DEVELOPMENT OF A THRIPS RESISTANT, ADAPTED COTTON CULTIVAR FOR THE TEXAS HIGH PLAINS: SCREENING, CROSSING AND FIELD TRIALS

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Abstract

An ongoing experiment to develop a cotton cultivar resistant to the West Texas thrips complex is being conducted. Numerous resistant cottons have been identified. The best of these was crossed to breeding program elites and tested under field conditions. A 2009 field trial indicates that the resistance was inherited. Selections were made to allow development to continue.

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 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.

Testing in this project began in earnest in 2005. The objectives are to screen wild cotton and other germplasm of interest for resistance to the West Texas pest thrips complex and to incorporate any traits conveying resistance into an adapted cultivar and/or multiple trait germplasm releases.

Materials and Methods

Free-choice screening

Accessions from the collections, cultivars and breeding project strains were first screened using large tray style free choice experiments in a 30x60 ft greenhouse. A RCB design with five blocks was used and the experimental unit consisted of six plants, each in potting soil in a 0.5 liter foam drink cup with holes at the bottom to allow drainage. The commercial cultivar “All-Tex Atlas” was used as a susceptible control in all experiments. Blocks were arranged across the temperature gradient between the evaporative cooling pads and the exhaust fans on the opposite side of the greenhouse. All seed used in the experiment were hot water treated at 80 degrees Celsius for 90 seconds then planted at a uniform depth of one cm. After seedling emergence, wheat infested with thrips was placed next to the test cottons and killed with herbicide, forcing the thrips to move to the cotton seedlings. At the fifth true leaf stage, all plant tissue above the cotyledons was excised, washed for thrips (Burris et al. 1990) then measured for surface area using a LiCor area meter. Leaf size between the cottons tested varied considerably, so it was not possible to compare leaf surface areas of the test cottons directly. A method devised by Quisenberry and Rummel (1979) which calculates a variable percentage reduction by comparing the test plants to plants of the same genotype kept thrips free with insecticide was used for LSA comparisons. Thrips collected were counted, and adults were mounted in PVA and identified to species.

No-choice screening
An accession showing a high degree of resistance isolated using free-choice screening was tested in a no-choice experiment using cages to eliminate antixenosis as a mechanism of resistance. A RCB design with five blocks was used, with each experimental unit consisting of an individual cages containing 18 plants. Other methodology was identical to the free-choice testing with the exception that body length of thrips immatures was measured using a micrometer.

Crossing and field testing
The resistant accession TX110 was identified as a short day *Gossypium barbadense*. It was decided to attempt to move the trait using an interspecific cross and a combination of both the pedigree and backcross methods. TX110 was crossed to breeding project elites CA2266 and CA3027. The F_1 seed produced was sent to winter nursery in Mexico for selfing to produce F_2 seed. The F_2 seed was planted in a field trial at Halfway, TX in the 2009 growing season along with all three parents and the susceptible, Atlas. The test was irrigated using a center pivot, so a CRD design with six replications was used. Selections were made for thrips resistance at the fourth to fifth true leaf stage, then for day-neutrality at the end of the season. Leaf surface area reductions and thrips counts were obtained using the same methods used in the greenhouse testing.

Results and Discussion

Free-choice screening
A total of 52, free-choice experiments were conducted from 2005-2009 testing 463 genotypes. Numerous resistant cottons have been identified. The 16 best performing cottons are shown in Figure 1. All had 50% or higher leaf surface area retention versus the susceptible control, while two wild accessions had over 90%. Half of the 15 cottons are *G. barbadense*, which supports reports in the literature (Ballard 1951) that the species as a whole is thrips resistant. All of the cottons presented in Figure 1 had significantly less leaf surface area reduction when compared to the susceptible control.

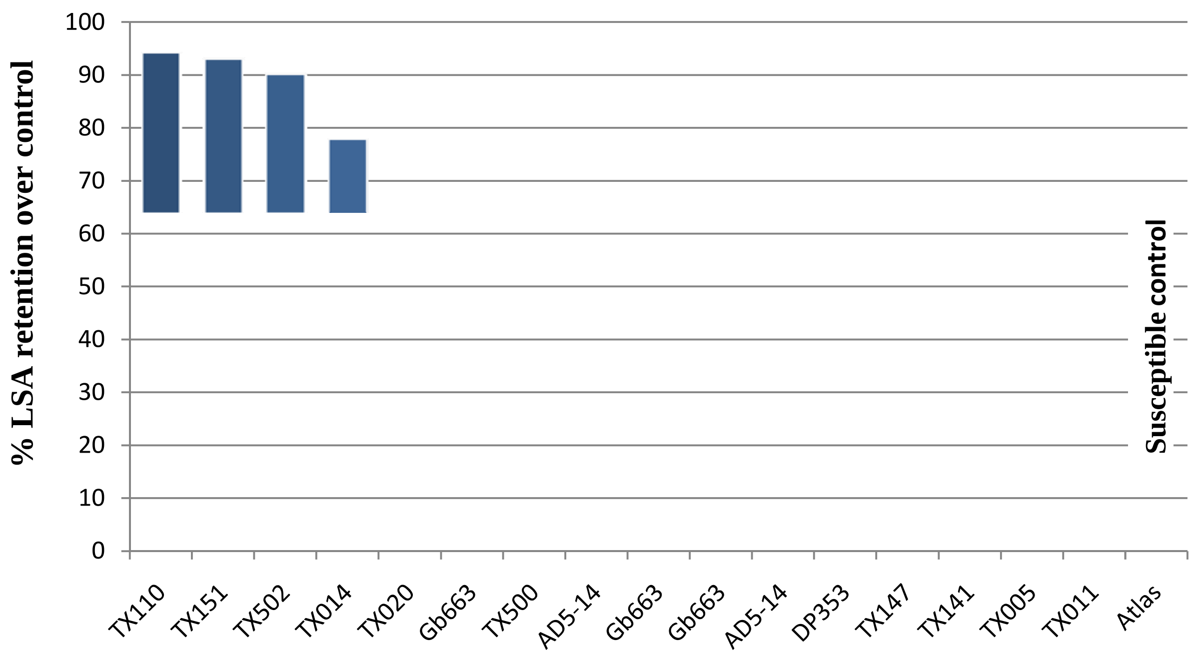

Figure 1. Abbott's statistic for best performing cottons from free-choice, thrips host plant resistance experiments conduced by AgriLife Research, Lubbock, Texas, 2005-2009.

No-choice screening
Results from a successful no-choice (antixenosis blocked) caging experiment testing TX110 against All-Tex Atlas (susceptible control) are presented in Figure 2. Leaf surface area (plant health) is plotted against total thrips body length (insect health indicator) using standard HPR methodology. The chart indicates that TX110 exhibits both

tolerance and antibiosis as compared to the susceptible. Susceptible control points are mostly clustered at the top right, indicating comparatively little resistance.

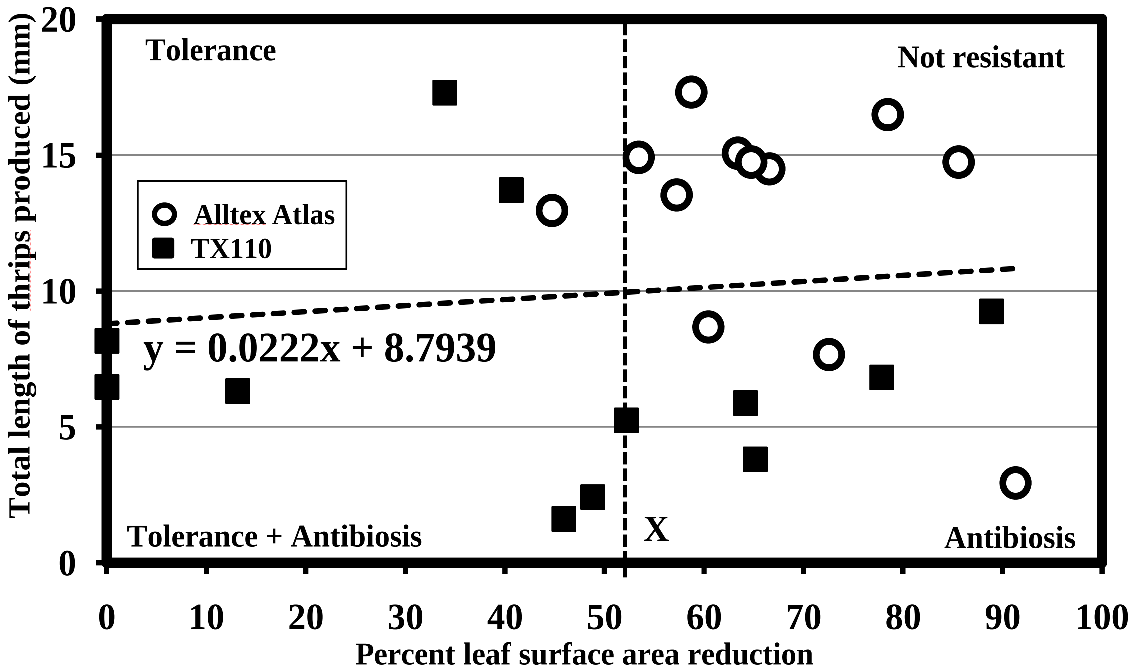

Figure 2. Plot of thrips versus cotton health indicators from a no-choice host plant resistance experiment at Texas Agrilife Research, Lubbock, Texas, 2008.

Crossing and field testing

Leaf surface area reductions from a field trial comparing the cottons described in the materials section are presented in Figure 3. The resistant parent, 110, and the cross F_2s all had less leaf surface area reduction than the susceptible

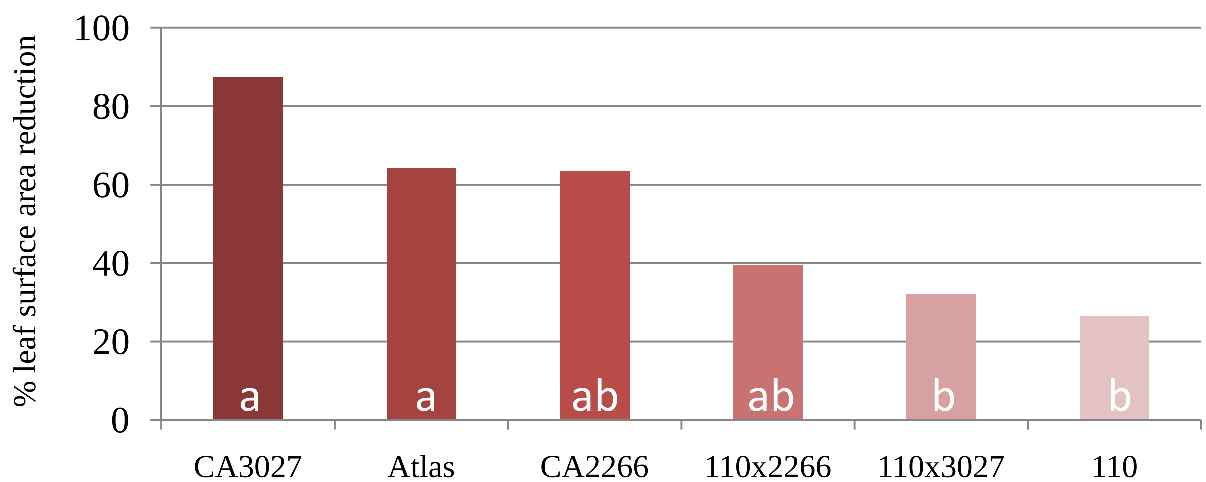

Figure 3. Plot of thrips versus cotton health indicators from a no-choice host plant resistance experiment at Texas Agrilife Research, Lubbock, Texas, 2008.

parent lines, indicating that resistance was inherited. The F_2s segregated cleanly for thrips resistance and individual plant selections were made. Then the final condition for a successful experiment was met. Numerous plants selected for thrips resistance fruited early enough to produce viable seed.

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, 463 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 TX110xelite 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.

Acknowledgements

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References

Ballard, W.W. 1951. Varietal differences in susceptibility to thrips injury in upland cotton. Agron. J. 43:37-44.

Burris, E., A.M. Pavloff, B.R. Leonard, J.B. Graves, and G. Church. 1990. Evaluation of two procedures for monitoring populations of early season insect pests (Thysanoptera: Thripidae and Homoptera: Aphididae) in cotton under selected management strategies. J. Econ. Entomol. 83:1064-1068.

Quisenberry, J.E. and D.R. Rummel. 1979. Natural resistance to thrips (Thripidae) injury in cotton as measured by differential leaf area reduction. Crop Sci. 19:879-881.