2005 Beltwide Cotton Conferences, New Orleans, Louisiana - January 4 - 7, 2005

# COTTON FLEAHOPPER: SCREENING FOR HOST PLANT RESISTANCE IN COTTON

**Allen Knutson**
**Texas A&M Research and Extension Center**
**Dallas, TX**

## Abstract

The goal of this project is to identify cotton germplasm with resistance to cotton fleahopper and develop cotton genotypes with high levels of resistance to this pest. The focus of the project during 2004 was to evaluate 116 converted race stocks, primarily from Mexico, for resistance to cotton fleahopper. These race stocks are expected to have a wide variety of genetic material not currently available to cotton breeders and may represent previously unknown sources of resistance to insect pests. Each race stock was evaluated in replicated, small plot field studies (choice experiments) and in caged-plant studies (no-choice). Square damage in the no-choice cage studies ranged from 31% to 79% among the 116 converted race stocks. The mean percent square loss in the resistant standard was 18%. In 2005, we will continue to screen the *G. hirsutum* land races from Mexico in the USDA Cotton Germplasm collection at College Station and other sources of germplasm which have not co-evolved with cotton fleahopper.

## Introduction

During the past five years, the cotton fleahopper (CFH) (*Pseudatomoscelis seriatus* Reuter) has been one of the five most damaging insect pests of cotton in the US. In 2003, CFH and the related plant bug, *Lygus* species, ranked 4$^{th}$ and 2$^{nd}$, respectively, among cotton pests in the US. Cotton fleahopper is especially damaging in Texas, Oklahoma and is an occasional pest in Louisiana, Kansas, Arizona and other states. In 2003, CFH was responsible for an estimated $18 million loss, second only to the $19 million loss due to bollworm/budworm in Texas. The CFH and Lygus are expected to retain their status of key insect pests in future years as losses to boll weevil and bollworm/budworm continue to decline due to the success of the boll weevil eradication program and the adoption of Bt transgenic cotton, respectively. While boll weevil eradication in many cases reduces the need for early season insecticides, it will be necessary for many producers to continue these early season treatments to control fleahoppers, and thus they will not fully benefit from the insecticide savings and conservation of beneficial insects associated with boll weevil eradication.

Treatment with insecticides is the only tactic available to cotton producers for control of cotton fleahopper. Effective use of insecticides requires timely and accurate field sampling methods and reliable economic thresholds. The development of cotton varieties with high levels of resistance to cotton fleahopper could increase profits due to reduced insecticide costs and crop loss and is a control tactic which requires little management time (no need for field scouting or field spraying).

The insect screening studies conducted in 2004 are part of a larger project at the Texas A&M Cotton Improvement Laboratory to identify and incorporate new germplasm into the cotton breeding program. Identifying genetic sources of host plant resistance to cotton fleahopper is an important part of this program.

The cotton race stocks evaluated in these studies originated primarily from collections of *Gossypium hirsutum* made in Mexico and Guatemala from 1946-48. Due to the subtropical origin of these stocks, they flower in response to short day lengths and as a result do not flower under the longer day lengths in the temperate regions of the US. To overcome this constraint, McCarty and Jenkins converted these race stocks to day neutrality through a series of backcrosses to a day neutral donor line (McCarty and Jenkins 1993, 2002). These backcrosses, known as converted race stocks, were released during 1993-2004 and flower independent of day length (day neutral). Many of these race stocks are believed to have high but unknown level of variability. A total of 79 converted race stocks released by McCarty and Jenkins were evaluated in this study. An additional 37 converted race stocks from the Texas Race Collection were also evaluated for a total of 116 genotypes.

## Methods and Materials

A consistent source of insects of uniform age, sex and condition are necessary to standardize screening trails for host plant resistance studies. Cotton fleahoppers were reared in the lab according to the procedures described by Breene et. al 1989. Cotton fleahopper deposits eggs in woolley croton stems in the fall. These eggs over winter and hatch in the spring once exposed to warm weather and spring rains. We collected a large number of croton stems in February, 2004 from weedy areas near College Station and stored them in a cold room. Once a week, stems are removed from storage, soaked in water, dried and held in an incubator. After about 10 days, CFH eggs hatch and the nymphs are transferred to containers and provided with green beans for food. Food is replaced 2-3 times per week and the nymphs develop to adults in about 3 weeks. Adult fleahoppers live 2-3 weeks in captivity. Young adults, less than one week old, are used in the screening studies. Adults are sexed to standardize sex ratio in the event there is a difference in the damage potential or feeding activity among males and females. The converted race stocks were screened using 1) no-choice caged plant method 2) field method and a 3) no-choice seedling stage method.

**No-choice Caged-Plant Screening Studies.**

Each of the 116 race stocks was evaluated under no-choice cage studies by caging cotton fleahoppers on cotton plants grown in pots. Plants were germinated in the greenhouse and moved to outdoor benches once the first true leaves emerged. Growing plants outdoors resulted in better quality plants than if kept in the greenhouse. Plants were thinned to two plants per one-gallon pot. Once plants were in the second week of squaring, the terminal portion of the plant was caged and 2 female and 2 male cotton fleahoppers were introduced into the cage. Fleahoppers were from the laboratory colony and were less than one week old as adults. Each adult was cooled on ice and sexed by determining the presence (female) or absence (male) of an ovipositor using 10 X magnification. Two plants were caged per replication, and the trial was replicated four times. Because of the large number of entries, the study was repeated each week (replication) for four weeks. A known susceptible and resistant standard were included in each replication. Also, check plants without cotton fleahoppers were included to determine background (physiological) square damage. Forty plants, requiring 160 adult fleahoppers, were inoculated per day as this was the maximum number of plants which could be rated for damage in a single day. The caged plants were held in an insectary at 29 C and square damage due to cotton fleahopper feeding was determined by examining each susceptible square (up to 4 mm in diameter) on each plant with a dissecting microscope. Each square was examined for feeding lesions characteristic of cotton fleahopper and dissected to observe evidence of internal damage.

**Field Screening Studies**.

Converted race stocks were screened in replicated field plots (choice experiments) planted at the Texas A&M Research and Extension Center at Dallas on May 7, 2004. Each of the 116 stocks was planted in a single row and replicated four times in a randomized, complete block design. Rows were 25 feet long and spaced 40 inches apart. Weedy hosts of cotton fleahopper were planted around the plots the previous fall to serve as a source of this pest. These plants, *Monarda* and *Croton*, were periodically mowed in May and June to force the fleahoppers into the test plots. A permanent field nursery is now established for rating genotypes in the field. The number of fleahoppers, fleahopper eggs and the number of squares and blasted squares was counted in each genotype during June or July. On each date, 12 terminals were collected from each plot (48 per genotype), placed in labeled bags, and returned to the lab. The number of squares present and absent (as determined by the presence of a blasted square or scar at a fruiting site) was determined for each terminal. All of the squares visible at the base of the node with a fully expanded the leaf the size of a quarter and at the node directly below were examined.

**Seedling Stage Screening Studies.**

Screening plants for square damage in greenhouse or field grown plants is time consuming and expensive because plants must be grown for about 4-6 weeks before squares are present and the plants can be evaluated. Painter (1930) reported that cotton fleahopper feeds on the stems of pre-squaring cotton and results in sunken lesions on the stems. We evaluated feeding damage to seedling plants with two true leaves to determine if plant damage in this stage could be used to screen for resistance.

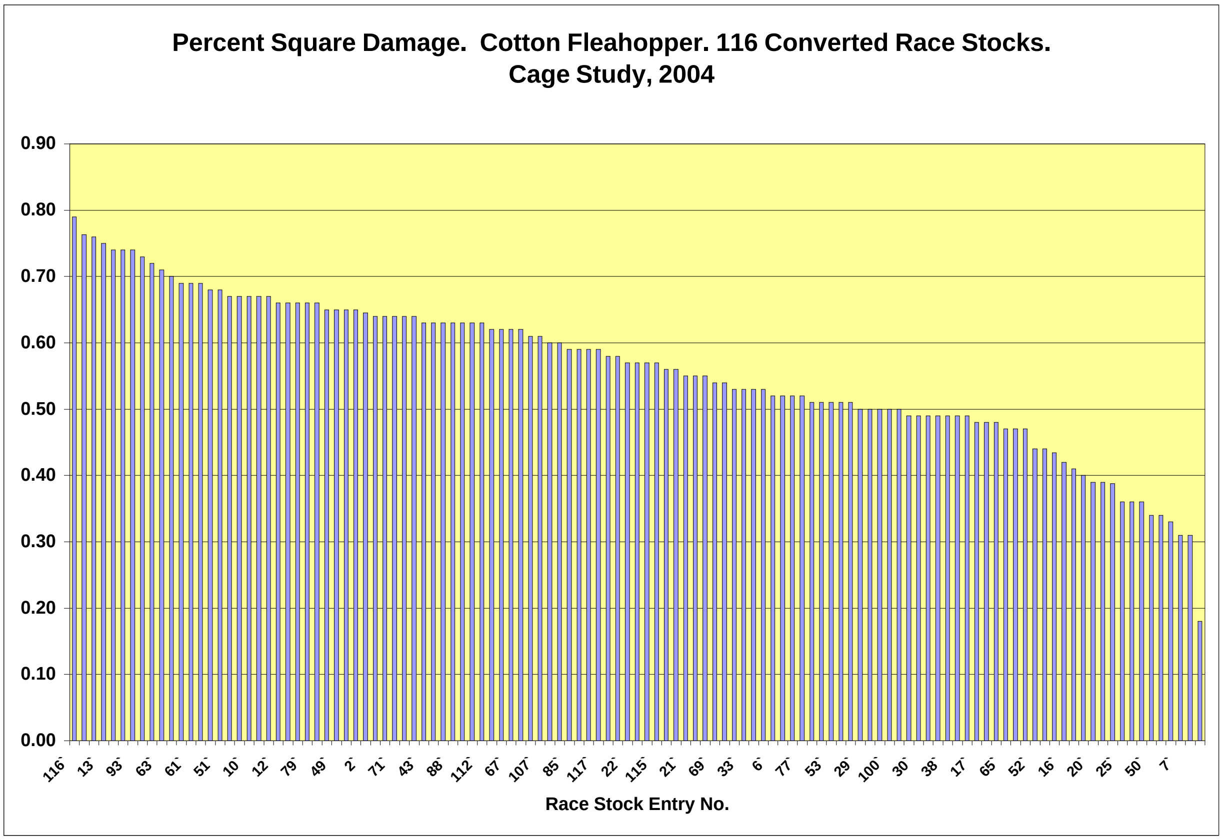
Two seeds of each of the 116 race stocks were grown individually in plastic tubes or “conetainers” six inches long. Each race stock was planted in 7 conetainers and once the first true leaves were fully emerged, five containers with the most vigorous plants were selected for study. Each conetainer was thinned to one plant and caged inside a cylindrical, clear-acetate cage. Two adult cotton fleahoppers were placed on the plant inside the cage. Plants were held in an insectary at 80 F and 16:8 light and dark regime for 48 hours and the cages and insects were removed. The number of live cotton fleahoppers was recorded for each cage. Plants were held in the lab for an additional 24 hours to allow all symptoms of recent feeding to appear. The number of feeding lesions was then counted on each cotyledon and each true leaf of each plant with the aide of 10X magnification. The area of the leaf damaged by feeding was also rated on a scale of 0 = no damage, 1 = 1-25% damage, 2 = 26-50 %, 3 = 51-75% and 4 >76%

damage.

## Results

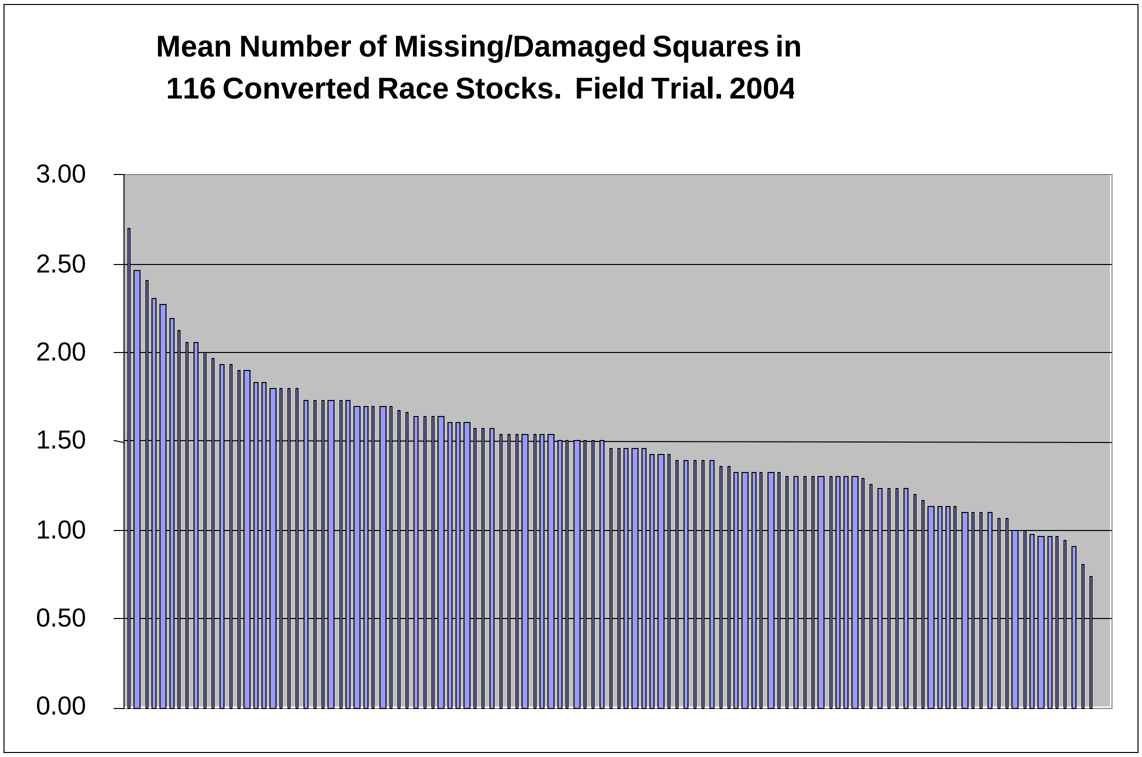
**No-choice Caged-Plant Screening Studies.**

Results of the no-choice cage studies are shown in the Figure below. Each mean represents four replications, each of two plants, for a total of eight plants. Percent square damage ranged from 31% to 79% among the 116 converted race stocks. The mean percent square loss in the resistant standard was 18% and is included in the figure below. These results indicate that although the 116 converted race stocks varied in their susceptibility to cotton fleahopper (mean of 31-79% square damage), none of these stocks were as resistant as the current standard identified from earlier studies.




**Field Screening Studies.**

Cotton fleahopper numbers were very light in the field trial in 2004. This is attributed to heavy and frequent rainfall in May and June which apparently drown cotton fleahoppers or otherwise suppress their reproduction. Data presented below are from samples collected in early July when fleahopper numbers increased following the return to normal, drier weather conditions. Among the 116 race stocks, the mean number of missing/damaged squares ranged from 0.75 to 2.70 per plant (see Figure). The ANOVA was significant (F= 1.36, P= 0.026) and the Least Significant Difference value was 0.85. Seventy-five of the entries fell within this range of significance (0.75-1.60).




**Seedling Stage Screening Studies.**

There was no evidence of feeding lesions to the stems of cotton seedling, as described by Painter (1930). Rather, cotton fleahopper feeding resulted in small, sunken, brown lesions on expanded leaves and cotyledons, although very few lesions were observed on the cotyledons. Lesions were most common near the leaf margins and encompassed several gossypol glands. Sunken, brown lesions also appeared on unexpanded leaves, and often these leaves and leaf buds would be entirely brown or black.

Leaf damage ratings among the 116 race stocks ranged from 0.3 to 3.6 on a scale of 0 to 4. However, there was often a great deal of variation among the five replications within a trial for each race stock. On some plants, feeding lesions were concentrated on the true leaves, whereas on other plants of the same race stock, no lesions were present on the expanded leaves and the unexpanded leaf buds were black and dead. In other plants of the same race stock, no feeding was evident. This variation in feeding pattern and intensity within the same race stock and replicate cast doubt on the repeatability of this screening method. More importantly, there was no correlation (correlation coefficient = 0.07) between damage rating on seedling plants and percent square damage, as determined from the no-choice cage trials, for a given race stock. The lack of a relationship between plant response to leaf feeding and square feeding is not surprising considering that leaves and fruit buds differ significantly in their physical structure and physiology. These results support the continued use square damage, although tedious, as the basis for screening for resistance to cotton fleahopper.

## Acknowledgments

Appreciation is extended to Cotton Inc. and the Texas Food and Fibers Commission for funding this project. We also thank Dr. Edsel Bynum and Ms. Baselisa Fontes for assistance in the laboratory and field.

## References Cited

Breene, R. G., W. R. Martin Jr., D. A. Dean and W. L. Sterling. 1989. Rearing methods for the cotton fleahopper. Southwest. Entomol. 14:249-253.

McCarty, Jr., J. C. and J. N. Jenkins. 1993. Registration of 79 day-neutral primitive cotton germplasm lines. Crop Science 33:351.

McCarty, Jr., J. C. and J. N. Jenkins. 2002. Registration of 16 day length-neutral flowering primitive cotton germplasm lines. Crop Science. 42: 1755-1756.

Painter, R. H. 1930. A study of the cotton flea hopper, *Psallus seriatus* Reut. with especial reference to its effect on cotton plant tissues. J. Agric. Research. 40:485-515.