DEVELOPING AN INDUSTRY-WIDE STANDARD FOR LEAF HAIRINESS

Gaylon Morgan
Texas A&M University
College Station, TX
Fred Bourland
University of Arkansas
Keiser, AR
Jane Dever
Texas A&M University
Lubbock, TX
Dan Fromme
Louisiana State University
Alexandria, LA
John Gassett
University of Georgia
Griffin, GA
Silvano Assango
Texas A&M University
College Station, TX
Ed Barnes
Cotton Incorporated
Cary, NC

Abstract

Several factors were previously believed to negatively influence the leaf grade values in cotton, including defoliation and desiccation levels. However, recent research identified leaf hairiness as being a primary culprit in higher leaf grade values in Texas. Additionally, during these trials, discrepancies in seed company ratings for leaf hairiness and quantified trichome densities were observed. Due to these findings, widespread support exist to obtain an objective and robust method for quantifying an industry-wide standard for leaf hairiness. Leaf hairiness data were collected from existing variety trials and is being used in developing an industry-wide leaf hairiness standard.

Introduction

Cotton leaf hairiness, also known as trichome density, is highly variable between cotton varieties and can range from 0 to over 550 hairs/cm^{-2} (Bourland, et al. 2003). See Figure 1. Previous research by Norman et al. (1994) with whiteflies and Mekala (2004) with fleahoppers has shown important impact of leaf hairiness on insect management and thus variety selection. For example, cotton varieties with a high density of leaf hairs have resulted in increased insecticide applications for white flies in the Rio Grande Valley and leaf hairiness should be a major variety selection criteria for these producers (Norman, 1994). Eder et al. (2012) and Boykin et al. (2012) demonstrated the detrimental impact of leaf hairiness on cotton leaf grade both in small plot research and commercially grown and ginned cotton.

Research at multiple locations in Arkansas and Texas identified environmental conditions impact on trichome density, but has a minimal impact on the leaf hairiness ranking among varieties (Bourland et al., 2003, Norman and Sparks, 1997, Boykin, et al., 2013, and Eder, et al., 2012). Consistency of variety ranking across locations for leaf hairiness provides an excellent opportunity to develop an industry-wide leaf hairiness rating system that is much more objective and descriptive than the current leaf rating system.

Figure 1. Cotton leaf with low (left) and high (right) leaf trichome density.

Objectives

1. To document leaf trichome densities for varieties at numerous production regions across the Cotton Belt.
2. To identify a methodology for developing an industry-wide leaf hairiness rating system.
3. Describe methods for moving forward with the implementing the industry-wide standard for leaf hairiness.

Methods

In 2013, the concept of developing an industry-wide leaf hairiness rating system was proposed and discussed with the agronomists, entomologists, breeders, and ginners from universities, Cotton Incorporated, and Cotton Foundation. Additionally, input and support from Bayer, Monsanto, and Phytogen was obtained for the concept of developing and implementing an industry-wide standard for leaf hairiness.

From existing small plot variety trials in 2013- 2015 in Matagorda county, TX, Lubbock, TX, Keiser, AR, and Tifton, GA, and Alexandria, LA, leaf trichome densities were quantified across major cotton production regions using Bourland's published methodology (Figure 2). Standardized hairy check varieties, including ST 5288B2RF, ST 5289GLT, and TX-06-WE have been included in various years. Only seven varieties were in-common across all locations in 2013, and nine were in-common across four locations in 2014 and 2015. However, commonality over years has been less consistent due to the rapid turnover of varieties and regionally adapted varieties not being planted in all regions. The trichome density of the in-common varieties across locations ranged from low (smooth) to high (hairy).

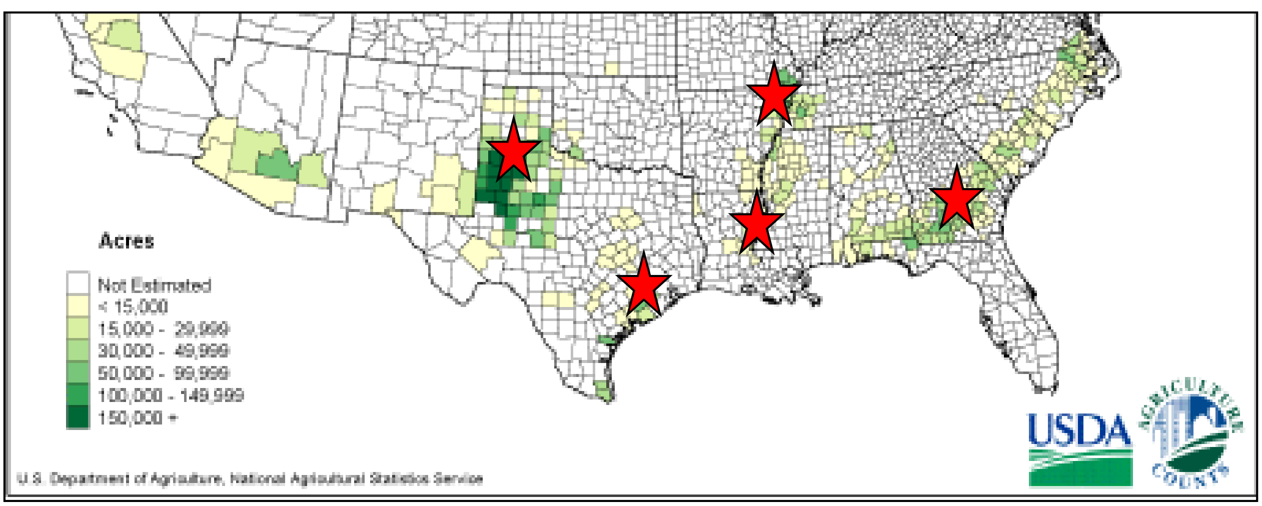

Figure 2. Map of geographic regions and testing sites in 2013 - 2015.

Only the locations with consistent varieties were included in these analysis and results and were used to validate the methodology for developing an industry-wide standard for leaf hairiness. However, trichome densities were quantified for each location and the data are available to assign a leaf hairiness rating for every variety.

Analysis of variance for mean and normalized trichome density was conducted using both Mixed and Fixed models with the GLM procedure in SAS. Using the in-common varieties, genotypes were fixed whereas years, locations, and their interactions were random for the Mixed model. In the Fixed model, the locations, years, genotypes, and interactions were fixed and significance was set at 0.05. Bi-plot analysis was conducted using GenStat for both mean and normalized trichome density.

Results

Based on the objective of continued evaluation of varieties and assigning of leaf hairiness rating, this poster will focus on the Mixed model analysis. Location or Location x Variety was not significant for mean trichome density; however, a significant interaction was observed for Location x Year x Variety. After normalizing the leaf trichome density for all locations to a standardized hairy variety (ie ST 5288 B2RF)at ech site and converting to a scale (1-10), no significant interaction was observed for Location, Year, Variety x Location, or Variety x Location x Year. The Boxplot analysis for the 2014 and 2015 locations demonstrates the stability between most locations and years (Figure 3). The Matagorda – 2015 location had significant foliar disease incidence and was sampled beyond recommended timing which likely impacted the results. Some varieties exhibited a higher level of variability in trichome densities across locations than other varieties.

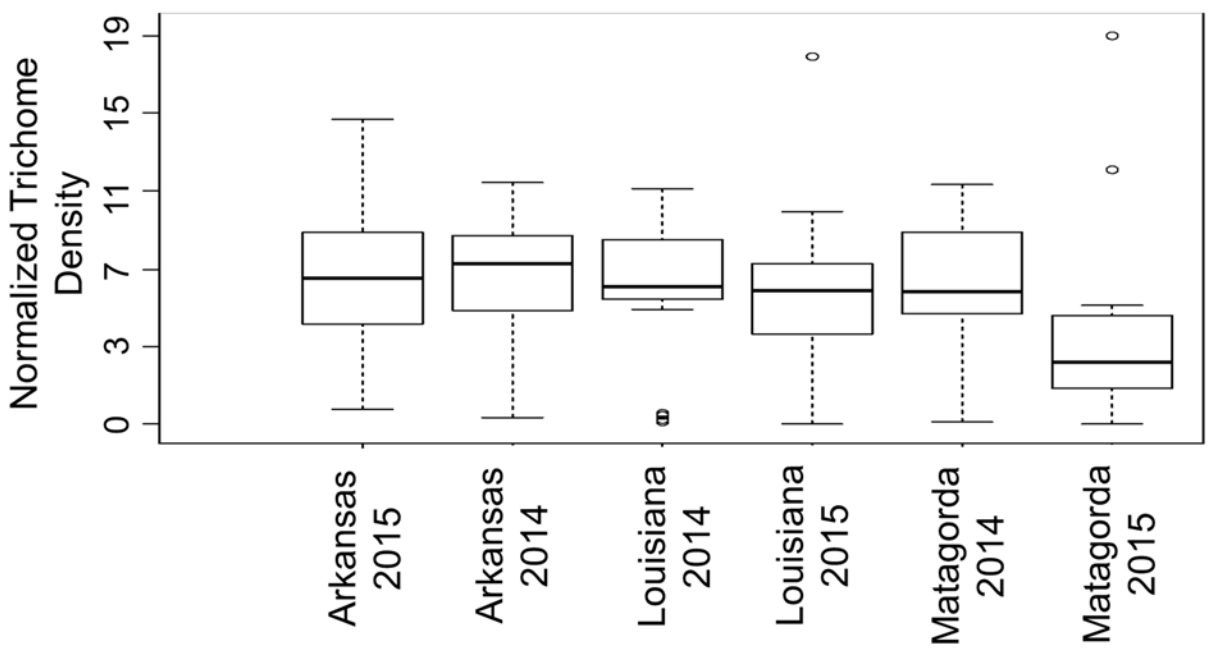

Figure 3. Biplot analysis of the normalized trichome density for the 2014 and 2015 locations in Arkansas, Louisiana, and Matagorda County, TX. The normalized trichome ratings were based on ST 5288 B2RF for each location. Other locations were excluded due to the lack of ST 5288 B2RF at the site.

To determine if a single location could be used as a designated location to quantify trichome density and assign ratings for the industry-wide standard, biplot analysis of the ideal environment was conducted (Figure 4). Little consistency was observed over years for any given location. Based on the analysis conducted thus far, there does not appear to be a single location that is highly representative of the entire Cotton Belt. However, the Louisiana location was identified as the nearest to the ideal location in both years and could serve as a principal location for assigning leaf hairiness ratings.

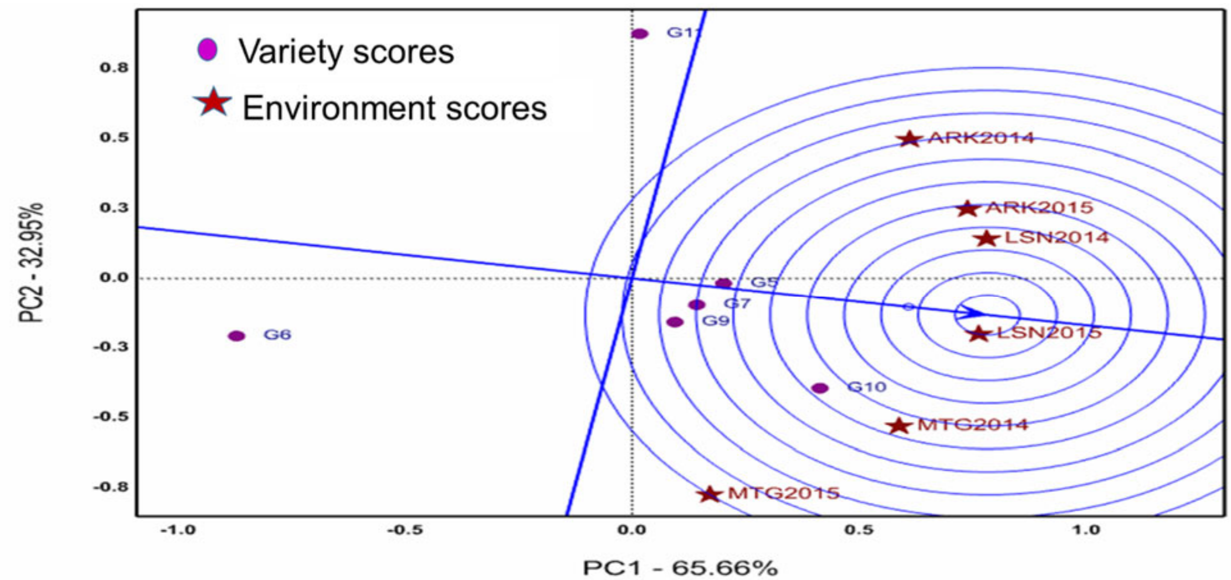

Figure 4. Biplot view of the ideal environment for the normalized trichome density for the 2014 and 2015 locations in Arkansas, Louisiana, and Matagorda County, TX. The normalized trichome ratings were based on ST 5288 B2RF for each location. Other locations were excluded due to the lack of ST 5288 B2RF at the site.

Conclusions

Leaf trichome densities do differ by environment, including by location and year, which concurs with previous findings by Bourland et al. (2003) and Norman et al. (1994). However, the relative hairiness of a variety to other varieties within trial location was consistent and agrees with Bourland et al., (2003) reports of no site by variety interaction. With the lack of site by variety interaction for normalized trichome density across the diverse locations, then the premise for developing an industry-wide standard for leaf hairiness is achievable.

Some varieties exhibited a higher level of variability in trichome densities across locations than other varieties. Normalizing the trichome density to a hairy check variety reduced the variation, but a fair classification of these varieties will need to be considered, when implementing an industry-wide rating system.

No single location proved to be ideal for assigning the normalized leaf hairiness rating and a lot of variability occurred between years at some testing sites. Louisiana was the most ideal location in both years and would be the best representative location to assign the industry-wide leaf hairiness ratings. However, a southwestern location, such as Lubbock, may be required to capture the diversity of varieties planted in the south-western production regions.

Future Direction and Research

Discussions with Cotton Incorporated, cotton breeders (private and public), and seed companies in the spring of 2016 will occur to discuss the adoption and implementation of the industry-wide stand for leaf hairiness. Based on these discussions, a plan for disseminating the 2016 variety ratings will be identified. Additionally, approach for identifying leaf hairiness ratings for new varieties in 2016 and into the future will be established.

Acknowledgements

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