Population development, selection, and evaluation for heat stress, fiber quality, lint yield, and pest resistance

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Objectives: To improve cotton germplasm with potential heat stress tolerance, better fiber quality, lint yield and pest resistance, broadening the genetic base of cotton.

Justification and Problem Statement

Over the last 35 years, the cotton germplasm base used in plant breeding has narrowed. This relatively narrow genetic diversity has been suggested as a contributor to an apparent plateau in breeding progress. It may also represent an impediment to efforts to sustain high yields (May and Taylor, 1998; Meredith, 1992; Ulloa, 2006). Since the re-establishment of a cotton breeding effort within the USDA-ARS, Western Integrated Cropping Systems Research Unit, we have focused on increasing genetic diversity through acquisition of novel germplasm (from multiple sources including non-commercial landraces and species of wild cottons).

Cotton varieties grown commercially in California such as Acala Maxxa and Phytogen 72 yield poorly in the heat stress environment of Maricopa, AZ. In the San Joaquin Valley (SJV), when above normal temperatures occur during the critical stage of peak flowering, yield losses may occur in response to the heat sensitivity of varieties that are currently grown here. In addition, the vulnerability of cotton production in California to race 4 Fusarium wilt highlights the need for comprehensive research to protect the future of the cotton industry in the San Joaquin Valley. This strain of Fusarium has proven especially damaging to most varieties of Pima cotton (Hutmacher et al., 2005). Development of host-plant resistance is currently the most economic and effective strategy for managing Fusarium wilt (Ulloa et al., 2006).

To improve cultivar performance above current heat stress, yield, fiber quality, and pest resistance baselines, it is essential that new genetic variability be introduced into elite germplasm pools used by breeding programs. Currently, we continue to make progress on germplasm development for heat stress tolerance, better fiber quality, lint yield and pest resistance.

Summary

We continue to advance breeding lines from a germplasm pool created in 2002 in Maricopa, AZ (USDA-ARS) utilizing four double cross populations, which involved cultivars ST 474, Phytogen 72, Maxxa, DP565, SG 248, and NM67 as parents in different cross-combinations. Potential heat tolerant breeding lines are currently being evaluated in Florence, SC, Tifton, GA, Baton Rouge, LA, Maricopa, AZ, and Shafter, CA. From 70 lines tested in 2006 in non-replicated progeny tests, 16 were selected for replicated testing across the five locations in 2007.

In California, these 16 lines exhibited superior fiber characteristics, with lint percentages ranging from 36.0 % to 42.0 % , upper half mean fiber lengths ranging from 1.20 to 1.29 inches, and strengths ranging from 23.0 to 26.0 grams/tex in 2006. Field experiments utilized a randomized complete block design with four replications. In 2007, these 16 lines also exhibited superior fiber characteristics, with lint percentages ranging from 35.3 % to 40.3 % , upper half mean fiber lengths ranging from 1.11 to 1.21 inches, and strengths ranging from 32.0 to 36.7 grams/tex (HVI). In comparison, 'Phytogen 72' exhibited lint percentage averaging 41 % , upper half mean fiber length averaging 1.15 inches, and strength averaging 34.2 grams/tex (HVI). Currently, we are testing selected breeding lines to validate improved heat tolerance, yield, and fiber quality properties for future release. We hope that by this coming fall or early next year, we will release improved germplasm from this project. Demonstration plots will be available for viewing during the September 16, 2008 field day at the University of California Research and Extension Center, Shafter, CA.

Recently, the Agricultural Research Service, United States Department of Agriculture, and University of California released four Pima cotton germplasm lines (SJ-07P-FR01, SJ-07P-FR02, SJ-07P-FR03, and SJ-07P-FR04). SJ-07P-FR01 – FR03 lines originated from a cross of germplasm lines 8810 and NMSI 1601, which was originally accomplished at the New Mexico State University at Las Cruces, NM in 1997. SJ-07P-FR04 is a population originating from re-selection within P 73. Based on the results of field and greenhouse studies, these lines possess good, but not complete, levels of resistance to Fusarium wilt (FOV) race 4. In addition, these lines produced moderate yields of cotton lint with good to superior fiber length and strength. Cotton breeders in California need alternative sources of germplasm for improving resistance of Pima cottons to this disease. We hope that the SJ-07P-FR lines will provide needed alternative sources of FOV resistance, and will broaden the genetic base of resistant germplasm critical to maintaining a healthy Pima cotton industry in the San Joaquin Valley of California.

Currently, we are in the process of gathering and analyzing data for an additional germplasm release with improved resistance to race 4 FOV, fiber quality, and yield. These Pima breeding lines originated from a cross made by Dr. Richard Percy between PS 6 and 89590 cultivars. These lines have been tested for three years, and have exhibited excellent levels of FOV resistance. We are also advancing 20–25 Pima lines that were selected under FOV race 4 infested field conditions for the past two years. We hope that this improved Pima germplasm will contribute to the current germplasm resources available for development of future commercial cultivars grown in California.

References

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