ENVIRONMENTAL FACTORS INFLUENCING THE RESPONSE OF COTTON VARIETIES TO *XANTHOMONAS CITRI* SUBSP *MALVACEARUM* IN MISSISSIPPI

T.W. Allen
B.R. Golden
Delta Research and Extension Center – Mississippi State University
Stoneville, MS
S. Lu
Mississippi State University
Mississippi State, MS
G.L. Sciumbato
Delta Research and Extension Center – Mississippi State University
Stoneville, MS

Abstract

Bacterial blight of cotton is considered to be one of the most devastating diseases of cotton the world over. However, the widespread adoption of acid delinting practices in the early 1970s reduced the disease throughout much of the United States. However, over the past two seasons, bacterial blight has been observed over a large number of acres in the Mid-southern U.S. To attempt to gain insight into the potential yield losses attributed to bacterial blight inoculation trials were conducted in Stoneville, MS using several commercially available cotton varieties. A split-plot arrangement was used whereby each block included all of varieties screened for each year but one block was inoculated while the second block remained non-inoculated. Inoculation trials conducted during 2011 provided important information and suggested that approximately 23% yield could be lost in the event of a severe epidemic in susceptible varieties. Disease symptoms were expressed several weeks post-inoculation during 2011; however, the environment that occurred during 2012, generally a little warmer and with greater relative humidity wasn't as conducive for disease development. Therefore, the results from the 2011 inoculation trials were more reliable especially since observable symptoms of the disease post-inoculation were present. Several yield variables were also considered. Prior to harvest in 2011, plant heights were recorded. The additional yield and quality parameters considered included foliar rating, lint yield, micronaire, boll weight, and seed index. Data were averaged across all varieties contained within the inoculated block and are presented as such.

Introduction

Bacterial blight (angular leaf spot) of cotton, caused by *Xanthomonas citri* subsp. *malvacearum* (*Xcm*), can be a devastating foliar disease. The seedborne nature of the disease is the primary reason for widespread adoption of acid-delinted seed. In general, *Xcm* can cause seedling blight, leaf spot, lesions on stems, petioles, and bolls, and a boll rot (see Figure 1A and B). In severe cases, bacterial blight in susceptible varieties results in defoliation, a reduction in plant height, and subsequent yield loss on the order of 20-25%. Poor fiber quality and excessive yield reductions can be the result of elongated periods of environmentally conducive conditions.

During 2011 and 2012, a bacterial blight epidemic was identified throughout MS. Many of the fields with excessive infection had not recently been in cotton production or had never produced cotton. Based on the available literature, the primary source of the bacterium is from infested seed. However, numerous methods of secondary infection can occur once a point source exists within a given field. The majority of the commercially available cotton varieties are susceptible to the bacterium.

Field-level bacterial blight inoculation trials of commercially available varieties have been conducted for the past six years in Stoneville, MS. However, in an attempt to further our knowledge regarding the pathosystem, yield and cotton quality variables in addition to disease ratings were considered important. The main objective of the project was to determine the reaction of 22 commercially available cotton varieties to bacterial blight inoculation.

Figure 1. Typical bacterial blight lesions on cotton leaf (A) and boll (B) infected with *Xanthomonas citri* subsp. *malvacearum*.

Materials and Methods

Cotton was planted using a split-plot design. Whole plots were defined by inoculation strategy (inoculated vs. non-inoculated). Sub plots consisted of varieties arranged in a randomized complete block with four replications consisting of two 40" wide by 40' long rows. Four isolates (race 1, 2, 18(2)) were cultured on potato carrot dextrose agar and maintained by transferring to new media every 10 to 14 days. Inoculum was prepared by mixing bacteria with water at a concentration of approximately 5.0×10^5 viable cells/ml and included 1.25% of Dyne-Amic (Helena, Inc.). Inoculum was applied to the abaxial side of leaves using a tractor mounted sprayer (150 psi) at first white flower (see Figure 2). In 2012, plots were re-inoculated 28 days later. Plots were visually examined for disease symptoms on a 0 to 9 scale where 0 was indicative of no disease symptoms or defoliation, 1 = presence of disease symptoms on leaves, 2 = infected plant material present in the lower canopy, 5 = infected plant material present in the mid to upper-canopy along with some defoliation, and 9 = total defoliation of the plant. Environmental variables (temperature, rainfall, relative humidity) were collected from a weather station on the experiment station in Stoneville. Lint yields were determined by mechanical harvest and hand-picked boll samples. Fiber quality parameters were evaluated at Starlab, Inc.

Figure 2. Typical bacterial blight lesions on cotton leaf (A) and boll (B) infected with *Xanthomonas citri* subsp. *malvacearum*.

Results

The environmental conditions varied greatly between 2011 and 2012 (Figure 3 A & B). Air and soil temperature, as well as relative humidity were essentially the same between 2011 and 2012. However, 36% more precipitation fell during 2012 than did 2011 and could account for the differences in the expression of disease symptoms between the two seasons since six inoculation attempts made in Stoneville between two separate trials were attempted and resulted in no symptom expression. A similar circumstance occurred in breeding trials conducted in Arkansas (Bourland, personal communication).

The foliar disease rating observed 14 d after inoculation (in 2011) suggested approximately 5 of 22 varieties expressed some form of tolerance to *Xcm*. Specifically, DP 1133 B2RF, FM 1740B2F, FM 9058F, PHY 375 WRF, and ST 5288B2RF conferred tolerance (data not presented). Foliar symptoms did not develop in 2012 even after six inoculation attempts.

Seed index was significantly influenced by the inoc × variety interaction. In general, averaged over varieties seed from inoculated plants weighed 0.6 g less in 2011 and 0.3 g less in 2012 than seed from non-inoculated plots (Fig. 4B). Individual boll weight was marginally influenced by inoculation, with a 9.3% reduction observed between inoculated and non-inoculated plots in 2011 but only a 3% reduction in 2012 (Fig. 4B). Averaged across varieties, plots receiving inoculation with *Xcm* yielded approximately 26% less lint than non-inoculated plots resulting in a 214 lb lint/acre lint yield decrease in 2011. However, the reduction in 2012, without the development of observable bacterial blight symptoms translated into 29 lb lint/acre reduction or a 3% decrease (Fig. 4C). Fiber micronaire was also influenced by the main effect of inoculation. Micronaire was reduced by 0.19 or 4% when comparing inoculated vs. non-inoculated varieties, respectively (Fig. 4D).

Summary

In summary, additional work is necessary to determine the specific susceptible and tolerant cotton varieties to bacterial blight inoculation annually. Moreover, research to determine the specific race of the bacterium present during 2011 and 2012 is important and will aid in protecting farmers by allowing us to use the most commonly present races in field inoculation trials. The differences between the two years in the reaction to inoculum can be explained by the prevailing environment. However, cotton farmers throughout the Mid-southern United States rely on this type of information to determine the best varieties to plant in situations where bacterial blight may have occurred during 2011 and 2012.

Table 1. Analysis of variance p-values for yield and quality parameters as affected by variety, *Xcm* inoculation and their interactions for field experiments conducted during 2011.

		Variable (2011)					
Source of variation	**df**	**Foliar rating**	**Plant height**	**Lint yield**	**MIC**	**Boll weight**	**Seed index**
		---------------------------------- *p*-value ----------------------------------					
Inoculation	1	< 0.0001	0.0017	< 0.0001	0.0008	0.0134	0.0131
Variety	21	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Variety × inoculation	21	< 0.0001	0.2101	0.1181	0.5670	0.6119	0.0147

Table 2. Analysis of variance p-values for yield and quality parameters as affected by variety, *Xcm* inoculation and their interactions for field experiments conducted during 2012.

		Variable (2012)					
Source of variation	**df**	**Foliar rating**	**Plant height**	**Lint yield**	**MIC**	**Boll weight**	**Seed index**
		---------------------------------- *p*-value ----------------------------------					
Inoculation	1	.	.	0.0170	0.8572	0.0019	< 0.0001
Variety	37	.	.	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Variety × inoculation	37	.	.	0.1035	0.7203	0.6254	0.1419

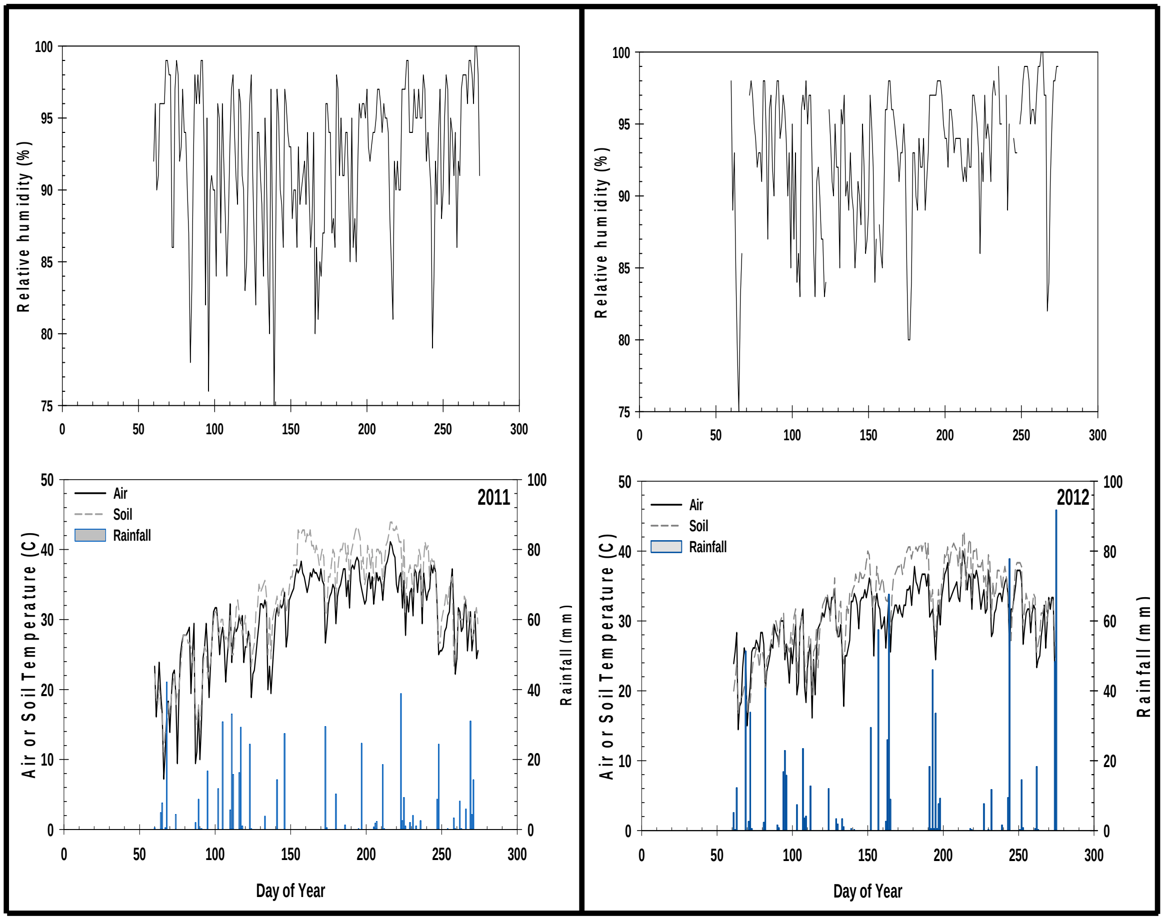

Figure 3. Environmental variables including air and soil temperature, rainfall, and relative humidity from 2011 (A) and 2012 (B) in Stoneville, MS.

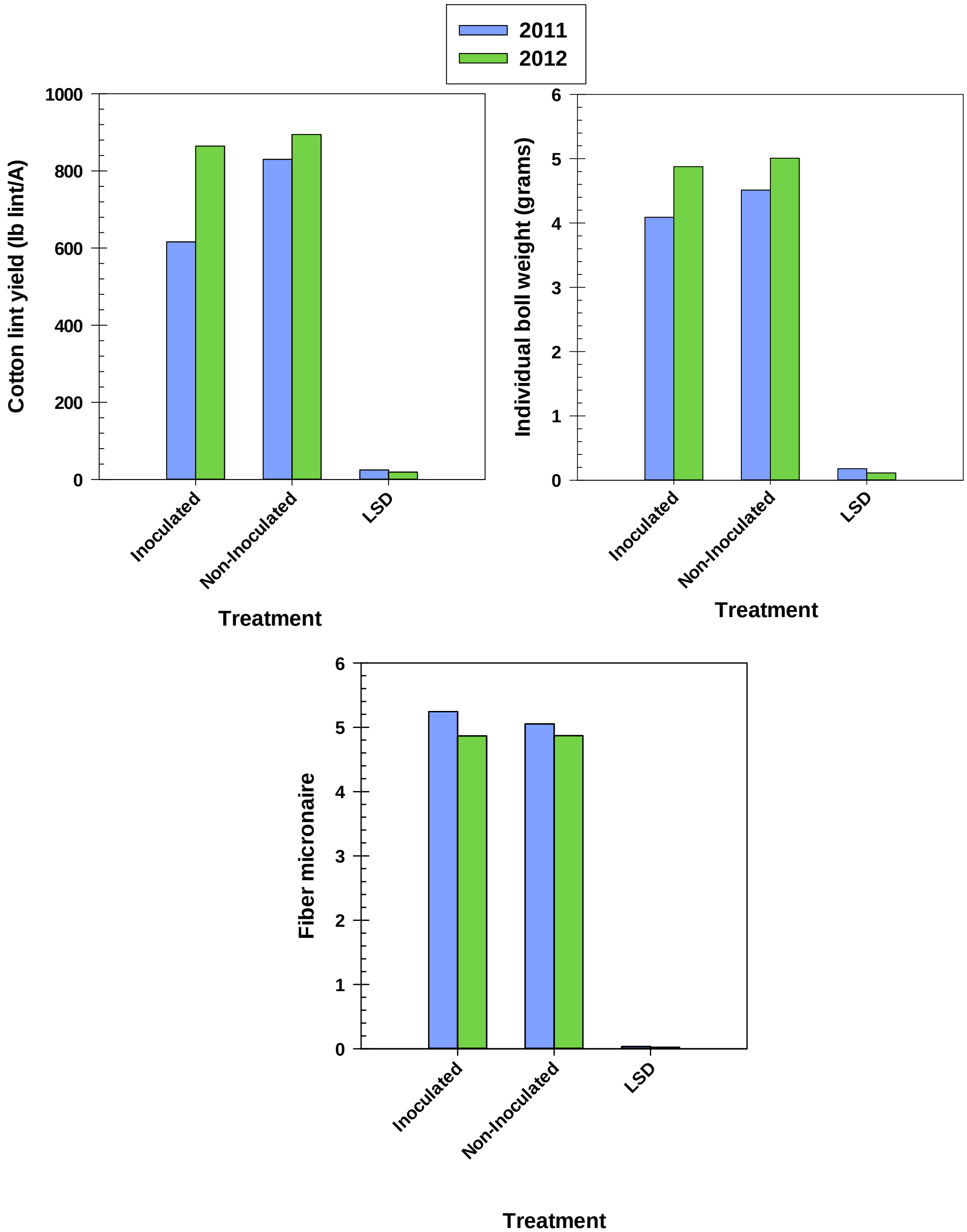

Figure 4. Measurements influenced by the significant main effect of inoculation for 2011 and 2012 field research trials.