ALARC Highlights

Summer 2022

USDA-Agricultural Research Service
Arid-Land Agricultural Research Center
Maricopa, Arizona

ALARC's mission is to develop sustainable agricultural systems, protect natural resources, and support rural communities in arid and semi-arid regions through interdisciplinary research.

IN THIS ISSUE

ALARC Updates

Re-opening

After more than a two year period of maximum telework and limited occupancy of the ALARC facility, USDA initiated a full re-opening on March 28 with everyone expected to be back to the Center by May 28, 2022. Like many businesses, we have learned how to meet our mission to agriculture and the public with a variety of flexibilities such as telework, remote work and limited on-site work. As of now, most of our scientific staff have returned to the workplace on a full-time basis with access to telework as needed. Several of our administrative and support personnel have been designated and taken advantage of the flexibility of remote work, so that they no longer come to the facility to do their jobs. It is a new paradigm, and we are all adjusting, but the bottom line is that we continue to deliver science-based solutions to regional, national and global agricultural challenges for arid-land production systems. Our vision for sustaining agriculture in a water-limited environment has never been more critical as we find ways to adapt to the unprecedented constraints to our precious water resources. We hope that this issue of ALARC Highlights will provide you an enjoyable update on how we are meeting this challenge through the efforts of our exceptional staff.

Budget Update

ALARC has received a permanent funding increase to support monitoring and control efforts to contain a recent outbreak of the cotton seed bug, a serious pest found throughout much of the world. First appearing in 2019, infestations have been detected at a few locations in southern California but still far removed from cotton growing areas. The funding will allow ALARC to hire an additional scientist in the Pest Management and Biocontrol Unit. Efforts are underway to establish research collaborations in California to study the pest *in situ.* Funding at other ARS locations will support pheromone lure development, for monitoring and trapping, and work on genomics and genetics. The President's Fiscal Year 2023 budgets has targeted ALARC for substantial funding increases ($6.5M) in bioenergy feedstocks, climate change related to crop production and pest management, and the development of a Biotech Innovation Center in the Pest Management Unit. The reality of funding will depend on congressional appropriations.

The cotton seed bug, *Oxycarenus hyalinipennis*, is native to Africa and found globally. It was recently detected in California and is the subject of new funding and research at ALARC.

Featured Accomplishment

Is pink bollworm really "gone-baby-gone"?

Although the pink bollworm (*Pectinophora gossypiella*) (PBW) remains one of the most invasive and destructive pests of cotton globally, it is no longer found in the cotton growing areas of the U.S. This is due to the successful implementation and execution of the Binational Pink Bollworm Eradication Program, which began in 2002 and culminated in the official announcement on October 19, 2018, by former U.S. Secretary of Agriculture Sonny Perdue that PBW was eradicated from all cotton growing areas in the continental United States. This invasive pest had cost U.S. producers tens of millions of dollars annually in control efforts and yield losses for decades.

PBW control was revolutionized in 1996 by the introduction of transgenic cotton engineered to produce insecticidal proteins from the bacterium *Bacillus thuringiensis* (Bt). Bt proteins kill some major insect pests yet are not toxic to most non-target organisms, including people and most beneficial insects. In the western U.S. and northern Mexico, transgenic Bt cotton not only reduced the damage associated with PBW, but also eliminated grower reliance on insecticidal sprays, thereby avoiding environmental and safety hazards associated with the use of these chemicals.

Grefenstette et al. 2009
http://www.aphis.usda.gov/plant_health/plant_pest_info/cotton_pests/downloads/pbw-erad-plan2-09.pdf

Figure 1. The Binational Pink Bollworm Eradication Program successfully eliminated this invasive pest from the cotton growing areas of the continental USA. Together with Bt transgenic cotton, the release of sterile males, and other practices (planting non-Bt refuges, mandatory plow down dates, and careful use of insecticides), these integrated pest management strategies effectively controlled and eliminated the pest in the southwestern USA 100 yeas after it first became established.

Although Bt cotton kills nearly 100% of susceptible pink bollworm larvae, this pest rapidly evolved resistance to Bt proteins in laboratory selection experiments in Arizona as well as in Bt cotton fields in parts of Asia. Specifically, India has millions of small-scale (mainly subsistence) farmers that grow cotton. These growers have access to Bt cotton, with single-toxin Cry1Ac Bt cotton first planted in 2002 and the dual-toxin Cry1Ac + Cry2Ab cotton pyramid shortly after in 2006. Although resistance management steps were mandated (e.g., use of non-Bt refuges) by the government and seed companies, many reports suggest that refuges were not implemented. In the absence of other delaying strategies, field-evolved practical resistance to Cry1Ac Bt cotton was detected after just 6 years and to the dual-toxin pyramid after 8 years. Today, pink bollworm remains a major pest of cotton in India and populations resistant to Bt cotton are widespread.

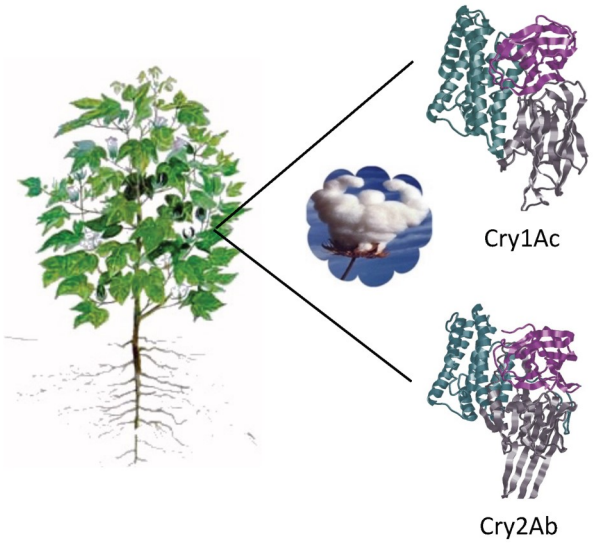


Figure 2. Transgenic Bt crops are genetically engineers to produce insecticidal proteins from the bacterium *Bacillus thuringiensis*, which target specific insect pests (such as PBW) yet are safe to people and most other organisms. Bt cotton used to eradicate PBW in the USA initially produced only a single Bt protein (Cry1Ac) but "pyramided" Bt cotton that produced two or more toxins that kill the same pest (e.g. Cry1Ac + Cry2Ab) were later used to help delay the evolution of resistance.

Our published research shows that the molecular mechanisms of resistance to both Cry1Ac and Cry2Ab Bt toxins are similar in pink bollworm from both the U.S. and India. That is, both lab-selected pink bollworm from Arizona and Cry1Ac- and Cry2Ab-resistant pink bollworm collected from cotton fields in India have mutations in the same respective receptor genes that prevent the toxin from being taken up from the gut. For Cry1Ac resistance, five mutated forms of a cadherin gene were identified after screening thousands of individuals from Arizona pink bollworm strains. In contrast, only seven pink bollworm collected from cotton fields in India needed to be sampled in order to find eight mutant cadherin genes. Resistance to the Cry2Ab toxin was found to be due to mutations in the same ATP-binding cassette A2 (*PgABCA2*) gene in strains from Arizona and resistant individuals from India. In fact, the most common mutation that was found in India was previously identified in a Cry2Ab-resistant strain from Arizona.

Unfortunately, the possibility of a pink bollworm reinfestation of the southwestern U.S. and northern Mexico remains a threat. This pest still occurs in more than 100 nations worldwide, including nearby regions where cotton is grown, such as the Caribbean and South America. Furthermore, the pink bollworm in Asia have become resistant to the same Bt toxins used in the U.S. and across the globe. With no new traits currently commercially available that can effectively kill these resistant pests, it is critical that we continue to characterize molecular markers for resistance and remain diligent in monitoring resistance in global populations of pink bollworm to prevent its reestablishment in the U.S.

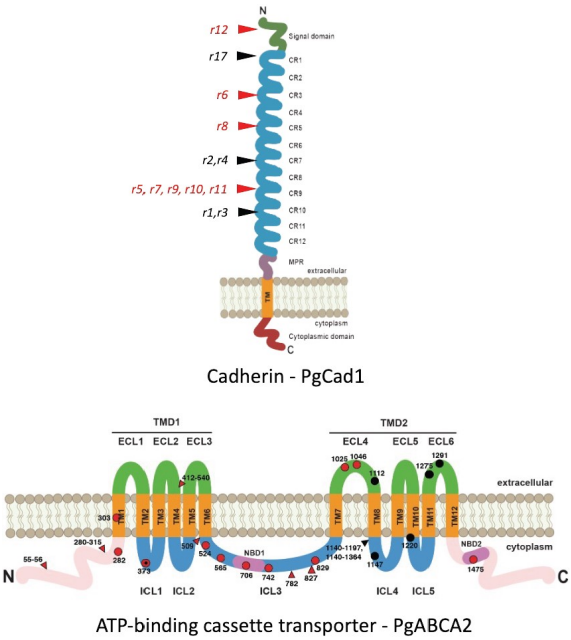


Figure 3. Mutations in the genes encoding receptors of Bt toxins that are expressed in the gut are found in strains from both Arizona (black) and India (Red). In pink bollworm, cadherin (PgCad1) is a receptor of the Cry1Ac toxin and ATP-binding cassette transporter A2 (PgABCA2) is a functional receptor of the Cry2Ab toxin.

Suggested Reading

Tabashnik, B.E., Liesner, L.R., Ellsworth, P.C., Unnithan, G.C., Fabrick, J.A., Naranjo, S.E., Li, X., Dennehy, T.J., Antilla, L., Staten, R.T., and Carrière, Y. 2021. Transgenic cotton and sterile insect releases synergize eradication of pink bollworm a century after it invaded the United States. Proc. Natl. Acad. Sci. USA 118 (1): e2019115118. (PDF)

Fabrick, J.A., LeRoy, D.M., Unnithan, G.C. Yelich, A.J. Carrière, Y., Li, X., and Tabashnik, B.E. 2020. Shared and independent genetic basis of resistance to Bt toxin Cry2Ab in two strains of pink bollworm. Sci. Rep. 10: 7988. (PDF)

Mathew, L.G., Ponnuraj, J., Mallappa, B., Chowdary, L.R., Zhang, J., Tay, W.T., Walsh, T.K., Gordon, K.H.J., Heckel, D.G., Downes, S., Carrière, Y., Li, X., Tabashnik, B.E., Fabrick, J.A. 2018. ABC transporter mis-splicing associated with resistance to Bt toxin Cry2Ab in laboratory- and field-selected pink bollworm. Sci. Rep. 8: 3531. (PDF)

Fabrick, J.A., Unnithan, G.C., Yelich, A.J., DeGain, B., Masson, L., Zhang, J., Carrière, Y. and Tabashnik, B.E. 2015. Multi-toxin resistance enables pink bollworm survival on pyramided Bt cotton. Sci. Rep. 5: 16554. (PDF)

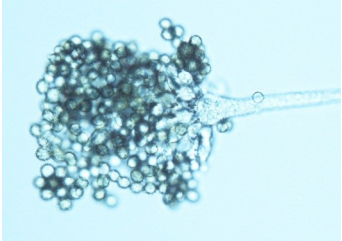
Contact: jeff.fabrick@usda.gov

Other Accomplishments

Development of a multi-strain aflatoxin biocontrol product for Texas corn. Aflatoxin contamination of corn grain causes significant economic losses. Two aflatoxin biocontrol products are commercially available in the United States, but neither one was developed specifically for corn, and both are based on a single non-aflatoxigenic strain. At the request of the Texas Corn Producers, ARS researchers in Maricopa, Arizona identified four biocontrol strains that are well adapted to corn in different regions of Texas, and these were developed into a formulated biocontrol product. Field studies demonstrated the efficacy and safety of the product, which is now under the final stages of review by the Environmental Protection Agency for full registration. This will be the third commercial aflatoxin biocontrol product registered for use in the United States, and it will provide Texas corn growers with an additional tool to mitigate crop aflatoxin contamination. Contact: Hillary.Mehl@usda.gov and Ken.Callicott@usda.gov

Development of an aflatoxin biocontrol product for Pakistan. Aflatoxin biocontrol is one of the most effective approaches to minimize the incidence and severity of crop contamination but developing countries do not always have access to the technology. In collaboration with industry and government partners in both the United States and Pakistan, ARS researchers from Maricopa, Arizona, developed an aflatoxin biocontrol product based on a non-aflatoxigenic strain of *Aspergillus flavus* that is endemic to the corn production region of Pakistan, and provided guidance for the commercial manufacturing and distribution of the product in Pakistan. This is the first aflatoxin biocontrol product to be developed for South Asia, and its availability in the region will improve food/feed safety and the ability of Pakistan to meet international trade standards. Contact: Hillary.Mehl@usda.gov

AflaSat: A database of global genetic diversity of *Aspergillus flavus*. Global populations of *Aspergillus flavus* are genetically diverse. Understanding distributions of aflatoxigenic and non-aflatoxigenic genotypes is important for developing effective aflatoxin control strategies for crops. ARS researchers in Maricopa, Arizona, utilized DNA-based markers to genotype nearly 29,000 isolates originating from 35 countries in North America, Central America, Africa, Europe, Asia, and Australia. An online database called “AflaSat” was developed, and standardized genotype data for each of these isolates was uploaded and made accessible to core collaborators. AflaSat will be made available in Spring 2023 to beta testers, followed by a full public release anticipated later that year. It will serve as a valuable resource for aflatoxin researchers worldwide, especially for identification of non-aflatoxigenic genotypes common to target areas that have potential as biocontrol strains. Contact: Ken.Callicott@usda.gov



Effects of elevated CO_2 on global agriculture food production. Essential information is required to accurately assess the impacts of climate uncertainty on global agriculture food production. An ARS scientist and a retired ARS collaborator, from Maricopa, Arizona, in cooperation with scientists from 23 other domestic and international research centers determined that it is possible to narrow the uncertainties in CO_2-induced crop responses so that climate change impact simulations omitting CO_2 effects – known as the 'without CO_2-fertilization effects' scenario – can now be conducted. This proposed approach will improve and streamline future investigations on climate uncertainty effects on global food security. Contact: Bruce.Kimball@usda.gov

Improved temperature-yield response of irrigated US wheat. High temperature and drought have detrimental effects on growth and phenology that result in yield reductions in agricultural crops. Nevertheless, homeostatic ranges of tolerance exist. An ARS scientist from Maricopa, Arizona, and two German scientists applied a binned temperature exposure statistical yield model on experimental and simulation data. They determined that accounting for phenological development (phenological effect), and rescaling (normalizing) the absolute seasonal length in the temperatures to a maximum season length, resulted in more realistic yield predictions. This improved statistical modeling approach will enable more accurate assessment of climate uncertainty on global food security. Contact: Gary.Wall@usda.gov

Occurrence and distribution of antibiotics and resistance genes in different soil types irrigated with treated wastewater. Up to 90% of antibiotics used for therapeutic treatment can be excreted and carried through the sewar treatment system in unchanged form. When wastewater is used for irrigation the presence of antibiotics it has been hypothesized to lead to an increase in the development of antibiotic resistance. An ARS researcher in Maricopa, AZ quantified the development of antibiotic resistance due to antibiotic challenges and found no direct link between the concentration of antibiotics and the development of antibiotic resistance. Thus, growers who use reclaimed water for irrigation are not increasing the prevalence of antibiotic resistance. Contact: Clinton.Williams@usda.gov

Transgenic cotton and sterile insect releases synergize eradication of pink bollworm from the United States. The pink bollworm is one of the world's most invasive insects and has been a major pest of cotton in the USA since 1917. However, decades of effort and implementation of the Binational Pink Bollworm Eradication Program culminated in the USDA Secretary of Agriculture officially declaring the pink bollworm eradicated from the cotton-growing regions of the continental United States in 2018. ARS researchers in Maricopa, Arizona, and collaborators from USDA APHIS, Arizona Cotton Research and Protection Council, and the University of Arizona used models to demonstrate that eradication was made possible by the synergistic interaction of Bt cotton and sterile insect releases. They further quantified that eradication saved cotton growers in the United States $224 million from 2014 to 2020 and was associated with an 82% reduction in insecticide use for all cotton pests in Arizona during this same period. The economic and social benefits achieved have wide sweeping impacts on agriculture and society and demonstrate the benefits of using agricultural biotechnology in concert with classical pest control tactics. Contact: Jeff.Fabrick@usda.gov and Steve.Naranjo@usda.gov

Field-based high-throughput plant phenotyping for chlorophyll fluorescence. Photosynthetic efficiency is an important phenotype for improving crop yields in a hot dry environment. The LEMNA-TEC field scanalyzer located at Maricopa, Arizona, the largest field robot in the world, and operated by the University of Arizona is equipped with a chlorophyll fluorescence imaging system (PSII). ARS researchers at Maricopa, Arizona along with collaborators from the University of Arizona and the Donald Danforth Plant Science Center validated the PSII system for a field setting and developed a data processing pipeline to extract measurements for determining photosynthetic efficiency. The validation of this system and development of the processing pipeline has enabled field trials to capture the temporal dynamics of chlorophyll fluorescence for plants grown in a hot dry environment. This system provides a valuable new tool for plant researchers to develop novel germplasm adaptable to a hot dry environment for sustainable crop production. Contact: Matthew.Herritt@usda.gov

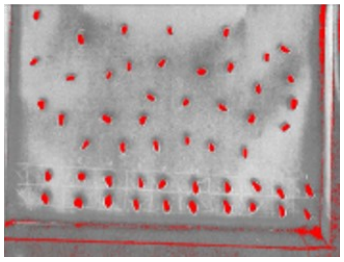
Shuttle breeding collaboration releases five upland cotton germplasm adapted to multiple environments. Cotton fiber quality is an important characteristic for USA producers who compete to sell cotton in an international market. When purchasing bulk cotton, textile mills have certain "premiums" established for differing fiber characteristics, like length and strength, that improve production of yarn and woven fabrics. Unfortunately, fiber quality characteristics are affected by many factors including the environment and management practices. ARS researchers in Maricopa Arizona, College Station Texas, and Florence South Carolina developed, grew, characterized, and selected germplasm from a breeding population at each location over the last four years. The lines provide public and private breeders with resources that broaden the genetic base while concurrently improving fiber quality and yield performance in upland cotton and have broad adaptation across the United States. Contact: Alison.Thompson@usda.gov

Revised cotton petiole nitrate sufficiency/deficiency guidelines for cotton in the Western USA. Petiole nitrate-nitrogen sampling and testing remains a popular in-season nitrogen (N) management practice in the Western USA for cotton. ARS researchers at Maricopa, Arizona, in collaboration with scientists at the University of Arizona, revised and updated cotton petiole nitrate sufficiency/deficiency guidelines for irrigated cotton in Arizona (last updates in 1984). Additionally, a phone app was developed that easily allows growers and consultants to use the new guidelines to manage in-season N for cotton. Users input their planting date and petiole nitrate data including the date of analysis into the app, if the levels are deficient, a N fertilizer recommendation is returned. The re-

vised guidelines and new phone app will lead to more profitable N management practices for western cotton growers and a reduction in over-fertilization and related export of N to the environment. Contact: Kevin Bronson (retired). Phone App URL

A desert-adapted insect pest trap-crop for the cotton agroecosystem. Cotton is vulnerable to a wide array of insect pests. However, pest damage to cotton can be reduced by planting a more attractive host plant adjacent to cotton. An ARS researcher in Maricopa, Arizona showed that vernonia, a desert-adapted plant, is strongly attractive to cotton pests and harbors an abundance of natural enemies. Further, very few arthropods were captured beyond the vernonia trap crop after being tracked using a protein immunomarking technique. The arthropods' strong attraction and fidelity to vernonia indicate that it could serve as a trap crop for the cotton pest complex and as a refuge for natural enemies. Contact: James.Hagler@usda.gov

Measuring cottonseed size for cotton improvement. Cotton production in the United States is a multi-billion-dollar industry that reaches far beyond textile and fabric production. Cottonseed is an important by-product of cotton fiber production and supports the cattle and food industries. Over the last 20 years cottonseed size has diminished, resulting in a call by the National Cotton Council for breeders to focus on cottonseed size improvement. ARS researchers at Maricopa, Arizona along with collaborators from Cotton Incorporated and the Regional Breeders Testing Network developed an imaging method using inexpensive, off-the-shelf imaging equipment and a custom processing pipeline to facilitate high-throughput cottonseed phenotyping. The development of this method has enabled novel research into cottonseed size and the effects on seed germination and plant stand establishment in the field. This technology provides a valuable new method for plant researchers to develop germplasm that meets grower and industry needs. Contact: Matthew.Herritt@usda.gov and Alison.Thompson@usda.gov



Evaluating water use calculations in the Cropping System Model (CSM). Many methods exist for calculating water use in crop production. Comparing the accuracy among the methods can lead to improved techniques for water management and conservation. ARS researchers at Maricopa, Arizona, compared six methods for calculating crop water use in the CSM, a popular crop simulation tool. The evaluations were based on measurements from a cotton field near Bushland, Texas. One calculation method performed statistically better than the other five. The results are guiding CSM developers toward better methods for calculating crop water use. More than 2,000 download requests are received for the CSM annually, and its listserv (https://dssat.net/) reaches 10,600 email addresses worldwide. The CSM is used primarily for agricultural research, and uses for policy decisions, yield forecasting, and on-farm management decisions are increasing. Contact: Kelly.Thorp@usda.gov

Diapause provides short and long-term benefits for Lygus bug. *Lygus hesperus*, a major cotton pest, survives winter conditions by entering diapause, a dormancy that limits reproductive development. Once environmental conditions are favorable, the insects become reproductively active. An ARS researcher in Maricopa, Arizona examined whether there are consequences for diverting resources towards diapause rather than normal development. Diapausing females were larger, lived longer, had greater stores of fat, and mobilized resources for egg production faster than non-diapausers. The stored resources accrued during diapause may allow females to take advantage of improved environmental conditions and prolong life by shielding them against stressors. Targeted disruption of diapause processes may render Lygus more susceptible to those stressors. Contact: Colin.Brent@usda.gov

Updates and advances to the FAO56 crop water requirements method. The Food and Agriculture Organization guidelines on crop evapotranspiration estimation (FAO56) are now universal standard methodologies for agricultural water management. However, since its introduction there have been numerous requests by the agricultural community to clarify various FAO56 procedures and to update the crop coefficient data. ARS researchers at Maricopa, Arizona, in collaboration with an international group, provided updated or new crop coefficient data for nearly 100 vegetable, herb, specialty, forage, and field crops, including lettuce, bell pepper, quinoa, cotton, wheat, canola, sugar cane, soybean, rice, and sorghum. An ARS scientist in Maricopa served as guest editor of a special issue in Agricultural Water Management (https://doi.org/10.1016/j.agwat.2020.106697) devoted to updating FAO56. This responds to the need for incorporating into the FAO56 methods advances in data handling, better use of the available research, and use of newer tools like remote sensing. The information provided is expected to improve the accuracy of crop water requirement calculations and support precision irrigation applications in agriculture. Contact: Doug.Hunsaker@usda.gov

Identification of candidate genes involved in drought stress tolerance in soybean. Drought causes significant soybean yield losses each year in rain-fed production systems. Genetic improvement of soybean for drought tolerance is a cost-effective approach to stabilize yield under such management. ARS researchers in Maricopa, Arizona, Stoneville, Mississippi and Columbia, Missouri in collaborations with researchers from University of Arkansas and University of Missouri designed a multi-state trial to assay 200 diverse maturity group VI soybean accessions under irrigated and rain-fed conditions to confirm and identify molecular markers and candidate genes related to slow canopy wilting traits. Among the 183 identified candidate genes, 57 single nucleotide polymorphic (SNP) markers were co-located within genes coding for proteins with biological functions involved in plant stress responses. The confirmed genomic regions may be an important resource for pyramiding favorable alleles and as candidates for genomic selection aimed at enhancing soybean drought tolerance. Contact: Hussein.Abdel-Haleem@usda.gov

Current Grant Awards (*new)

*Gene modification in *Lygus hesperus*, Cotton Incorporated. (PI **Colin Brent**, Co-PIs **Jeff Fabrick**, **Joe Hull**) 2022

*Evaluation and improvement of crop simulation models to meet the data needs of modern cotton production systems, Cotton Incorporated (PI **Kelly Thorp**) 2022

*Applying proximal sensing to enhance upland cotton yield trials, Cotton Incorporated (PI **Alison Thompson**) 2022

*Antimicrobial resistance in surface waters: Pilot environmental monitoring effort, FDA (PI **Clinton Williams**, 7 other USDA-ARS PI covering different areas) 2022

*Sustainability of groundwater and irrigated agriculture in the Western United States under a changing climate, USDA-NIFA (PI Isaya Kisekka, Co-PIs **Kelly Thorp**, S. Benes, P. Brown. A. Daccache, A. Gaudin, C. Hillyer, C. Lazcano, K. Longley, S. Ostoja, L. Parker, D. Sanyal, K. Suvocarev, H. Wang, W. Wright, P. Xu) 2021-2026

Viral hijackers: Can viral pathogens manipulate honey bee behavior to increase disease transmission?, USDA-NIFA (PI Adam Dolezal, Co-PIs Bryony Bonning, **Colin Brent**, Gene Robinson) 2019 – 2022

Genomics and phenomics to identify yield and drought tolerance alleles for improvement of Camelina as a biofuel crop, USDA-NIFA (PI **Hussein Abdel-Haleem**, Co-PIs Daniel Schachtman, Yufeng Ge, Toni Kutchan, Noah Fahlgren, Russ Gesch, Sheeja George) 2016-2022

Accelerating water and nutrient recycling: Evaluating risk tradeoffs for developing best management practices in agricultural waste stream use, USDA-NIFA (P- Kerry Hamilton, Co-PI's Rebecca Muenich, Trevor Boyer, **Clinton Williams**) 2020 – 2024

Genomic resistance risk assessment for Vip3-producing transgenic Crops in *Helicoverpa zea*, USDA-NIFA-Biotechnology Risk Assessment Grants Program. (PI Yves Carrière, Co-PIs **Jeff Fabrick**, Luciano Matzkin, Bruce Tabashnik) 2021-2023

Artificial intelligence to increase sustainability of water, nutrient, salinity, and pest management in the Western US, USDA-NIFA (PI E. Scudiero, CO-PIs H. Ajami, R. Anderson, K. Bali, M. Cahn, N. Chaney, K. Chief, A. Eldawy, **Andrew French**, R. Khosla, M. McGiffen, C. Nugent, E. Papalexakis, A. Put-man, M. Rivera, C. Sanchez, K. Schwabe, T. Skaggs, G. Vellidis) 2020-2026

Sustainable bioeconomy for arid regions, USDA-NIFA (PI K. Og-den, Co-PIs D. Ray, P. Waller, R. Maier, I. Meghan Downes, W. McCloskey, T. Teegerstrom, O. Idowu, P. Gutierrez, K. Grover, F. Holguin, C. Brewer, S. Angadi, **Hussein Abdel-Haleem**, C. McMahan, D. Dierig, A. Landis, J.Quinn, X. Bai, K. Seck) 2017-2022

Aflatoxin mitigation in Sudan, International Institute of Tropical Agriculture. (PI **Kenneth Callicott**) 2020-2022

MASTERS (Mentoring Agriculture Students through Training, Experiential learning, and Research Skills) for the future agricultural workforce, USDA-NIFA (PI Catherine Simpson, Co-PI **Clinton Williams**) 2020-2023

Utilizing genes from the soybean germplasm collection to mitigate drought stress, United Soybean Board (PI, Larry Purcell, CO-PIs **Hussein Abdel-Haleem**, Felix Fritschi, Jason Gillman, James Smith, Jeff Ray) 2018-2022

Population genomics of Bt resistance in *Helicoverpa zea*, USDA-NIFA, (PI Bruce Tabashnik, Co-PIs Yves Carriere, Luciano Matzkin, **Jeff Fabrick**) 2020-2022

The nexus of agricultural & urban trade-offs: Interdisciplinary education & research to create emerging opportunities in urban agriculture, USDA-NIFA, (PI Rebecca Muenich, CO-PIs Otakuye Conroy-Ben, Peter Condon, **Clinton Williams**) 2018-2022

Molecular and environmental factors controlling aflatoxin reduction by non-toxigenic *Aspergillus* strains, Arizona Cotton Research and Protection Council (PI **Hillary Mehl,** Co-PI **Ken Callicott**) 2018-2023

Identifying effective farming practices to reduce risks of per- and polyfluoroalkyl substances (PFAS) in food crop productions, USDA-NIFA (PI Alex Chow, Co-PI's Huan Chen, Tanju Karanfil, **Clinton Williams**) 2021-2025

Prevention of aflatoxin contamination of maize in Pakistan with biological control based on atoxigenic strains of *Aspergillus flavus*, Ingredion Inc. (PI **Hillary Mehl**) 2018-2022

Temporal evaluation of CEC's in the effluent from the Norman Oklahoma water reclamation facility, Garver Engineering (PI **Clinton Williams**) 2021-2022

ALARC Staff Updates

Despite the COVID pandemic, ALARC has been busy bringing on new scientific and administrative staff over the past eighteen months. We are excited to introduce them here.

Dr. Matthew Herritt. Ph.D. Plant, Insect and Microbial Sciences, University of Missouri (2018), B.S. Biotechnology, Rochester Institute of Technology (2007). Matthew is interested in improving crop production by understanding plant response to abiotic stresses, how plants use light, water and nutrient resources, developing field-based, high throughput phenotyping platforms and sensors, and identifying physiological traits impacted by abiotic stress.

Dr. Desalegn Serba. Ph.D. Plant Breeding and Genetics, University of Nebraska-Lincoln (2009), M.Sc. Plant Breeding and Genetics, University of Agricultural Sciences, Bengaluru, India (1999), B.Sc. Plant Sciences, Haramaya University, Ethiopia (1992). Des is interested in utilizing genomic and phenotypic approaches to characterize genetic and phenotypic variability, identifying genes underlying desirable traits germplasm enhancement, and enhancing the aesthetic value, and biotic and abiotic stress tolerance in grasses.

Dr. Reagan Hejl. Ph.D. Water Management & Hydrological Science, Texas A&M University (2021), M.S. Agronomy, Texas A&M University (2014), B.S. Agronomy, Texas A&M University (2011). Reagan is interested in applied practices and technologies that support improved turfgrass management, turfgrass quality, and ecosystem services in arid environments, including reduced input requirements that maximize turfgrass benefits in the urban landscape.

Dr. Prasad Bandaru. Ph.D. Plant and Soil Sciences, University of Delaware (2009). Prasad is interested in improving modeling capabilities to reliably simulate crop growth, water, carbon, and nitrogen interactions under different climatic, soil and management conditions at various spatial scales, and developing operational decision support tools using a combination of process-based crop models, and remote sensing.

Dr. Colin Brent. Ph.D. Biology, Boston University (2001), M.A. Biology, Boston University (1996), B.A. Biology, University of Chicago (1990). Colin is the newly appointed Research Leader of the Pest Management and Biocontrol Unit at ALARC where he provides administrative and research leadership of the unit. Colin is interested in insect behavior, ecology and physiology with a focus on the mechanisms regulating development and reproduction in lygus bugs and other pests of cotton.

Dr. Clinton Williams. Ph.D. Soil Physics/ Soil Chemistry, University of California, Riverside (1998), M.S. Soil Physics, Brigham Young University (1995), B.A. Chemistry, Brigham Young University (1992). Clinton is the newly appointed Research Leader of the Water Management and Conservation Unit at ALARC where he provides administrative and research leadership of the unit. Clinton is interested in finding ways to increase water supplies through the safe use of reclaimed waters with a focus on the environmental and human health impacts of biologically active contaminants in reclaimed wastewater, such as pharmaceuticals, hormones and trace organic compounds.

Charlotte Grace. B.S. Genetics, Cell, and Developmental Biology, Arizona State University (2014). Charlotte provides technical support for the Aflatoxin Biocontrol Lab (Pest Management and Biocontrol Unit) where the main focus is reduction of aflatoxin producing fungi in various food crops by in-depth examination of how aflatoxins affect our crop and soil health and through collaborations with local, national, and international growers.

Roni Gross. M.S. Biology, New Mexico State University, B.S. Criminal Justice with Biology Minor Northern Arizona University. Roni provides technical support in functional genomic studies on *Lygus Hesperus,* characterizing gene families through bioinformatics, gene cloning, expression profiling, and RNAi/CRISPR. (Pest Management and Biocontrol Unit).

Aaron Szczepanek. Aaron provides technical support for a research program focused on improvement of oilseeds and industrial crops, biofuels and natural rubber using conventional and molecular breeding methodologies, high-throughput phenotyping and genotyping technologies, with an emphasis on abiotic stress resistance and productivity traits (Plant Physiology and Genetics Unit).

Ela Czyzowska-Wisniewski. Ela provides technical support to a research program focused on the use of remote and proximal sensing to help monitor and manage scarce water resources over agricultural lands, with emphasis on multispectral thermal infrared observations (Water Management and Conservation Unit).

Kevin Whalen. Licensure, Veterinary Technician, Washington State 2016, AAS Veterinary Technology, Pima Medical Institute 2015, Certified Air Conditioning & Refrigeration Technician 2001. Kevin is a member of ALARC's administrative staff where he is a jack of all trades, assisting with facilities and greenhouse maintenance, and fabrication, welding and machining as needed to support the research mission.

Ruben Figueroa. Ruben joined ALARC this month and provides custodial services to the Center.

Moving On

Over the past year, several ALARC staff members have retired. **Kevin Bronson**, the former Research Leader of the Water Unit retired in August 2021 after 14 years of ARS service, 11 with ALARC. He has relocated to Texas to be near family. **Connie Graham**, a technician with the Aflatoxin Lab in the Pest Unit retired in March 2022 with 35 years of USDA service, 8 with APHIS and 27 with ARS. She relocated to her hometown of Weslaco, TX. **Kathy Johnson**, a tech in the Water Unit, retired in April 2022 after 35 years of service with ARS. **Steve Naranjo**, the current Center Director of ALARC will retire at the end of May 2022 after 36 years of federal service, 35 with ARS. He will remain in Chandler and will enjoy woodworking, restoring and showing classic cars, traveling and spending time with family and friends.

Recruitment activities are either completed or underway to refill all of these vacancies.

Matt Conley with the Avenger high throughput phenotyping platform, one of our workhorses for crop improvement research.

Recent Professional Awards and Recognition

Drs. Jeff Fabrick and **Steve Naranjo** were part of a team that received the Entomological Society of America, Plant-Insect Ecosystem Section's IPM Team Award for "Arizona Pink Bollworm Resistance Management and Eradication" (see Other Accomplishments). Other team members were from the Arizona Cotton Research and Protection Council, University of Arizona and Industry. The award, sponsored by Corteva Agriscience, recognizes the successful efforts of a collaborative team approach to pest control. Team members were honored during the ESA meeting in Denver in November 2021.

Dr. Bruce Kimball, a retired ARS Collaborator, was recognized as one of the top 1000 scientists in Plant Science and Agronomy by Research.com. He ranked #140 in the world and #40 in the USA. The honor is based on the H-index tracked by Microsoft Academic.

Dr. Steve Naranjo was the recipient of the ARS, Pacific West Area Research Leader/ Center Director of the Year award. Dr. Naranjo was recognized for outstanding leadership of a multi-disciplinary program focused on improving sustainability, productivity, profitability and safety of U.S. agriculture in arid-land agroecosystems. He was honored at a virtual ceremony from Washington D.C. in April 2022.

Employee Engagement

Jeff Fabrick continues as the Center's representative on the **PWA Employee Engagement Committee**. The goal of the committee is to report engagement activities that can be featured on AXON, ARS' intranet, and to generate and share employee engagement ideas that could potentially be implemented at the Location, Area or Agency level.

ALARC Seminar Series. Each year, ALARC hosts bi-weekly scientific seminars on a variety of topics related to entomology, plant science, water management and food safety from September through May. The series has continued intermittently via Zoom over the past year due to the pandemic, but we hope to resume hybrid live/Zoom seminars this coming Fall. If you are interested in getting advance notice of seminar speakers and topics, please email Clinton.Williams@usda.gov or Colin.Brent@usda.gov

Employee Appreciation Day. We used Administrative Professional Day as a mechanism to recognize and extend our thanks and appreciation to all ALARC employees, especially considering what they have had to contend with during the pandemic. We hosted a live event on April 27, 2022 to welcome our employees back to the workplace. Everyone got to enjoy lunch and engage in some fun activities like cards, dominos, and cornhole while getting acquainted with new employees and catching up with old friends.

Unit- and Center-Wide Meetings. Virtual monthly Unit meetings and quarterly Center-wide meetings provided updates on new staff, on-going recruitments, budgets, employee engagement, health and safety, facilities improvements and IT as well as sustained a sense of cohesion and community and dissemiated new and exciting research results. We are eager to return to in-person meetings now that we are re-opened.

Recent events and outreach

May 2021. The ALARC EEO/Diversity Committee hosted a virtual event to celebrate Asian American and Pacific Islander Heritage Month with a showing of "Advancing Leaders Through Purpose-Driven Service".

June 2021. The ALARC EEO/Diversity Committee hosted a virtual event to celebrate LGBTQIA+ PoC Month by sharing a virtual presentation entitled "A Look at Notable people of Color (PoC) within the LGBTQIA+ Community".

Sept 15 – Oct 15 2021. The ALARC EEO/Diversity Committee hosted a virtual event to celebrate Hispanic Heritage Month entitled "Esperanza: A Celebration of Hispanic Heritage and Hope".

February 2022. The ALARC EEO/Diversity Committee hosted a virtual event to celebrate Black History Month with a showing of "Black Health and Wellness".

February 2022. **Farm Science Day**, our annual community outreach event, done in partnership with the statewide AZ SciTech Festival, was cancelled this year due to the pandemic. We had hoped to be re-opened in time to host the event, but COVID had other plans. The event will return in February 2023 so be on the lookout and come join us for a fun day of learning about agriculture and the science behind it!

March 2022. The ALARC EEO/Diversity Committee celebrated Women's History Month with a virtual event entitled "Women in STEM A Look at Underrepresented Minorities and Notable Women of Color in Science." USDA also arranged for all employees to watch the powerful documentary "Picture a Scientist" followed by several USDA hosted virtual sessions called the Mirror Dialogues where they got to hear the work and life experiences of women from the department.

The **ALARC EEO/Diversity Committee** posted 45 EEO & Diversity articles in the Teams "In the Media" tab in the past year. Special thanks to **Brenda Singleton** and **Damien Seay** for their dedicated efforts on behalf of the EEO/Diversity Committee.

Publications

Water Management and Conservation Research

Elshikha, D.M., **Hunsaker, D.J**., Waller, P.M., **Thorp, K.R**., Dierig, D., Wang, G., Cruz, V.V., Katterman, M.E., Bronson, K., **Wall, G.W**., **Thompson, A.L**. 2022. Estimation of direct-seeded guayule cover, crop coefficient, and yield using UAS-based multispectral and RGB data. Agricultural Water Management 265. https://doi.org/10.1016/j.agwat.2022.107540

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