TEXAS A&M AGRILIFE RESEARCH | EXTENSION

TEXAS A&M UNIVERSITY

TEXAS A&M PLANT BREEDING BULLETIN

May 2018

TEXAS A&M UNIVERSITY--EDUCATING AND DEVELOPING PLANT BREEDERS WORLDWIDE TO ALLEVIATE HUNGER AND POVERTY THROUGH GENETIC IMPROVEMENT OF PLANTS

The Department of Soil and Crop Sciences graduated one distance plant breeding student in Spring 2018 along with three on-campus graduate students. Below are abstracts and other information about these outstanding future plant breeders.

Fabian Echeverria-Beirute received his Ph.D. this month in plant breeding under direction of Dr. Seth Murray, corn breeder, and Dr. Patricia Klein, sorghum genomics. Prior to starting his Ph.D. in 2015, Fabian worked for almost eight years on coffee breeding and phytopathology for the Center of Investigation in Coffee of the Institute of Coffee of Costa Rica and as a plant breeding professor at Technological Institute of Costa Rica. His research at Texas A&M University focused on evaluating the gene expression of coffee plants under physiological stress caused by *Hemileia vastatrix* (leaf rust) and crop load and their impact on cup quality. He has accepted a professorial position at the Instituto Tecnologico de Costa Rica.

Dissertation title: Coffee transcriptomics and cup quality under stress.

Abstract: The coffee (*Coffea arabica* L.) plant is known for its special beverage. However, genotype (G), environment (E), management (M), coupled with biotic and abiotic stresses, the post-harvest processing, and roasting can change sensory, chemistry, and gene expression profiles. We investigated how yield (abiotic stress) and coffee leaf rust disease (CLR) (*Hemileia vastatrix* Berk. et Br.) management affected the cup quality and gene expression in two susceptible cultivars. The cup quality

was qualitatively and quantitatively measured by two sensory analyses (SCA and WCR sensory lexicon), revealing that 10 of 70 attributes were significantly affected by our treatments. Parallel analysis of the volatile fraction using SPME-GC/MS, revealed that 18 of 154 chemical volatile compounds changed their abundance according to the treatments. Remarkably, acetaminophen was found for the first time in roasted coffee and in higher concentrations under stress. Further study of the coffee green bean's volatile's, revealed that the compounds related to the fatty acids were increased under biotic stress. Using immature and mature fruits, we were able to explore the transcriptome of both cultivars under stress and found an active oxidation process occurring in the cell walls. A total of 471 gene ontology (GO) functional terms organized in 19 categories were associated with differentially expressed genes (DEGs) according to the treatments, cultivars, and maturity stages. Sixteen candidate genes for later validation were reported. As part of the research, we also explored the leaf transcriptome under stress. We found a differential response of the cultivars under biotic stress revealed by 88 DEGs mediating qualitative or hypersensitive response (HR) and quantitative or systemic acquired resistance (SAR). Both differential-defense responses are hypothesized as the cause of changes in cup quality and tolerance to CLR stress. This study is a first step in understanding the complexity of the physiological, metabolic, and molecular changes in coffee production, which will be useful for the improvement of coffee cultivars.

Nicholas Boerman was awarded his M.S. in Plant Breeding under direction of Dr. Bill Rooney, sorghum breeder. His work centered around evaluating chemical male gametocides in sorghum under field conditions. Nicholas currently is a Ph.D. student in Dr. Tom Lubberstat's corn breeding program at Iowa State University where he works in the area of doubled haploid breeding systems in corn.

Thesis title: Efficacy of the chemical Trifluoromethanesulfonamide as a male gametocide in field grown sorghum.

Abstract: *Sorghum bicolor* (L. Moench) is a cereal grain and forage crop that is grown from tropical to temperate regions of the world. Sorghum has a complete flower resulting in self-pollination as the primary form of reproduction, but it is grown commercially as a hybrid. Consequently, methods of cross pollination for both breeding and hybrid seed production are important. In sorghum breeding, current methods of cross-pollination are effective, but they have limitations in regard to complete and temporal male sterility. Given new breeding approaches such as doubled haploids, temporal male sterility is essential to its implementation. Further, temporal male sterility would be useful in testing new seed parent lines prior to an investment in sterilization of the line in the cytoplasmic male sterility system. The objective of this study was to evaluate the efficacy of trifluoromethanesulfonamide (TFMSA) as a sorghum male gametocide under field conditions. In two environments, foliar applications of TFMSA were made to three male-fertile parental sorghum lines via pipette and sprayer in dosages ranging from 5 mg to 30 mg/plant. Repeated applications over time for the 10 mg and 15 mg dosage rates were conducted on a subset of individuals. Results indicate that once a minimum dosage threshold (between 10-15 mg) was reached, panicles were male sterile. Additional dosages and number of applications had little overall effect on male sterility and both hand- and sprayer applications of TFMSA had similar male sterility induction capability. From these studies, it appears TFMSA can be used as an effective chemical male gametocide on sorghum under field conditions.

Wardah Mustahsan completed a M.S. study aimed at understanding heat tolerance in rice by profiling the rice whole genome transcriptome. Her committee chair was Dr. Michel Thomson. Wardah currently is pursuing her Ph.D. degree in plant breeding at Kansas State University.

Thesis title: Whole genome transcriptome profiling for heat tolerance and genome-wide association for exotic traits in rice (*Oryza sativa* L.).

Abstract: High night temperature (HNT) has strong negative effects on rice plant growth and development. HNT also impacts many physiological characteristics of rice which affect the grain quality of rice grown around the world. One potential mechanism of HNT damage is from the induction of ethylene-triggered reactive oxygen species that can lead to increased membrane damage and negatively impact yield and grain quality. In this study, the changes in physiological behavior due to the interaction between HNT and the ethylene-inhibitor 1-MCP was investigated. Furthermore, genome-wide expression analysis under HNT was performed using RNA-Seq to gain insights into the gene functions underlying tolerance to HNT. Plants were grown under ambient night temperature (ANT) (25 °C) or HNT (30 °C) with or without 1-MCP treatment. RNA extraction was performed on two phenotype-contrasting rice cultivars (Antonio and Colorado) from which in-depth RNA-Seq analysis was used to identify differentially expressed genes involved in heat tolerance in these varieties. High temperature environments are fairly innocuous for some exotic rice varieties; however, these genetic donors for heat tolerance often have various undesirable traits, including red pericarp, black hulls, and awns. To improve the efficiency of using these exotic accessions in modern rice breeding programs, it would be beneficial to develop improved genetic donors by eliminating these exotic traits and thus preventing negative linkage drag when using these donors as parents in a crossing program. Recent advances in CRISPR/Cas9 genome editing can now enable the rapid knock-out of genes underlying negative traits in rice. To gain further insight in the

genetic loci controlling these traits, a genome-wide association study (GWAS) was performed on a diversity panel consisting of approximately 300 rice accessions. Traits of interest in this GWAS study included pericarp color, hull color, awn color, and awn length. The accessions were genotyped with an Illumina 7K rice SNP chip to identify genetic loci that control these traits. When combined with data on the chromosomal location of known major genes affecting exotic traits, these results can guide the development of improved HNT-tolerant genetic donors for future stress-tolerance breeding programs.

Evan Esau completed his M.S. non-thesis option (NTO) in our distance plant breeding program and graduated in May. Students in our NTO M.S. program are required to complete a scholarly activity that may be an internship, an exhaustive literature review, or, in Evan's case, a research project that is somewhat less rigorous than a thesis. Evan's scholarly activity was to research ways to improve the germination rates in the four berries marketed by Driscoll's. Evan is R&D Farm and Greenhouse Operations Manager at Driscoll's in Watsonville, CA and his mission in that role is to assist the breeders and other research scientists. Evan supervises cross pollinations, seedling production, farming of test plots, and assist with data collection. This company has expanded operations significantly since the 1990s and has grown from a local company at its beginnings to a having operations in 21 countries on six continents. With this expansion and the Driscoll's business model, Evan was interested in exploring ways to improve the dismal germination rate of the berries developed and sold by the company. Beginning germination rates were as low as 17% and Evan and his team significantly improved those rates through various mechanisms.

Congratulations to these outstanding young plant breeders. We are looking forward to following their careers and learning of their discoveries and developments. We feel fortunate to have been a part of their education and professional development.

Meetings of Interest

Meetings of Interest

National Association of Plant Breeders, NAPB will hold their annual meeting at the University of Guelph, Ontario, Canada August 7 – 10, 2018. More information will be available soon at https://www.plantbreeding.org.

American Society of Agronomy and the Crop Science Society of America's annual meeting will be in Baltimore, MD, November 4 – 7. More information at https://www.acsmeetings.org/.

Distance Plant Breeding at Texas A&M

Distance Plant Breeding at Texas A&M

Distance Plant Breeding Program and Continuing Education courses available for Summer & Fall 2018 (https://scsdistance.tamu.edu/available-courses)

Continuing Education

Available Courses

Summer Courses: May 21 – August 31, 2018

To fully participate in our continuing education courses, students should have:

- **High speed internet connection and updated browsers, including Internet Explorer and either Chrome of Firefox**
- **Common plug-ins (e.g. Adobe Reader, Flash Player, Virus Protection, Java, etc.)**
- **Speakers and Webcam with microphone**
- **Skype**
- **Ability to either scan or fax course documents to the instructor**

Summer 2018

Plant Breeding Fundamentals – Full Course (3 Units) – Cost $679.65
May 21 – August 31, 2018

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
May 21 – August 31, 2018

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
May 21 – June 22, 2018

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
June 25 – July 27, 2018

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
July 30 – August 31, 2018

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.

Fall Courses: August 27 – December 14, 2018

Fall 2018

Plant Breeding Fundamentals – Full Course (3 Units) – Cost $679.65

August 27 - December 14, 2018

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 27 - December 14, 2018

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 27 – September 28, 2018

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 1 – November 2, 2018

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 5 – December 14, 2018
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 27 - December 14, 2018

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 27 – September 28, 2018
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 1 – November 2, 2018
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 5 – December 14, 2018
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 27 - December 14, 2018

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 27 – September 28, 2018
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 1 – November 2, 2018
Topics covered include: Split-plot and split-split plot designs, nested designs, variance analyses, interactions with years and locations, comparisons 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 5 – December 14, 2018
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.

Intellectual Properties in the Plant Sciences - Full Course (3 Units) - Cost - $679.65
August 27 - December 14, 2018
This course introduces the major foci of intellectual property (IP) impacting plant sciences, including: 1) traditional vs. emerging knowledge economies, 2) governing U.S. statutes and international treaties, 3) forms of IP protection, and 4) IP asset identification, valuation, capture, and deployment towards an understanding of best practices for the development of effective IP strategies and management of IP portfolios.

Unit I - Introduction to Intellectual Property, International Treaties and Patents Cost - $226.55
August 27 – September 28, 2018
Unit I of the Intellectual Properties in the Plant Sciences Course. Topics covered include: IP Culture and the Knowledge Economy, Traditional Knowledge vs. Biopiracy, Sui generis Systems, International Treaties, Overview of Patentability, Utility Patents, and Plant Variety Patents.

Unit II - Intellectual Property Documentation Cost - $226.55
October 1 – November 2, 2018
Unit II of the Intellectual Properties in the Plant Sciences Course. Topics covered include: Trademarks, Copyrights, & Trade Secrets; USPTO; Inventorship, Ownership, Compensation, IP Training; Confidential Information; IP Audit; IP Value; Competitive Intelligence; Cyberspace – IP and IT Cooperation.

Unit III - Intellectual Property Transfer and Enforcement Cost - $226.55
November 5 – December 14, 2018

Unit III of the Intellectual Properties in the Plant Sciences Course. Topics covered include: Intellectual Property Transfer and Enforcement, IP Case Studies, IP Portfolio, IP Strategy and Leveraging IP Value.

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 Degrees in 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.