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BREEDING AND GENETICS

Utilization of Cotton Germplasm in the Winter Nursery at Tecoman, Mexico for Plant Breeding Training and Research

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ABSTRACT

The cotton industry benefits from the use of genetic diversity in cotton breeding programs as well as from robust educational programs that train future cotton plant breeders. This project was coordinated in an effort to familiarize plant breeding students with the diversity of cotton germplasm resources within the National Plant Germplasm System (NPGS). In 2009, a group of students from Texas A&M University and Texas Tech University spent five days at the winter nursery in Tecoman, Mexico. They assisted in the characterization and roguing of a portion of the national cotton germplasm collection. Learning experiences included observation of novel phenotypic characteristics, understanding the utility and resource value of the national germplasm collection, and mastering international travel and exposure to unfamiliar cultures. This program enhanced the graduate school experience and contributed to students' professional development.

The cotton industry is in continual need for the infusion of genetic diversity into plant breeding programs. Sources of genetic variability can be found in exotic, wild, or commonly grown species of cotton (McCarty and Jenkins, 2001). There are 51 known species of cotton (*Gossypium* spp.) (Wallace et. al., 2008), but just two allotetraploids (*2n=52)* species, *G. hirsutum* and *barbadense* account for almost all commercial cultivation. It is likely that many favorable alleles exist in most other *Gossypium* species and wild races of *G. hirsutum* and *barbadense* but these secondary and tertiary gene pools remain largely untapped. Exotic cotton germplasm has made several contributions to commercial cultivar breeding programs. A triple hybridization involving two diploid species, *G. thurberi*, Todaro, and *G. aboreum, L.;* and G. *hirsutum,* L. resulted in a functional tetraploid (Beasley, 1940). This breeding line became part of the foundation of the Pee Dee cotton breeding program (Campbell et al., 2009). The nectariless trait, which provides host plant resistance against certain hemipertan pests such as *Lygus lineolaris*, was transferred from *G. tomentosum*, Nuttall, into *G. hirsutum*, (Meyer and Meyer, 1961). More recently, resistance to reniform nematodes (*Rotylenchus reniformis*, Linford & Oliveria, 1940) was taken from *G. longicalyx* and introgressed into Upland cotton via two triple species hybrids, HLA – derived from crosses of *G. hirsutum* and *G. longicalyx*, subsequently crossed with *G. armourianum* , and HHL – derived from crossing *G. hirsutum* and *G. herbaceum* and then with *G. longicalyx* (Robinson et al., 2007). Today, most U.S. public cotton breeding programs use at least some exotic germplasm to increase genetic diversity in their breeding populations.

Another issue of concern for the cotton industry is the training of students in cotton plant breeding. The U.S. is in the midst of a decline in public plant breeders engaged in cultivar development and germplasm enhancement (Bliss, 2007). Since most public and private plant breeders are educated at land grant universities, there eventually will be a deficiency in the number of U.S. - trained plant breeders who are able to evaluate phenotypes and utilize phenotypic methods if this trend is not reversed. Providing hands-on experience with complex traits in field populations is an important component of the contemporary plant breeding curriculum (Gepts and Hancock, 2006). In addition, students need to be aware of the available genetic resources contained in the national collections.

The objective of this project was to introduce graduate students who are studying cotton plant breeding to the phenotypic diversity of cotton. This experience represented the best opportunity to sharpen the student's critical eye towards evaluating

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phenotypes as well as gain an appreciation for the abundance and utility of available genetic diversity within the cotton genus.

EXPERIENCE AT THE WINTER NURSERY

The U.S. National Plant Germplasm System (NPGS) contains nearly 10,000 accessions. Each year approximately 1/10 of the collection is increased at the Tecoman Cotton Winter Nursery, which is a joint program involving the United States Department of Agriculture (USDA),el Instituto Nacional de Investigaciones Forestales, Agricoles, y Pecunarias (INIFAP), the National Cotton Council, and Cotton Incorporated. The nursery is located at Tecoman, Mexico, in the state of Colima.

A group of seven cotton plant breeding students from Texas A&M University and Texas Tech University worked at the Tecoman Winter Nursery from 28 February 2009 to 04 March 2009. At the nursery, students characterized approximately 1,000 germplasm lines for nineteen morphological traits (Table 1). They also were expected to rogue any off-types. This experience allowed students to see living ancestors of modern upland cotton and witness procedures taken to preserve such exotic cotton races. A carryover nursery was used for seed increase of perennial cotton germplasm because of delayed maturity as well as photoperiodic flowering behavior. The nursery supervisor also showed the students a wild species, *G. aridum*, growing naturally in areas outside the nursery. Additionally, students had the opportunity to observe INIFAP germplasm collections of citrus (*Citrus*, L.), coconuts (*Cocos nucifera*, L.), sugarcane (*Saccharum* spp.), tamarindo (*Tamarindus indica*, L.), bananas (*Musa* spp.), and mangoes (*Mangifera indica*, L.).

Table 1. Morphological traits scored by students at the Tecoman Winter Nursery in March 2009.

height	**pollen color**
maturity	**petal color**
productivity	**petal spot**
habit	**stigma**
leaf hair	**lint color**
leaf color	**seed type**
leaf shape	**seed linter type**
gossypol glands	**bract type**
nectar glands	**fruiting habit**
green boll shape	

LEARNING OUTCOMES

This experience resulted in three primary benefits for students. First, it allowed them to observe several cotton phenotypes that are infrequently represented in cotton breeding programs. Examples of novel traits that were observed included frego bracts, brown and green fiber, nectariless fruiting structures and leaves, kidney shaped seed, leaking gossypol glands, and complete and partial glandless phenotypes. Each of these characteristics provided 'teaching moments' so students could understand the value of these traits and the milestones they represented in cotton breeding.

Secondly it permitted students to gain insight into possible germplasm lines that could be of value to their own existing or future research projects. The descriptors used for cotton in the Germplasm Resources Information Network (GRIN) are better understood now that these students are contributors. Some students eliminated some breeding lines while other students added germplasm to their dissertation projects because of what they observed during this program. For example, one line of *G. herbaceum* , 'Dezi Khaki' (PI 630027) and two lines of *G. aboreum* ,'Western Bani' (PI 629870) and 'White Kappas' (PI 616480) were eliminated because of poor productivity and late maturity. In another project, two *G. hirsutum* lines collected from Africa, '448' (PI 607201) and 'OR 25' (PI 607194) were included as parental material based on productivity and fiber quality. Hopefully as these students transition into careers as plant breeders, they will be more likely to make use of germplasm within NPGS because of this program. Various reports suggest that commercial cotton germplasm has a narrow genetic base and that diversity is necessary to break yield barriers and meet demands for high fiber quality (Esbroeck et al. 1999). Also, additional uses for cotton such as oilseed products are enhanced with diverse germplasm (Hague et al. 2008). Campbell et al. (2010) provided a detailed account of the current status of the global cotton resources and explained why some of the most unique germplasm is threatened with extinction. Students who have seen the material growing should have a better understanding of the potential of exotic germplasm and more directly appreciate why such threats of extinction are dangerous to the viability of the cotton industry.

Finally, the program immersed students into a foreign culture. They interacted with local employees, witnessed indigenous farming practices of Mexico, and were exposed to some of the challenges of international seed increases. This international experience contributed to their professional development on many levels and illuminated the fact that international resources are often needed for commercial and public breeding and germplasm conservation.

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