TEXAS A&M AGRILIFE RESEARCH | EXTENSION

TEXAS A&M UNIVERSITY

TEXAS A&M PLANT BREEDING BULLETIN

September 2015

Our Mission: **Educate and develop Plant Breeders worldwide**

Our Vision: **Alleviate hunger and poverty through genetic improvement of plants**

Amanda Hulse-Kemp recently received her PhD in Genetics under the direction of Dr. David Stelly in Soil & Crop Sciences. Amanda hails from Harrisonburg, VA and received her BS degree in Biology and Animal Biotechnology from the University of Nevada-Reno in 2010. She matriculated to Texas A&M and our Genetics Program in 2010, completing her PhD in Spring 2015. Amanda currently is a Postdoctoral Research Associate with Dr. Allen Van Deynze at UC-Davis.

Amanda had an outstanding career as a graduate student at Texas A&M. She received several awards and recognitions during her tenure with us, including several travel grant awards, the Texas A&M University Distinguished Graduate Student Award, the University's Ethel Ashworth-Tsutsui Memorial Award for Research, and the Dean's Outstanding Achievement Award for Graduate Research. Amanda is the senior author on four refereed publications and associate author on another five. She also has 11 presentations at professional meetings. As one would expect from a graduate student with the above credentials, Amanda has been and continues to be a leader, serving through the officer rotation of the Genetics Graduate Student Association at Texas A&M, being a member of six professional societies, and serving as a manuscript reviewer for *Genome* and *PLoS One*.

Amanda's research focused on developing cotton DNA markers, multiple types of genome maps, transciptomic and genomic sequence data, and integrating them into platforms that serve the needs of multiple communities, including genome sequencing, germplasm characterization, introgression, genetic dissection and applied breeding. She was a major contributor to the development of an international "SNP Chip" that was spearheaded by

Dr. Stelly's lab. The chip is already being used globally for associating SNPs with phenotypes of value in upland cotton breeding programs. Our congratulations to Amanda on a job well done. Amanda's dissertation abstract is below.

Dissertation Title - DEVELOPMENT OF GENOMIC MARKERS AND MAPPING TOOLS FOR ASSEMBLING THE ALLOTETRAPLOID *GOSSYPIUM HIRSUTUM* L. DRAFT GENOME SEQUENCE

Abstract - Cotton (*Gossypium spp.*) is the largest producer of natural textile fibers. Most worldwide and domestic cotton fiber production is based on cultivars of *G. hirsutum* L., an allotetraploid. Genetic improvement of cotton remains constrained by alarmingly low levels of genetic diversity, inadequate genomic tools for genetic analysis and manipulation, and the difficulty of effectively harnessing the vastly greater genetic diversity harbored by other *Gossypium* species. Development of large numbers of single nucleotide polymorphisms (SNPs) for use in intraspecific and interspecific populations will allow for cotton germplasm diversity characterization, high-throughput genotyping, marker-assisted breeding, germplasm introgression of advantageous traits from wild species, and high-density genetic mapping. My research has been focused on utilizing next generation sequencing data for intraspecific and interspecific SNP marker development, validation, and creation of high-throughput genotyping methods to advance cotton research.

I used transcriptome sequencing to develop and map the first gene-associated SNPs for five species, *G. barbadense* (Pima cotton), *G. tomentosum*, *G. mustelinum*, *G. armourianum*, and *G. longicalyx*. A total of 62,832 non-redundant SNPs were developed. These can be utilized for interspecific germplasm introgression into cultivated *G. hirsutum*, as well as for subsequent genetic analysis and manipulation. To create SNP-based resources for integrated physical mapping, I used BAC-end sequences (BESs) and resequencing data for 12 *G. hirsutum* lines, a Pima line and *G. longicalyx* to derive 132,262 intraspecific and 693,769 interspecific SNPs located in BESs. These SNP data sets were used to help build the first high-throughput genotyping array for cotton, the CottonSNP63K, which now provides a standardized platform for global cotton research. I applied the array to two F_2 populations and produced the first two high-density SNP maps for cotton, one intraspecific and one interspecific. By resequencing two interspecific F_1 hypo-aneuploids, I also demonstrated that the chromosome-wide changes in SNP genotypes enable highly effective mass-localization of BACs to individual cotton chromosomes. These efforts provide additional validation and placement methods that can be directly integrated

with the physical map being constructed for *G. hirsutum* and enable the production of a high-quality draft genome sequence for cultivated cotton.

Distance Plant Breeding Program and Continuing Education courses available for Fall 2015. Courses for Spring 2016 will be listed in the October Plant Breeding Bulletin.

Introduction to Plant Breeding Fundamentals – Cost $679.65

August 31- December 18, 2015

Introduction to the field of plant breeding for students without a plant breeding background. Includes common plant breeding terminology and introduction of concepts. Genetic improvement of crops by hybridization and selection; special breeding methods and techniques applicable to naturally self-pollinated, cross-pollinated and asexually reproduced plants.

Basic Plant Breeding - Full Course (3 Units) - Cost - $679.65

August 31- December 18, 2015

Basic Plant Breeding can be taken as an entire course (all three units) or each unit can be taken individually. For participants in our Professional Certificate in Plant Breeding and Genetics, completion of all three units is required.

Unit 1 - Introduction to Basic Plant Breeding *Cost - $226.55*
August 31 – October 2, 2015
Introduction to Basic Plant Breeding provides a review of plant reproduction, genetic variation, gene banks, germplasm preservation, gene segregation, the power of selection and its role in plant breeding, and an introduction to intellectual property and its role in the life of a plant breeder. This unit is designed to prepare the participant to explore the genetics and methodologies employed by plant breeders of self and cross pollinated crop species in units two and three of Basic Plant Breeding.

Unit 2 - Breeding Self Pollinated Crops *Cost - $226.55*
October 5 – November 5, 2015
The frequency of any specific heterozygous locus will be reduced by 50% for every generation of selfing, resulting in a mixture of homozygous lines within any natural population. Phenotypic selection within heterozygous generations will lead to homozygous or near homozygous germplasm lines or cultivars under self-pollination. This unit is designed to communicate plant breeding methodologies that take advantage of the genetic consequences of natural or forced self-pollination in agronomic crops. Topics will include: [1] the basics of segregation, [2] breeding methodologies, [3] the grain sorghum conversion program-an example of backcrossing in a different direction, [4] review of a commercial soybean cultivar development program, and [5] a review of the types of genetic releases from Texas A&M AgriLife Research.

Unit 3 - Breeding Cross Pollinated Crops *Cost - $226.55*
November 9 – December 18, 2015
Topics covered include: quantitative genetics and plant breeding, effects of selection on Hardy Weinberg Equilibrium, mating designs with cross pollinated crops, breeding methods for cross pollinated crops, deviations from Mendelian ratios, genetic male sterility and hybrid seed production, seed certification and types of release.

Recommended textbooks are “Breeding Field Crops” by J.M. Poehlman and D.A. Sleper, and “Principles of Cultivar Development” by W.F. Fehr. A final exam will allow the participant to assess their grasp of topics

covered. Participants in the Plant Breeding and Genetic Certificate Program must score 70% on the final exam for each unit.

This is a "self-paced" course and is available for viewing for a limited time. Time commitment is individual student driven. Few outside assignments are made. Students should view each lecture, review all previous lectures and be prepared to discuss any issues that are unclear. Each unit has a printable note set and most units have a set of review questions that can be used as a tool to check your comprehension and grasp of unit concepts. Feel free to contact the instructor, Dr. Wayne Smith, by e-mail (cwsmith@tamu.edu) or phone (979-845-3450) with any questions you have or if you need additional information.

Advanced Plant Breeding - Full Course (3 Units) - Cost - $679.65
August 31- December 18, 2015

Expectations of genetic improvement for different plant breeding methods; relative efficiency for crops of different reproductive mechanisms; genetic variances, covariances and genotype-environment interaction components of variance used in planning selection procedures. Advanced Plant Breeding can be taken as an entire course (all three units) or each unit can be taken individually. For participants in our Professional Certificate in Plant Breeding and Genetics, completion of all three units is required.

Unit 1 - Advanced Genetic Principles in Plant Breeding
August 31 – October 2, 2015
Topics covered include: Hardy Weinberg, means and variances, covariances and heritability, mating designs, genetic diversity.
Cost - $226.55

Unit 2 - Selection: Theory and Practice in Advanced Plant Breeding
October 5 – November 5, 2015
Topics covered include: recurrent selection, inbred line selection and testcrossing, selection environments, indirect selection, multiple trait selection, QTL MAS, heterosis and hybrid prediction. Cost - $226.55

Unit 3 - Statistical Tools in Advanced Plant Breeding
November 9 – December 18, 2015
Topics covered include: statistical concepts review, expected mean squares and combined analysis, GxE interactions and stability analysis, polyploidy.
Cost - $226.55

Experimental Designs in Agronomic Research - Full Course (3 Units) - Cost - $679.65
August 31- December 18, 2015

Teaches fundamental principles and procedures of experimental designs in agricultural sciences. Emphasis includes factorial designs, predicting outputs, use of covariance, and balanced and unbalanced experimental designs as related to common agricultural research projects under field, greenhouse or growth chamber culture. Students will become familiarized with computer programming of common statistical software. Experimental Designs in Agronomic Research can be taken as an entire course (all three units) or each unit can be taken individually. For participants in our Professional Certificate in Plant Breeding and Genetics, completion of all three units is required.

Unit 1 - Factorial Experimental Designs in Agronomic Research
August 31 – October 2, 2015

Topics covered include: Fundamentals of agricultural research methodology and methodology, basic statistical concepts for testing of hypothesis, introduction to simple computer statistical software programs and applications, complete randomized design, randomized complete block design, and Latin square design.
Cost - $226.55

Unit 2 - Factorial and Unbalanced Designs in Agronomic Research
October 5 – November 5, 2015
Topics covered include: Split-plot and split-split plot designs, nested designs, variance analyses, interactions with years and locations, comparisions of paired and grouped mean, estimation of missing values, the general linear model, and planned incomplete block design.
Cost - $226.55

Unit 3 - Correlation, Regression, Covariance, and Biplot Analysis in Agronomic Research
November 9 – December 18, 2015
Topics covered include: Correlation, regression, path coefficient analysis, covariance analysis, nearest neighbor analysis, augmented designs and moving means and analysis, database management, biplot analyses.
Cost - $226.55

This is a "self-paced" course and is available for viewing for a limited time. Time commitment is individual student driven. Students should view each lecture, review all previous lectures and be prepared to discuss any issues that are unclear. Each unit has a printable note set and voiced over PowerPoint video lectures.

Soil Fertility - Full Course (3 Units) - Cost - $679.65
August 31- December 18, 2015

Chemical and biological reactions in soils that influence nutrient availability to plants; environmental aspects associated with nutrient availability and fertilization, especially for nitrogen (N) and phosphorus (P). Topic covered include: introduction and historical background; plant essential nutrients, soil plant relations, calculations in soil fertility, soil acidity, soil nitrogen, soil phosphorus, potassium, calcium, magnesium, sulfur and the micronutrient elements.

Topic 1 – Introduction and Historical Background
Major contributions to soil chemistry and fertility. Introduction to soils and climate of Texas.

Topic 2 – Plant Essential Nutrients, Soil-Plant Relations
Plant available forms of nutrients, functions of nutrients in plants, types of soils where deficiencies might be anticipated, relative quantities required by plants.

Topic 3 – Calculations in Soil Fertility
Chemical notations, mole on a weight basis, mole on a charge basis, equivalents, ppm, concentrations of solutions, lbs/acre, kg/ha, lbs/1000 ft2, etc.

Topic 4 – Soil Acidity
Measurement and causes, active and reserve acidity, effects on nutrient availability and chemical properties, influence on plant grown, correction of, exchangeable Al, Al hydroxyl polymers, effective CEC

Topic 5 – Soil Nitrogen
Reactions of N in soils, N cycle, N gains and losses, biological N2 fixations, factors influencing availability, mineralization-immobilization, nitrification, NO-3 movement and groundwater contamination, eutrophication, NH4+ fixation, NH3 volatilization, denitrification, nitrification inhibitors, production of N fertilizers, acidification from NH4+ fertilizers, selection of N source potential environmental effects

Topic 6 – Soil Phosphorus

Phosphorus cycle, low uptake efficiencies – reversion in acid and alkaline soils, solubility product constants of reversion precipitates, solubility diagrams, influence of soil pH on P availability, method of application, production of P fertilizers, potential environmental consequences, eutrophication

Topic 7 – Potassium, Calcium, Magnesium

Potassium cycle, available forms, soil reactions, K+ fixation, mineral sources, factors influencing plant availability, fertilizer sources

Topic 8 – Sulfur and the Micronutrient Elements

Reactions of S in soils, S cycle, sources of S fertilizers, anticipated crop responses, reactions influencing availability of micronutrients in soils, pH effect chelates, extent of micronutrient deficiencies, correction of deficiencies.

Other Academic and Continuing Education courses in plant breeding and related disciplines that will be available during other semesters include Host Plant Resistance; Crop Production; Selection Theory; Marker Assisted Selection; Genomic Analysis; Field Crop Diseases; Field Insects; Essential Nutrients in Crop Growth; and others. For more information visit https://scsdistance.tamu.edu/ or contact LeAnn Hague, Distance Education Coordinator in Soil and Crop Sciences at leann.hague@tamu.edu or (979)845-6148.

Distance Plant Breeding M.S. and Ph.D. degree programs at Texas A&M. Visit https://scsdistance.tamu.edu/plant-breeding-distance-education/ for details.

Please direct comments concerning this bulletin to Wayne Smith, cwsmith@tamu.edu or 979.845.3450.