

**Fusarium wilt race 4 [*Fusarium oxysporum f. sp. vasinfectum* race 4 (FOV4)] research progress update** – cooperative efforts by the USDA-ARS, PA, CSRL, Plant Stress and Germplasm Development Research (PSGD), Lubbock, TX, the University of California Cooperative Extension UC-ANR, and the University of CA Davis Plant Sciences Dept.

In all today, 1,155 entries have been evaluated in infested FOV4 fields and a portion (1/4) in the greenhouse using artificial FOV4 inoculation. Our primary objectives are to introduce a known FOV4 dominant gene that has shown resistance in Pima (e.g., Pima-S6) into Upland cultivars, and identify/develop within the Upland gene pool improved FOV4 tolerant germplasm. Entries have been planted in naturally-infested FOV4 fields and seeded in 5 x 1 meter plots and replicated three times. During the growing season, plant responses to inoculum pressure were assessed through evaluations of root and stem vascular staining levels, plant mortality, foliar wilt symptoms and measures of relative plant vigor. Selected cotton entries used as parents to make crosses and progeny developed from these parental entries (F<sub>1</sub> populations) were also inoculated with FOV4 and grown under greenhouse conditions for rating and reselection. In 2013, we evaluated 511 entries in the field, including progeny from the “PS6 X TM1” and “TM1 X PS6”. In 2014, we evaluated 316 new accessions and selected 39 (12%) entries for increase and introgression of Pima resistant and Upland cultivars under FOV4 field and greenhouse evaluations. In 2015, we evaluated 207 new accessions from the USDA-ARS collection that were increased in Lubbock Texas. From 207, we selected 37 (17.5%) lines. We also received 40 U.C. Riverside lines and selected only 4 (10%).

One of the breeding methodologies applied during the identification and development of these new improved FOV4 resistant cotton germplasm is “Recurrent Selection”. So far, we made 141 selections (13% of total entries), 18 recurrent selections (2% of 2013-14 entries) and made 142 crosses (F<sub>1</sub> populations). The 54 selections and the progeny from 2015 will be increased and evaluated in the greenhouse for reselection along with the recurrent selections and progeny from 2013 and 2014. Table 1 presents a 2015 summary of the selections and crosses made so far. Also, Table 1 is part of a Proceeding article that will be included in the Proceedings of the Cotton Beltwide Cotton Conference 2016, National Cotton Council. We are including this article as appendix at the end of this document.

During the life of this research cooperative project, we have made tremendous contributions to the Cotton Industry, especially in California. First, we identified sources or cotton entries (commercial cultivar PhytoGen 800 and germplasm Pima-S6) with resistance against the fungus-pathogen FOV4 which allowed the continued Pima production in the state. Over 95% of experimental and commercial germplasm tested during the 2003 to 2007 period were found to be moderately to highly susceptible to FOV4, with very limited resistance/tolerance identified in other tested Pimas and Uplands during the first 5-6 years of field screening for FOV4 susceptibility. Second, we have been releasing to the public and private breeding programs tolerant/resistant Pima germplasm or Pima lines, once in 2008 and again 2015. These lines have broadened the genetic base of resistance which is critical to the success and future of the cotton industry. And Third, since the new phase and adjustment of the project (2011 to now – Dr. Mauricio Ulloa moved to Lubbock, TX), we developed new Pima lines with improved FOV4 resistance combined with a more determinate growth habit. We also identified Upland entries with a good level of tolerance to FOV4 which have been used to develop new progeny or breeding lines with a better level of FOV4 resistance (see recurrent selection progress

above). We hope that some of these new Upland lines will be released in late 2017 or 2018 to the public.

Table 1. 2015 Total selections made for each objective group.

Objective group	Total pedigree frequency
Pima collection	29
Upland collection	8
UC Riverside collection	4
Recurrent selection from 2014	14
Recurrent selection from 2013	8
RIL creations from 2014 F <sub>1</sub> s	30
New F <sub>1</sub> creations	105
<i>Total selections made</i>	<i>207</i>

### **Review of FOV4 Breeding efforts in California**

We continued to follow our established breeding scheme or strategy for identify, selecting, and developing FOV4 resistant/tolerant germplasm. Cotton entries are introduced for evaluation into California and possible selection for FOV4 resistance from different sources (Fig. 1). Some of the evaluated entries represent a wide range and diverse genetic backgrounds of germplasm material, including germplasm releases from 1930 to 2012 from private and public institutions (DP, STV, DES, etc.) and several other public breeding programs. In our breeding strategy, cotton entries are primarily identified from ongoing new germplasm development, screening and selection efforts at the USDA-ARS, PA, CSRL, Plant Stress and Germplasm Development Research (PSGD), Lubbock, TX.

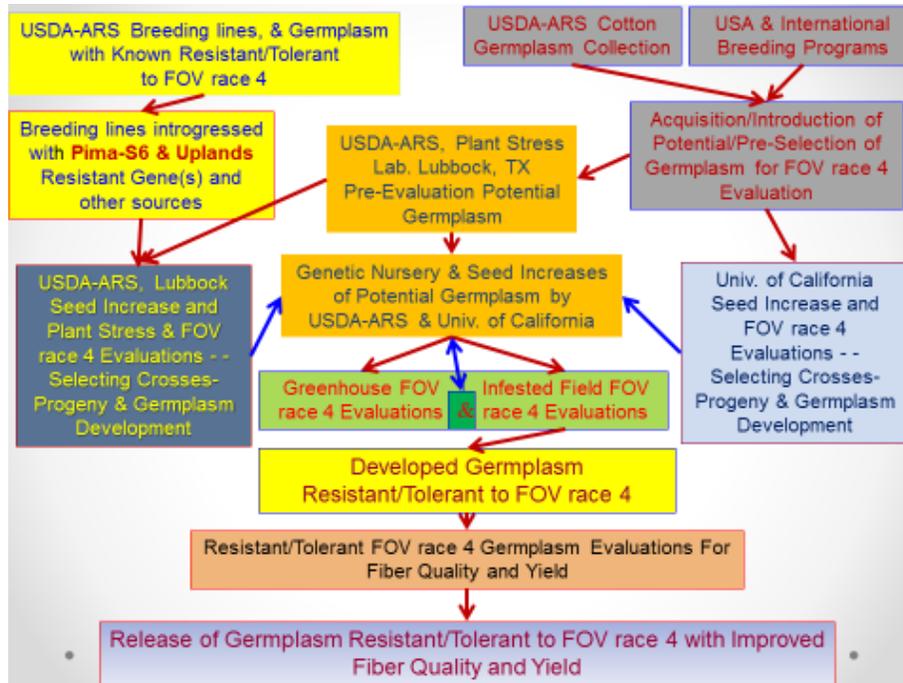


Figure 1. Established breeding scheme or strategy for identify, selecting, and developing FOV4 resistant/tolerant germplasm.

At the USDA-ARS, PSGD, we are integrating approaches to develop and accelerate the selection of superior or improved cotton lines with better tolerance to stress/drought and disease resistance, and yield and fiber quality (Fig. 2). Under limited irrigation or induced-stress, we are identifying and/or developing cotton entries with drought tolerance. Identified or developed entries with possible stress tolerance are then send to California for further FOV4 resistance evaluation. By applying two stress conditions (drought and FOV4 disease), we hope to release to public and private cotton breeding programs better cotton entries with stacked disease and drought tolerance.

In addition, at the USDA-ARS, molecular markers such as SSRs or SNPs to be associated with FOV resistance have been used to screen/select lines with resistance/tolerance to FOV4 selected field evaluation. These selected lines are being examined for the introgression of DNA fragments from known resistant germplasm such as Pima-S6. This marker assisted selection approach will be used to speed the selection and to increase the efficiency during the breeding process.



## Plant Stress Research

Lubbock, TX



- Identify the range of diversity for disease resistance and drought tolerance
- Identify and/or develop lines with stacked disease resistance and drought tolerance traits for release to Public and Private cotton breeding programs.



- Integrating approaches to accelerate the selection of superior or improved cotton lines &
- Develop tolerant to drought and disease resistance with good Yield and Fiber Quality

### Traits that may improve stress/drought Tolerance:

- Plant architecture
- Root-morphology
- Boll distribution
- Canopy temperature
- Maturity characteristics



Figure 2. USDA-ARS, PA, CSRL, Plant stress and germplasm development presentation Research slide showing some of the approaches for developing germplasm.