supported. The fact that even unclassified *G. barbadense* cottons have easily been isolated shows strong sensitivity of the free-choice testing methodology.

A successful no-choice test was conducted on TX110 and indicates resistance is due to both tolerance and antibiosis.

F_2 populations of seedlings grown in a field trial segregated for thrips resistance and photoperiodicity. Several plants selected for thrips resistance also fruited and matured enough seed to include progeny rows in next year's nursery. Field observations and leaf surface area reductions indicated that the thrips resistance has been inherited.

This poster reports results of research conducted at the Crops Genetic Research Facility located on the Texas AgriLife Research and Extension Center at Lubbock. Literature references cited or mentioned are available upon request.

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