# TEXAS A&M PLANT BREEDING BULLETIN

November 2019

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

Our graduate students represented the plant breeding program well at the recent TriSocieties annual meeting in San Antonio, TX. Four of our students were recognized for their presentations and posters. Those students, their placement, and their abstracts are below. These are outstanding young folks who will make significant contributions to providing improved agricultural cultivars during their plant breeding careers. I hope that you'll join me in congratulating these and all of our graduate students for their accomplishments.

Alper Adak—PhD candidate with Seth Murray, Corn Breeding. First Place C-1 Crop Breeding and Genetics

Title: Identifying loci for delayed temperate flowering: Improving southern maize (*Zea mays* L.) for Midwestern seed production.

Abstract: Flowering time and underlying evolutionary aspects of the adaptation of maize (*Zea Mays* L.) towards temperate zones have been evaluated to a limited extent. Tropical and temperate maize lines can be discriminated based on adaptive characteristics. Southern U.S.
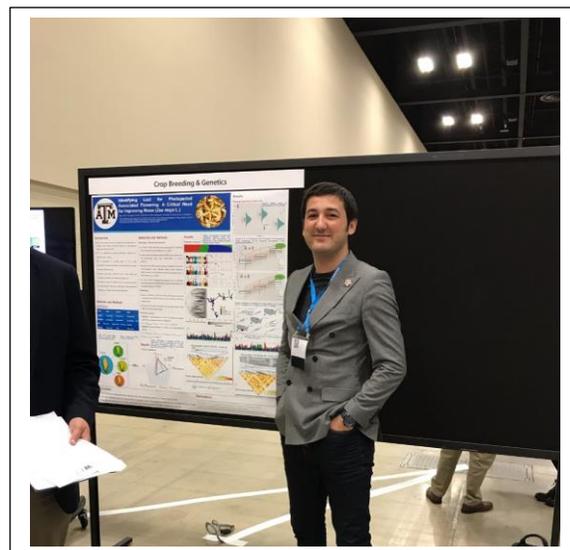
maize breeding programs are limited in their use of lines generated from tropical/exotic maize germplasm due to cryptic extended flowering time under longer days in Midwest seed production latitude (photoperiod or associated thermal times). Determining the loci affecting photoperiod associated flowering is useful for southern U.S. maize breeding programs to selectively eliminate photoperiod sensitive flowering out of advanced lines. Towards this, an elite late-flowering breeding line (Tx773) derived from an important lowland Bolivian maize breeding population was crossed with three Corn Belt adapted maize inbreds to construct a nested association mapping population (NAM) of 188 individuals evaluated on the first year (2018) and 327 individuals on the second year (2019). Of the ex-PVP lines, LH195 has a reversed response (early flowering in longer day locations), while LH82 and PB80 have an insensitive response. The NAM population was grown in Texas, Wisconsin and Iowa during two years (2018-2019) and flowering times (days to anthesis (DTA) and silking (DTS)) were recorded and converted to growing degree days (GDDs) to estimate multi-environment BLUPs (Best Linear Unbiased Predictions) used in GWAS. Overall, the NAM population flowered in Texas five and six days later than Wisconsin and Iowa, respectively. QTLs on chromosome 6 (position 115.45) and 3 (position 235.44) were found consistent between flowering times in Texas and occasionally in Iowa and Wisconsin. These underlying genes of these QTL are likely part of the phosphatidylethanolamine-binding protein (PEBP) genes family in maize. On the other hand, QTLs on chromosome 9 (position 144.19) and chromosome 10 (position 145.40 and 145.65) were also consistently found for flowering times in Iowa and Wisconsin but not in Texas.

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aniel Crozier—MS candidate with William Rooney, Sorghum Breeding.

Third Place C-1 Crop Breeding and Genetics

Title: Predicting heterosis in grain sorghum [*Sorghum bicolor* (L.) Moench] hybrids for multiple agronomic traits using genetic similarity derived from genome-wide SNP data.
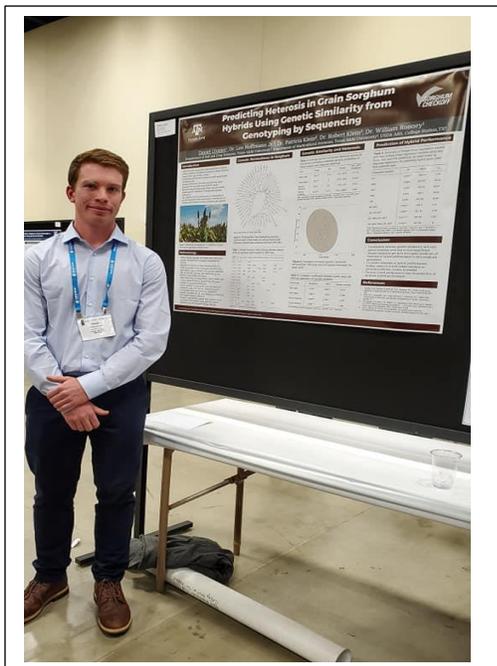
Abstract: Rates of genetic gain in US grain sorghum [*Sorghum bicolor* (L.) Moench] hybrids have been increasing over the past 50 years but at a slower rate than other US field crops. It is commonly hypothesized that genetic similarity is essential to maximize heterosis in a hybrid crop. As such, the purpose of this study was to assess genetic similarity within a set of elite sorghum inbreds and determine if heterosis was correlated with genetic similarity. The hypothesis of this work is, heterosis is greatest when the parents are more genetically distant. Twenty-four sorghum inbred parental lines, fifteen female parents (A/B lines) and nine male parents (R lines), were crossed in a partial half diallel design to produce 52 hybrids. The inbred lines, hybrids, and a commercial check were grown in a combined test across multiple environments in a randomized complete block design wherein all entries were evaluated for yield, height, maturity, and exertion. Genetic similarity among the inbred lines, based on single nucleotide polymorphisms, ranged from .59 to .79. For all traits, significant mid parent heterosis

was observed however, correlations between heterosis and genetic similarity were low and not significant for any trait. The results indicate that among elite material within a breeding program, genetic similarity based on random SNP assay is not a good predictor of heterosis or hybrid performance.

J ales Fonseca—PhD candidate with William Rooney, Sorghum Breeding.

Second place poster C-1 Crop Breeding and Genetics

Title: Agronomic evaluation of elite hybrid combinations between U.S. public sorghum breeding programs.

Abstract: In terms of public sorghum breeding, the programs at Texas A&M and Kansas State each have a long history of continual improvement. As distinct programs focused in different production environments, selection in each likely results in lines with significant variation. Given this diversity, it is possible that hybrid combinations produced between these two groups might be more productive across a wider range of environments. To assess the productivity of these hybrids, a design II mating scheme composed by ten pollinator and ten seed parents (5 of each from both programs) were hybridized to evaluate mean performance of different groups and the variation both across all parents and within distinct groups. Hybrids were evaluated in seven environments across both states using a randomized complete block design. Mega-environment analyses separated the tested environments into two logical production environments. Within these environments, results indicated that some of the best performing hybrids resulted from cross program combination. Further, variation within groups indicated that significantly more variation in the males of both programs than in the seed parents. Results from this

experiment provide a better understanding of additive and dominance genetic variance across public sorghum breeding programs.
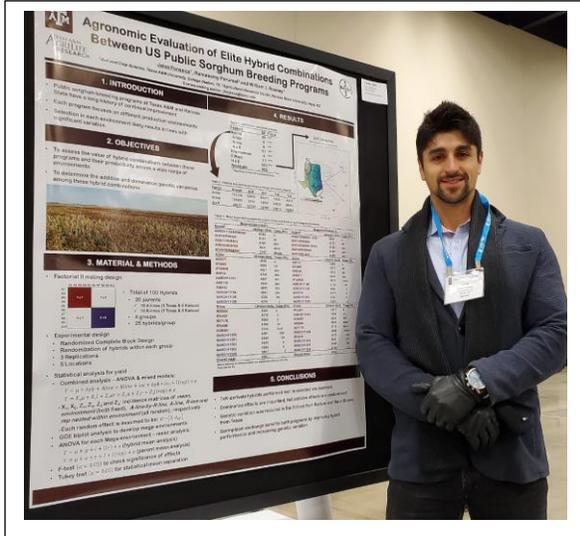
Jales Fonesca

Holly Lane

Holly Lane—MS candidate with Seth Murray, Corn Breeding. Second place C-1 crop breeding and genetics oral/poster

Title: Phenomic prediction of maize grain yield using near-infrared reflectance spectroscopy

Abstract: High-throughput phenotyping technologies, which can generate large volumes of data at low costs, may be used to indirectly predict yield. Here, we explore this concept, using high-throughput phenotype information from Fourier Transformed near-infrared reflectance spectroscopy (NIRS) of harvested kernels to predict parental grain yield in maize (Zea mays L.). A dataset of 2,563 kernel samples, representing over 300 pedigrees, from diversity panel hybrid testcrosses were scanned using NIRS, in the range of 4,000-10,000 cm-1. Corresponding grain yield for each sample was used to train predictive models using three types of statistical learning: (a) partial

least square regression (PLSR), (b) NIRS best linear unbiased predictor (NIRS BLUP) and (c) functional regression. Our results found that the spectral data were a useful tool to predict maize grain yield, and showed promising results for evaluating genetically independent breeding populations. All model types were successful, but the functional regression followed by the PLSR model resulted in the best phenotypic predictions. Pearson's correlations exceeded 0.7 in many cases, both within random cross validation and on independent breeding trials. Across the breeding trials, the functional regression models performed best. High correlations between predicted and observed values, even in cases where yield estimates were not accurate, demonstrated value for grain NIRS in ranking varieties yield relative to one another. More research in this area will provide better understanding how NIRS and other phenomic technology can be used in predicting phenotypes in breeding programs and identifying biological phenomenon underlying these correlated relationships.

Publications by Soil & Crop Sciences Plant Breeding Faculty

Third Quarter, 2019

Cason & Rooney: J.M. Cason, C.E. Simpson, W. L. Rooney, and J. A. Brady. 2019. First Report of Successful Hybridization Between *Arachis vallsii* and *Arachis dardani. Agrosystems, Geosciences & Environment* 2:190013.

Chandra: Manuel Chavarria, Benjamin Wherley, James Thomas, Ambika Chandra, and Paul Raymer. 2019. Salinity Tolerance and Recovery Attributes of Warm-season Turfgrass Cultivars. *American Society for Horticultural Science 54:9.*

Ibrahim & Rudd: Bin Peng, Xuejun Dong, Qingwu Xue, Clark B. Neely, Thomas Marek, Amir M. H. Ibrahim, Guorong Zhang, Daniel I. Leskovar, Jackie C. Rudd. 2019. Root morphological traits of winter wheat under contrasting environments. *Journal of Agronomy and Crop Science* https://doi.org/10.1111/jac.12360

Ibrahim & Rudd: Jackie C. Rudd, Ravindra N. Devkota, Amir M. Ibrahim, Jason A. Baker, Shannon Baker, Russell Sutton, Bryan Simoneaux, Geraldine Opena, Daniel Hathcoat, Joseph M. Awika, Lloyd R. Nelson, Shuyu Liu, Qingwu Xue, Brent Bean, Clark B. Neely, Robert W. Duncan, Brad W. Seabourn, Robert L Bowden, Yue Jin, Ming-Shun Chen, and Robert A. Graybosch. 2019. 'TAM 204' Wheat, Adapted to Grazing, Grain, and Graze-out Production Systems in the Southern High Plains. *Journal of Plant Registrations* doi:10.3198/jpr2018.12.0080crc.

Murray: Steven L. Anderson II, Seth C. Murray, Lonesome Malabo, Colby Ratcliff, Sorin Popescu, Dale Cope, Anjin Chang, Jinha Jung, and J. Alex Thomasson. 2019. Prediction of Maize Grain Yield before Maturity Using Improved Temporal Height Estimates of Unmanned Aerial Systems. *The Plant Phenome Journal* 2:190004.

Murray: Robert J. Arnold, Alejandra Ochoa, Chris R. Kerth, Rhonda K. Miller, and Seth C. Murray. 2019. Assessing the impact of corn variety and Texas terrior on flavor and alcohol yield in new-make bourbon whiskey. *PLOS* https://doi.org/10.1371/journal.pone.0220787

Rathore: Steffen Hagenbucher, Michael Eisenring, Michael Meissle, Keerti S. Rathore and Jörg Romeis. 2019. Constitutive and induced insect resistance in RNAi-mediated ultra-low gossypol cottonseed cotton. *BMC Plant Biology* 19:322.

Rathore: Yves Carrière, Alex J. Yelich, Ben A. Begain, Virginia S. Harpold, Gopalan C. Unnithan, Jae H. Kim, Lolita G. Mathew, Graham P. Head, Keerti S. Rathore, Jeffrey A. Fabrick, and Briuce E. Tabashnik. 2019. Gossypol in cottonseed increases the fitness cost of resistance to Bt cotton in pink bollworm. *Crop Protection* https://doi.org/10.1016/j.cropro.2019.104914

Rooney: Ulises Aranda-Lara Alfonso López-Benítez, Antonio Flores-Naveda, Víctor M. Zamora-Villa, Luis A. Rodríguez-del-Bosque, W.L. Rooney. 2019. Susceptibility of Sorghum Hybrids to the Sugarcane Aphid, *Melanaphis sacchari*, in Central Mexico. *Southwestern Entomologist* 44(3): 771-774.

Septiningsih: Yoichiro Kato, Bertrand C. Y. Collard, Endang M. Septiningsih, and Abdelbagi M. Ismail. 2019. Increasing flood tolerance in rice: combining tolerance of submergence and of stagnant flooding. *Annals of Botany* mcz118, https://doi.org/10.1093/aob/mcz118

Septiningsih: Sharmistha Ghosal, Carlos Casal Jr., Fergie Ann Quilloy, Endang M. Septiningsih, Merlyn S. Mendioro, and Shalabh Dixit. 2019. Deciphering Genetics Underlying Stable Anaerobic Germination in Rice: Phenotyping, QTL Identification and Interaction Analysis. *Rice* 12:50.

Meetings of

Interest

National Association of Plant Breeders, NAPB will hold their annual meeting at the University of Nebraska, August 16-19, 2020. More information will be available soon at https://www.plantbreeding.org.

Texas A&M Plant Breeding Symposium. Foresight 2020: Tuning Crops for Future Needs. A Corteva Agriscience Plant Sciences Symposia Series Event. Thursday, February 20, 2020 on the campus of Texas A&M University-College Station, TX. http://plantbreedingsymposium.com/

Distance Plant Breeding at Texas A&M Graduate Degrees

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.

Distance Plant Breeding at Texas A&M – Continuing Education

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.