PROGRESS IN SCREENING TEXAS RACE STOCKS AND OTHER WILD COTTONS FOR THRIPS AND COTTON APHID RESISTANCE

M. D. Arnold
J. R. Gannaway
H. D. Elkins
M. A. Sheehan
Texas Agricultural Experiment Station
Lubbock, TX

Abstract

An ongoing program is being conducted to screen accessions from the Texas Race Stock Collection in College Station, Texas and other wild cottons for natural host plant resistance to the Texas High Plains thrips complex, and to cotton aphids. In the thrips screening, test accessions are exposed to heavy thrips pressure created by forcing thrips reared in wheat to move to the cottons. Accessions showing resistance in this "tray style" testing are then tested in no-choice experiments to block antixenosis and identify the mechanism of resistance. Accessions showing resistance in no-choice testing are then crossed to Pima S7 and two breeding program elites, carried to the F_2 generation and passed to the cooperating molecular geneticist for further development. Many accessions have shown some resistance. Resources are currently being concentrated on the ten best. Screening for cotton aphid resistance has been attempted, but has failed due to problems with methodology. Different methods are being evaluated at this time.

Introduction

Thrips are a serious pest of seedling cotton in the Texas High Plains (THP), 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 THP, 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 do not always function as planned due to dry soil, or degradation over time. In furrow, systemic insecticides are expensive and often growers choose not to spend the money. Once thrips injury is visible the damage has usually been done, making foliar treatments marginally effective.

Cotton aphids (*Aphis gossypii* Glover) can be a serious pest of THP cotton causing loss of vigor in plants, and the very serious problem of sticky cotton if aphids persist into the fall and drop honeydew onto exposed lint. The areawide cotton aphid explosion of 1991 was a disaster. It was caused by adoption of a "wash day" strategy of control used through the 1980's. Growers often added insecticides to "clean up the aphids" when making pyrethroid applications for bollworm/budworm complex. This quickly selected resistant aphid populations. Previously effective rates of insecticides had to be increased by a factor of eight to gain any control, and supplies of insecticides dried up quickly. Since, development of new chemistries for cotton aphid control and use of sound IPM strategies have helped to control the aphid. Still, the cotton aphid is a potentially damaging pest, in particular due to its high reproductive potential.

Natural host plant resistance (HPR) is a environmentally friendly control method that is much more palatable to the media sensitive public than insecticides or GMOs. HPR can also be highly effective, example: greenbug resistant grain sorghum.

Modern cotton cultivars have become progressively inbred, and many believe lack the genetic diversity for spectacular 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 and cotton aphid resistance.

Materials and Methods

Thrips screening. A two-step strategy was adopted to screen accessions for thrips. First, large "tray style" experiments were used to quickly eliminate susceptible accessions. Good candidates were added to subsequent tests to confirm results. Second, accessions passing the initial testing were retested in no-choice experiments to block antixenosis as a potential mechanism of resistance. Plant and insect health data from no-choice of tests will be used to identify the mechanism of resistance.

A randomized complete block design with five blocks was used in all screening tests. Blocks were arranged across the temperature gradient that existed between the cooling pads and the opposite end of the greenhouse.

Thrips were reared directly in greenhouse grown wheat. Wheat was allowed to grow in 4l plastic flats for approximately six weeks, at which time is was used for testing. Prior to cotton seedling emergence, wheat was sprayed with herbicide to force thrips to move to the test cottons.

One pint Styrofoam cups were used as pots. All seeds were hot-water treated at 80 deg C for 90 seconds. Four seeds were planted per cup at a uniform ¼ inch depth. After emergence seedlings that emerged on the same day were selected and other plants removed. Any plants emerging after this thinning were removed as well.

Data were analyzed using Proc Mixed (SAS Institute, Cary, NC). Thrips numbers and variable leaf surface area reductions were compared directly, then compared to the susceptible control with using Abbott's formula (Abbott 1925).

In initial testing, eleven test accessions were compared to Altex Atlas (a commercial standard/susceptible cultivar) in each experiment. The experimental unit consisted of six plants, which provided an estimate of sampling as well as experimental error. After all cotton was planted, eight flats of wheat per block were placed next to the cups and sprayed with herbicide. Cotton plants were exposed for 18 days or until what should have been the 4-5th true leaf stage.

At this time all leaf tissue above the cotyledons was excised, washed for thrips (Burris et al. 1990) and measured for surface area using a LiCor area meter.There is natural variation in leaf size among the accessions, so leaf surface areas could not be compared directly. A complete set of accessions of the same genotype as the test accessions was grown on the same schedule and kept free of thrips using insecticide. A reduction in leaf surface area of test plants versus the same genotype kept thrips free was calculated (Quisenberry and Rummel, 1979). Thrips collected in the washing were counted, and adults were identified to species using taxonomic keys (Mound and Kibby 1998, Moritz et al. 2001).

In no-choice testing, which is in progress at this time, the accession of interest and the susceptible (Altex Atlas) are being grown in separate cages. Each block consists of two cages, one with each of the two cottons. 18 plants were planted in cages with wheat that was sprayed with herbicide. After approximately 18 days, all plant tissue above the cotyledons will excised, washed for thrips (Burris 1990), and leaves measured for surface area. "Clean" plants (no wheat, sprayed with insecticide for good measure) are also being grown in identical cages to block any effect of the cage on growth and development. These plants will be used to calculate the variable leaf surface area reductions (Quisenberry and Rummel, 1979).

Aphid screening. Single cotton aphid females were caged on cotton leaves using 2cm plastic clip cages and allowed to deposit one young. The female was then removed with an artists brush. The nymph was never touched. Aphids were then examined daily for molting or death. The data procured was used to construct age-specific life tables to describe patterns of aphid growth and mortality on the different accessions.

Results and Discussion

Thrips screening. Use of hot water treatment of seed and attention to uniformity of planting depth was very successful in achieving greater uniformity in emergence of seedlings. Usually at least one seedling per cup emerged on the same day, making it a simple matter to thin out seedlings emerging earlier or later, thus producing a test population that emerged on the same day.

The method of using wheat to rear and force thrips to move to the test cotton was highly successful. Heavy thrips pressure was created in almost every experiment, with leaf surface area reductions of 80-100% in the susceptible control common. To date, 268 accessions have been screened successfully in 34 experiments. Many accessions have shown resistance, and the top performers have been retested in later experiments for confirmation.
Abbott's statistic (leaf surface area reduction) for the 10 best performing accessions is shown in Figure 1. Each accession shown, in it's respective test, was significantly different from the susceptible control. Five of the accessions show a decrease in leaf damage 75% or more higher than the negative control. The actual numbers of the race stocks have been withheld here until resistance is confirmed.

Abbott's statistic (leaf surface area reduction) for the most promising accession, number 1, in multiple experiments is shown in Figure 2. In all but one experiment this accession outperformed the susceptible control. In four experiments the differences were significant at $P<0.05$, and in two had a decrease in leaf damage over 75% higher than the negative control.

To this point, no choice testing has been unsuccessful—probably due to cage design. An experiment testing accession #1 is underway at this point, and a new cage has been constructed which will be used in future testing.

To date 4850 adult thrips have been identified to species. *Frankliniella occidentalis* (Pergande) was the dominant species, comprising 90-100 % of the population, followed by *Thrips tabaci* (Lindeman) with 0-10%. Other thrips species found in low numbers were: *Anaphothrips obscurus* (Muller), *Chirothrips manicatus* Haliday, *Neohydatothrips variabilis* (Beach) and *Frankliniella williamsi* Hood. This mirrors the thrips population found outside the greenhouse, indicating little influence of the greenhouse on thrips species composition.

Results of this testing indicate that many of the wild cottons are resistant to some degree to the West Texas thrips complex. Research will continue, to screen more accessions. Accessions with confirmed resistance are in the process of crossing to produce the genotypes that will be passed to the molecular biologist.

Aphid screening. No results for aphid screening will be presented here. Some data was obtained in attempts made in 2006, but are considered unreliable due to problems with the methodology. Work is underway at this point to resolve these problems

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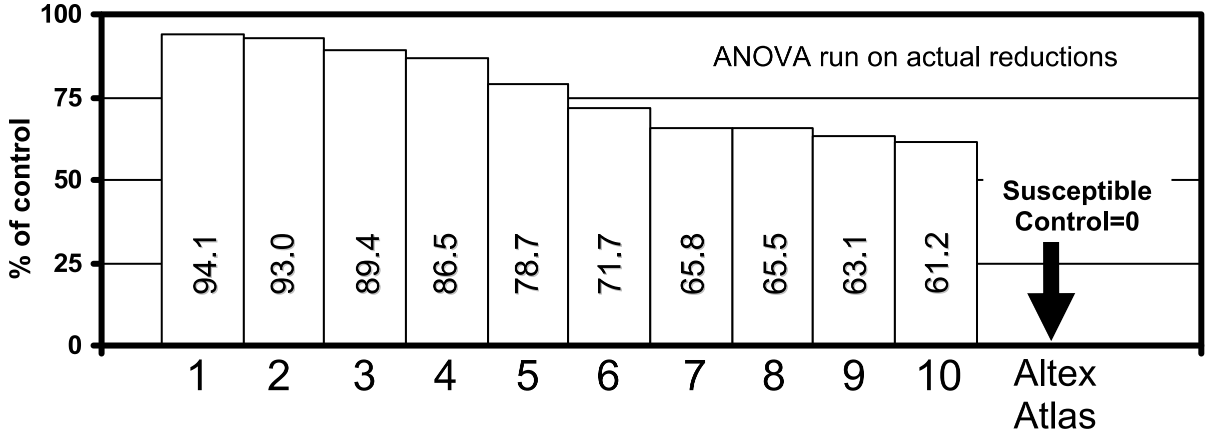

Figure 1. Plot of Abbott's statistic for the 10 best wild cottons showing significantly lower leaf surface area reduction than the control cultivar, Altex Atlas. In their respective tests, all means shown were significantly better than the control.

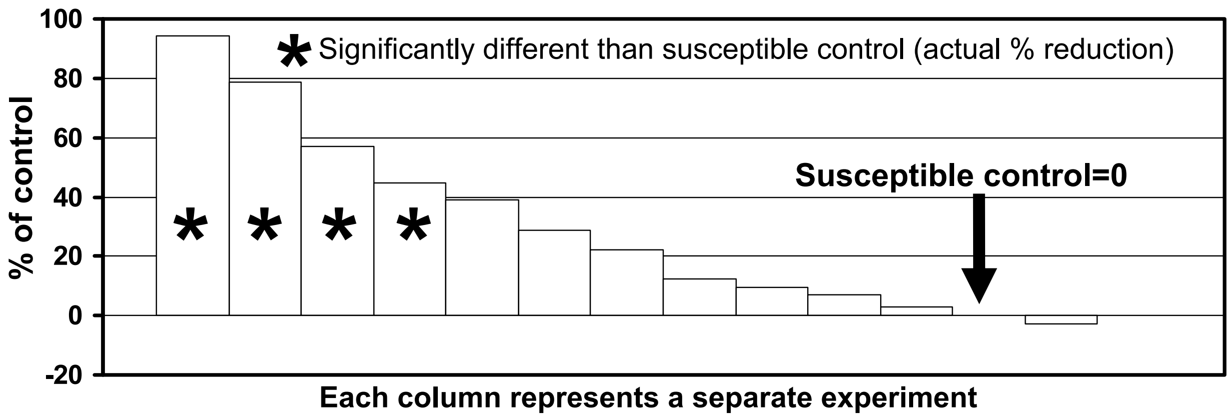

Figure 2. Plot of Abbott's statistic for the best accession (#1) showing leaf surface area reductions as compared to the control cultivar, Altex Atlas in multiple experiments.