



TEXAS A&M AGRILIFE RESEARCH AND EXTENSION CENTER AT WESLACO

The Weslaco Center is located in the Lower Rio Grande Valley (LRGV), where agriculture has played a major role in the region's tremendous economic and population growth. With the arrival of rail transportation and the development of a vast irrigation system in the early 1900s, the valley's fertile delta soils formed the foundation of a bountiful South Texas agricultural industry. In 1923, the state legislature approved the purchase of 60 acres of land east of Weslaco for an agricultural experiment station. Another 60 acres were bought with local donations, and the center was established. Research began primarily on citrus, but by 1925 it had expanded to local crops, including pecans, grain sorghum, soybeans, cotton, sugarcane, and a wide variety of vegetables.

Among the early achievements of the Weslaco Center were the development of red-fleshed grapefruit; the release of mildew-resistant melon varieties in the 1950s and 1960s; virus-resistant peppers, tomatoes, and melons; improved tomato varieties released in the 1960s and still grown worldwide; the first commercially successful spinach hybrids; commercial onion releases that resulted in the sweet onion releases of the 1980s; sugarcane studies that helped revive the industry in the early 1970s; water-use efficiency and soil studies that improved per-acre income; and improved harvesting methods for onions, potatoes, sugarcane, and other crops.

CURRENT RESEARCH

IMPROVING VEGETABLE PRODUCTION IN SOUTH TEXAS

The Vegetable Research Program, headquartered at the Weslaco Center, is composed of a multi-disciplinary team of scientists who are developing technologies and generating knowledge to address critical issues affecting the vegetable industry in the LRGV, the state of Texas, and beyond. Ongoing efforts from the team include the following:

- Identifying and characterizing resistance mechanisms that protect against insect-transmitted diseases in solanaceous crops (including tomatoes, peppers, eggplant, and potatoes). The research team focuses on the tomato and potato psyllid, which transmits the bacterium (*Candidatus Liberibacter solanacearum*, or Lso) that causes zebra chip disease in potatoes; the western flower thrip, which transmits tomato spotted wilt virus; whitefly, which transmits tomato yellow leaf curl virus; and the potato aphid, which transmits potato virus Y vector disease complexes. This research serves as a model to study plant insect-transmitted disease interactions for other pest and pathogen complexes of economic importance for South Texas.
- Assessing the feasibility of covered structures as an alternative to open field production to reduce yield losses caused by insect-transmitted diseases and to extend the tomato growing season to improve crop quality and availability in the LRGV.
- Evaluating disease incidence in solanaceous crops using remote-sensing technology to monitor disease-related symptoms and their impacts on plant growth and yields.
- Using the latest “-omics” molecular and genetic approaches to advance fundamental and applied research in agricultural crop stresses. Using high-throughput next-generation sequencing and phenotyping technologies, we are establishing genotype-to-phenotype knowledge bases for many different living and non-living stress factors.

COMBATING CITRUS AND SUGARCANE DISEASES THROUGH GENETICS



Current research involves first identifying the causes of disease and then incorporating resistance genes into crops important to South Texas agriculture, using technologies that were pioneered at the Weslaco Center. We have also used pathogen-derived resistance approaches to create transgenic citrus and sugarcane plants that are resistant to the viruses causing economic losses in these crops. Ongoing efforts from the team include the following:

- Using spinach defensins (natural antimicrobial peptides that are part of the immune system) to strengthen resistance to citrus greening, or Huanglongbing (HLB).
- Working closely with Southern Gardens Citrus, the world's largest supplier of Florida orange juice, to introduce spinach defensins into the most commonly grown orange, grapefruit, and lemon varieties in Texas and Florida. So far, these defensins have made many trees resistant to citrus greening and others more tolerant to it.

RESEARCH IMPACTS

- Vegetable producers will increase production and profitability by growing heat-tolerant, disease-resistant, high-yielding, flavorful cultivars in Texas.
- Increased production and consumption of Texas-grown vegetables will improve the local economy by reducing vegetable imports.
- The use of spinach defensins to strengthen citrus resistance to citrus greening will allow millions of trees to stay productive longer. This will save thousands of jobs, keep juice plants from going out of business, and save the U.S. citrus industry millions of dollars per year.

WESLACO CENTER FACILITIES

Weslaco — 55,000 square feet in faculty and staff offices, laboratories, a 256-square-foot, fully-equipped conference room, and a 2,094-square-foot auditorium, located in the main building. 74,000 square feet of greenhouses, workshops, storerooms, and outbuildings. Approximately 360 acres in croplands at the research station, annex farm, and Hiler farm. 21,800 square feet in the Vegetable Research and Education Building, equipped with offices, laboratories, work areas, a conference room/kitchen, and an auditorium.

ABOUT TEXAS A&M AGRILIFE RESEARCH

A member of The Texas A&M University System

Established in 1888, Texas A&M AgriLife Research is the state's premier research and technology development agency in agriculture, natural resources, and the life sciences. Headquartered in College Station, AgriLife Research has a statewide presence, with scientists and research staff on other Texas A&M University System campuses and at the 13 regional Texas A&M AgriLife Research and Extension Centers. The agency conducts basic and applied research to improve the productivity, efficiency, and profitability of agriculture, with a parallel focus on conserving natural resources and protecting the environment. AgriLife Research has 550 doctoral-level scientists, many of whom are internationally recognized for their work. They conduct hundreds of projects spanning many scientific disciplines, from genetics and genomics to air and water quality. The annual economic gains from investments in Texas's public agricultural research are estimated at more than \$1 billion. Through collaborations with other institutions and agencies, commodity groups, and private industry, AgriLife Research is helping to strengthen the state's position in the global marketplace by meeting modern challenges through innovative solutions.

Texas A&M AgriLife Research
600 John Kimbrough Blvd., Suite 512
2142 TAMU
College Station, Texas 77843-2142
Phone: (979) 845-8486 **Fax:** (979) 458-4765
Email: agrilife@tamu.edu
AgriLifeResearch.tamu.edu

Resident Director
Dr. Juan A. Landivar
2415 East Business 83
Weslaco, TX 78596
Phone: (956) 968-5585 **Fax:** (956) 969-5620
Email: jalandivar@ag.tamu.edu
Weslaco.tamu.edu

RIO GRANDE VALLEY VEGETABLE RESEARCH AND EDUCATION PROGRAM



The Rio Grande Valley's subtropical climate is well suited to vegetable production year-round, and the vegetable industry plays a major role in the region's economic development. In 2014, the total value of vegetable production in Texas was estimated at \$312.44 million, with an economic impact on the state's economy of \$493.46 million. Hidalgo, Cameron, Willacy, and Starr Counties are among the state's leading vegetable-producing counties, contributing 19% of the total production. In 2014, these four counties produced \$48.3 million, \$3.9 million, \$5.2 million, and \$3.2 million in vegetables, respectively, according to Texas A&M AgriLife Extension. The main vegetable crops produced in the Rio Grande Valley are watermelons, onions, leafy greens, cabbages, carrots, and potatoes.

The Rio Grande Valley Vegetable Research and Education Program, with headquarters at the Texas A&M AgriLife Research and Extension Center at Weslaco, will develop technologies,

generate knowledge, and provide training to advance and conduct economical and sustainable farming practices in the region. It will support the local and state vegetable industry in

- vegetable breeding and genetics
- cropping systems
- vegetable marketing and economics



OUR VISION

Become a leader and recognized innovator in the development of germplasm, technology, and information to support the vegetable industry of the Rio Grande Valley, the state of Texas, and beyond.

OUR MISSION

Develop and evaluate vegetable cultivars of economic importance to the region and the state, develop cropping systems to make these cultivars successful in our fields, and disseminate information relevant to stakeholders in the Rio Grande Valley and the Texas vegetable industry.

PROJECTED IMPACTS

- Vegetable growers will sustain and increase production and profitability by growing heat-tolerant, disease-resistant, high-yielding, flavorful cultivars in Texas.
- Consumers will benefit from improvements in locally produced, higher-quality, and diverse fresh-market vegetables.
- Increased production and consumption of Texas-grown vegetables will improve the local economy by reducing vegetable imports.
- Reducing dependence on vegetable imports and relying on more diverse local and regional sources of produce will reduce fluctuations in price and availability associated with drought and other severe weather events, as well as international port delays.
- Consumers will see lower vegetable prices, and reducing long-distance trucking of fresh produce will reduce the overall carbon footprint of food production.



GROWING TOWARD THE FUTURE: THE TEXAS VEGETABLE STRATEGIC PLAN

Texas once grew as many acres of fresh vegetables as the leading vegetable-producing states. But in recent years, the lack of adequate cultivars, pest and disease pressures, and problems with production practices caused farmers to largely abandon vegetable production in favor of other crops. As a result, Texas is now a net importer of vegetables. According to estimates, Texas imported and consumed more than 7.5 billion pounds of vegetables in 2014.

Tomatoes, potatoes, and lettuce account for about 70% of the state's total production deficit. Increasing vegetable production in Texas will have a significant effect on the local economy, especially at the farm level. For example, preliminary results indicate that supplying only 1% of the current tomato-production deficit (22.9 million pounds) with Texas-grown tomatoes would benefit the state's economy by about \$26.2 million.

AgriLife Research and Extension and their stakeholders have been developing short- and long-term strategic plans to revitalize vegetable production in Texas. They asked 80 Texas vegetable and fruit producers and 63 Texas A&M AgriLife personnel to conduct a strengths, weaknesses, opportunities, and threats (SWOT) analysis of vegetable production in the state. Identified needs included pest and disease control and produce quality. The group identified the demand for regionally and locally grown U.S. produce as a strength. They defined technological advancements and long-term applied research, along with education and outreach, as areas of opportunity.



The Texas Vegetable Strategic Plan was created after the SWOT analysis was completed. The strategic plan is based on the concept of three vegetable centers of excellence: at the Texas A&M AgriLife Research and Extension Centers at Weslaco and Uvalde and at Texas A&M University in College Station (in partnership with AgriLife Research and AgriLife Extension).

The vegetable centers will take advantage of current and future program strengths. These strengths include their location in regions that support large vegetable-producing acreage and extensive packing and shipping facilities. The centers will have multidisciplinary teams to address critical issues affecting the vegetable industries, including marketing and natural resources management.

To implement the strategic plan, Texas A&M AgriLife will provide funding to address gaps in research capabilities. This includes hiring plant breeders at Weslaco and Uvalde, a plant molecular biologist at Weslaco, a plant physiologist at Uvalde, and an entomologist at Weslaco.

The plan's goal is to increase the investment of AgriLife Research and Extension resources to address the short- and long-term limitations facing producers and, as a result, to increase vegetable production in Texas.



Juan Landivar, Resident Director
Texas A&M AgriLife Research and Extension Center at Weslaco
2415 E. Business 83
Weslaco, Texas 78596
Phone: (956) 968-5585

weslaco.tamu.edu

VEGETABLE-BREEDING PROGRAM

Carlos A. Avila, Ph.D., Assistant Professor

Texas A&M AgriLife Research and Extension Center at Weslaco

RESEARCH

Growing vegetables in the subtropical climate of South Texas represents a real challenge due to its harsh environmental conditions and high pressure of endemic or new pests and diseases that severely limit production. The vegetable-breeding program is combining conventional breeding and modern molecular methods to develop high-yield, heat-tolerant, disease- and pest-resistant, high-quality tomato and spinach cultivars for the region.

DEVELOPMENT OF TOMATO YELLOW LEAF CURL VIRUS RESISTANT CULTIVARS

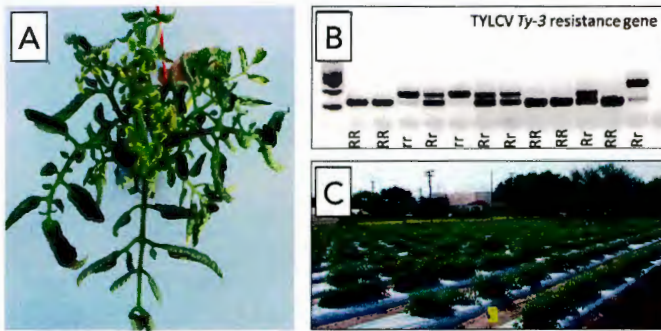


Figure 1. Breeding for TYLCV resistance. (A) TYLCV symptoms, (B) Marker-assisted selection, (C) Field evaluation

The main disease affecting tomato production in South Texas is the tomato yellow leaf curl virus (TYLCV; **Fig. 1A**), which is vectored by whiteflies. Several major resistance genes for TYLCV have been identified, but they need to be introgressed and stacked into locally adapted cultivars to ensure long-lasting disease resistance. Current efforts of the breeding program are focused to introgress resistance genes into heat-tolerant breeding lines. Marker-assisted selection (**Fig. 1B**) is being used to increase selection efficiency by allowing us to only evaluate plants carrying the resistance gene(s) in the field (**Fig. 1C**).

IDENTIFICATION AND INTROGRESSION OF RESISTANCE AGAINST THE POTATO PSYLLID IN TOMATO

To date, no commercial tomato cultivar carries resistance to the potato psyllid (PP), the vector of "*Candidatus Liberibacter solanacearum*" (Lso) and the causal agent of tomato vein greening in tomato and other economically important diseases in solanaceous crops. As a result, farmers rely solely on chemical applications to control the insect. It is imperative to develop resistant cultivars in combination with management strategies to reduce yield losses. As a first step to develop resistant cultivars, the breeding program is screening wild tomato relative species to use as a resistance source. Identified resistant wild tomatoes are being crossed with advanced tomato breeding lines to develop resistant cultivars.

IDENTIFICATION AND CHARACTERIZATION OF PLANT DEFENSIVE OXYLIPINS INVOLVED IN RESISTANCE TO THE POTATO PSYLLID AND ITS TRANSMITTED BACTERIA



Figure 2. In planta and artificial diet oxylipin evaluation

Oxylipins represent a large, diverse group of fatty-acid-derived compounds primarily generated through enzymatic oxidation of linoleic and linolenic acid. Synthesis of plant oxylipins is regulated in response to plant stress, and resulting oxylipins participate in signaling and defense. The goal of this project is to identify oxylipins that contribute to plant defensive signaling and their regulatory network in response to PP-Lso infection as a first step to develop tomato and potato selection targets to enhance plant resistance. Antibiotic and insecticidal properties of phloem mobile oxylipins against the PP-Lso are being evaluated when applied directly to leaves or to artificial diets (**Fig. 2**). Parameters tested include insect survival/fecundity and bacterial load change in both insect and plant. Researchers expect that results from this project can be extrapolated to other pests and diseases of economical importance, such as citrus greening.



EVALUATION OF TOMATO PRODUCTION UNDER COVERED STRUCTURES

Protected structures such as high tunnels, net-houses, and greenhouses provide an alternative to tomato production in harsh environmental conditions by extending the growing season. The breeding program is currently leading a project to evaluate the agronomic and economic feasibility of covered structures as an alternative to open field production to reduce yield losses caused by insect-transmitted diseases and to extend tomato growing season (Fig. 3). The project will develop an extended information network to provide grower education on factors influencing profitable production practices specifically developed for locally and regionally produced fresh market tomatoes.



Figure 3. Evaluation of tomato cultivars under covered structures



Carlos A. Avila, Ph.D., Assistant Professor
Texas A&M AgriLife Research and Extension Center at Weslaco
2415 E. Business 83
Weslaco, Texas 78596
Phone: (956) 969-5636 | Email: carlos.avila@ag.tamu.edu

DEVELOPMENT OF MOLECULAR TOOLS FOR WHITE RUST RESISTANCE SELECTION IN SPINACH



Figure 4. White rust evaluation

Breeding for spinach improvement requires new methods to speed up the development of cultivars with increased yield potential and disease and pest resistance. The major yield-limiting disease for spinach production in Texas is white rust (WR), caused by *Albugo occidentalis*. Since natural infection levels in the field varies year-to-year, conventional selection of resistant cultivars in the field is time consuming and unreliable. Therefore, in order to improve cultivar-development efficiency, the breeding program is evaluating spinach-breeding lines from the public and the private sectors and using genome-wide association analysis to develop molecular markers linked to WR resistance (Fig. 4). Currently, identified markers are being validated for their use in marker-assisted selection programs.

CURRENT CAPABILITIES AND EXPERTISE

The breeding program is located at the Vegetable Research and Education Center Building, a recently opened facility that includes a dedicated molecular biology laboratory, a greenhouse, and land field for conventional and molecular breeding. New cultivars are being developed by combining genomics, transcriptomics, and metabolomic tools.

INSECT VECTOR BIOLOGY RESEARCH PROGRAM

Ismael E. Badillo Vargas, Ph.D., Assistant Professor of Entomology
Texas A&M AgriLife Research and Extension Center at Weslaco

RESEARCH

POTATO PSYLLID MONITORING PROGRAM



Figure 1. Zebra chip disease symptoms in tubers

Zebra chip (ZC) has been the most economically damaging disease for potato producers in Texas since 2000 (Fig. 1). ZC is caused by the fastidious bacterium "*Candidatus Liberibacter solanacearum*" (Lso) which is vectored by the potato psyllid, *Bactericera cockerelli*. A statewide potato psyllid-monitoring survey was established in the mid-2000s to quantify the numbers of psyllids that were present in potato farmers' fields, and the percentage that were carrying the pathogen. In 2013, a ZC diagnostic lab was established in Amarillo, Texas, to monitor incidence of Lso in psyllid populations and to determine haplotype of Lso from positive psyllids and also psyllid haplotype. The potato psyllid-monitoring program continues in Texas, as does research activities associated with psyllid and pathogen haplotyping.

SCREENING OF NEW AND CURRENT INSECTICIDE CHEMISTRIES FOR EFFICACY AGAINST THE POTATO PSYLLID

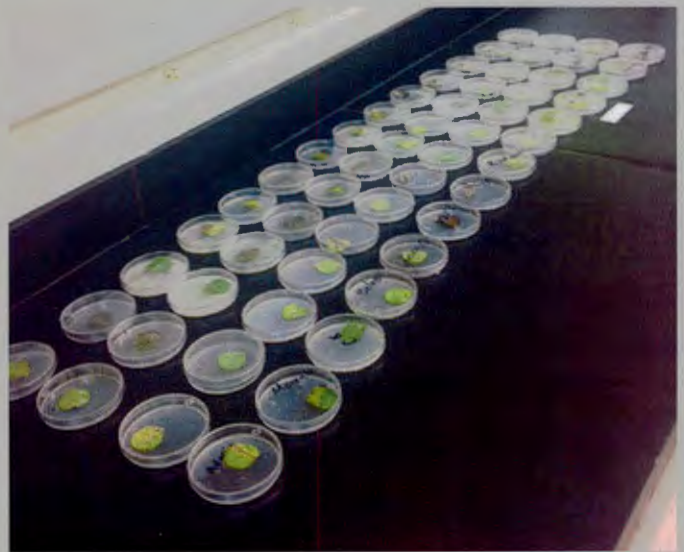


Figure 2. Laboratory screening assays

ZC disease has been very costly to manage in potato crops and has caused millions of dollars in losses to the potato industry, particularly in Texas. It is critical for growers to know which insecticides are more effective in controlling the insect vector, *B. cockerelli*, and which insecticide rotations manage insect resistance and reduce total applications per season. Furthermore, it is essential for growers to have access to an insecticide guide to assist them in making timely decisions and to prevent economic losses. Our research focuses on the following:

1. Evaluating the knock-out effect and longevity of currently used and new commercially available insecticides against *B. cockerelli* under laboratory conditions.
2. Utilizing the most promising insecticides from laboratory studies (Fig. 2) to determine the most effective combinations in field trials.
3. Preparing a Texas potato insecticide guide from results obtained from these trials.

DEVELOPMENT AND EVALUATION OF INTEGRATED INSECT VECTOR DISEASE MANAGEMENT STRATEGIES TO IMPROVE VEGETABLE PRODUCTION IN SOUTH TEXAS



Figure 3. Insect pest monitoring in three different production systems: open field (A), net-house (B), and greenhouse (C)

Our research team is part of an interdisciplinary research group that focuses on the evaluation of covered structures as physical and seasonal barriers against insect-transmitted diseases in tomato production. Our main goal is to monitor for pests in three production systems: greenhouse, net-house, and open field (Fig. 3). An additional study to evaluate planting dates and mulch cover to extend the tomato production season in South Texas is being carried out, where our team is also monitoring for pests in these fields.



Figure 4. *Aedes aegypti* mosquito, which transmits Zika, Dengue, and Chikungunya

MOSQUITO RESEARCH

Collaboration between private and public organizations has been established to conduct an integrated vector-human biosurveillance of high-consequence transboundary infectious diseases transmitted by mosquitoes, including the arboviruses: Zika, Dengue, Chikungunya, and West Nile. Our research team is directly involved in setting mosquito traps, sorting through the mosquito specimens, and identifying vector species that will be used for molecular tests by our collaborators to determine the presence of arboviruses in these mosquitoes collected in the United States.

INSECTICIDE EFFICACY TRIALS



Figure 5. Tomato efficacy trial in the greenhouse

Our research team conducts efficacy evaluation experiments of current, improved, and experimental active ingredients of chemical and organic insecticides sponsored by agrochemical companies. The experiments are conducted in laboratory, greenhouse, and field conditions for vegetable (Fig. 5) and row crops.

EXTENDING CURRENT CAPABILITIES AND EXPERTISE TO DEVELOP NOVEL STRATEGIES TO CONTROL INSECT-TRANSMITTED DISEASES

Genomics, transcriptomics, proteomics, and functional genomics tools will be used to better understand the intrinsic interactions between insect vectors and the pathogens they transmit. This basic knowledge is expected to aid in the development of novel strategies to control insect-transmitted diseases in the Lower Rio Grande Valley in Texas.

TURF RESEARCH PROGRAM

SCREENING GRASSES FOR HEAT, DROUGHT, AND COLD TOLERANCE

Warm-season grasses can suffer significant winterkill during cold winters, and cool-season turf grasses get severely stressed during hot and humid summer months. Therefore, the main emphasis of turf-breeding programs is to improve cold tolerance in warm-season grasses and heat and drought tolerance in cool-season grasses. At the Texas A&M AgriLife Research and Extension Center at Weslaco, we can easily screen for tolerance to these stresses. Hot and humid summers occur naturally in the Rio Grande Valley, and the cold chamber currently available in Dr. Jorge Da Silva's laboratory has been used to successfully screen for cold tolerance in energycane. This chamber can easily be used for other species, such as turf.



USING MICRO-PROPAGATION TO SPEED UP EVALUATION OF NEW GENOTYPES

One important peculiarity of turf is its perennial, vegetatively propagated nature, which presents a serious limitation for genetic breeding — the multiplication rate through vegetative cuttings is low. This means that several generations of growth in the field are needed to obtain sufficient plant material for replicated, statistically sound field evaluations. To overcome this limitation and dramatically reduce the time required for multiplication, a modern plant-tissue culture micro-propagation technique may be used (Figure 1). This technique is widely used in several plant industries and offers the potential to reduce the time (by several years) required for field evaluation of new genotypes. In addition, its use with turf offers the potential for new intellectual property development.



Figure 1: Micro-propagation technique

IDENTIFYING AND SOLVING CRITICAL ISSUES IN LARGE-SCALE TURF PRODUCTION

Texas A&M AgriLife Research has developed advanced meristem culture techniques for sugarcane, energycane, and miscanes (Figure 2). Our multiplication ratio has been 1:800 plants over a period of three months. The tissue culture, micro-propagation infrastructure already available at the Weslaco Center — including temporary immersion bioreactors and greenhouses — can be used to develop, optimize, and expedite scale-up procedures for seed stock planting materials of turf. In essence, this will be a parallel feedstock production and evaluation program that will identify and help solve critical issues associated with large-scale and commercial production of turf.

EXTENDING CURRENT CAPABILITIES AND EXPERTISE TO TURF GRASS BREEDING

The photoperiod/crossing facilities for sugarcane and energycane at the Texas A&M Annex Farm in Weslaco — with controlled temperature, light, and humidity conditions — could be used for controlled hybridization of other crops, including turf grass (Figure 3). The Weslaco Center also has two farms with greenhouse and field capabilities to conduct a genetic breeding program for turf, including field competition trials. In addition, the genomic work involving molecular markers currently being applied to tag cold- and other stress-resistance genes from wild cane (*S. spontaneum*) could be extended to turf. In addition to speeding up the breeding process, this would attract funding from the private sector and also generate important intellectual property. These capabilities and the expertise in plant genetic breeding and genomics would complement and leverage the current Texas A&M University turf-breeding program.



Figure 2: Seedlings resulting from micro-propagation in bioreactors



Figure 3: Photoperiod/crossing facilities at the Weslaco Center Farm

WATER AND SOIL WATER RESOURCES MANAGEMENT PROGRAM

Juan Enciso, Ph.D., Associate Professor
Texas A&M AgriLife Research and Extension Center at Weslaco

RESEARCH

DEVELOPMENT OF IRRIGATION GUIDELINES FOR MANAGING LIMITED WATER SUPPLIES



Figure 1. Research on crop water management using remote sensors

Our research team is currently involved in the third year of a funded project through a USDA-NRCS Conservation Innovation grant (Fig. 1) titled "Irrigation Management Practices for Water Conservation Using Weather Based Information." The main purpose of this project is to develop agronomic and irrigation strategies to plan and manage irrigation of small-acreage producers. The specific objectives of the project are as follows:

1. Establish irrigation management demonstration trials in which the amount of water applied will be measured and the amounts to apply will be estimated using information from automatic weather stations, which will be provided via the Internet to farmers.
2. Demonstrate the use of irrigation scheduling and small reservoirs in conjunction with drip irrigation to adjust the schedule determined via weather stations for small-acreage producers who are using multi-crops.
3. Organize field days and workshops in partnership with irrigation districts, NRCS, and grower organizations.
4. Develop English and Spanish publications oriented to farmers and irrigation operators on how to manage soil and water resources.

DISSEMINATION AND FATE OF FOODBORNE PATHOGENS AND INDICATORS ON PRODUCE POST- IRRIGATION WITH SURFACE WATER: AN INTERVENTION TRIAL



Figure 2. Experiments on water treatment for contaminated water



Figure 3. Comparing the effect of irrigation methods and management on food safety

Our research team is currently involved in a funded project through USDA-NIFA (Figs. 2 and 3) titled "Dissemination and Fate of Foodborne Pathogens and Indicators on Produce Post-Irrigation with Surface Water: An Intervention Trial." The long-term goal is to identify key risk factors for produce contamination so that improved control strategies can be developed, evaluated for cost-effectiveness, and implemented through science-based policy, education, and extension.

The first objective of the study consists of conducting intervention trials to test the effectiveness of irrigation water treatments in reducing produce contamination at harvest. Three water treatments (a no-treatment control, UV-radiation treatment, and a novel SA-fertilizer treatment) are being compared in a split-plot intervention trial, conducted over two growing seasons in parallel for spinach and cantaloupes. Our hypothesis is that the UV-radiation and SA-fertilizer treatments of irrigation water reduce the prevalence/level of indicators and pathogens on spinach and cantaloupes at harvest. The second objective of the study is to determine irrigation-induced dissemination and fate of indicators and pathogens on produce at harvest. The third objective is to develop good agricultural practices (GAPs) for management of irrigation.

RESEARCH WITH INDUSTRY GROUPS: SHELL OIL TRIALS

Our research team is currently involved in a funded project with Shell Oil Company to assess sweet sorghum yield, growth, and conversion efficiency. Five sweet sorghum genotypes are being evaluated at the Weslaco Center. Three irrigation regimens will be imposed on the test plots (Fig. 4). Factors of interest for this study are timing and rate of irrigation, with an aim of reducing total irrigation cost. In addition to the irrigation study, our research group is conducting sensor technology research on this plot.



Figure 4. Experiments with water-limited supplies for biomass production using unmanned aerial vehicles

EXTENDING CURRENT CAPABILITIES AND EXPERTISE

Our research team seeks to expand our current capabilities and expertise and seek interdisciplinary and multi-institutional collaborations that can encourage the development of innovative and groundbreaking strategies in investigating novel, complex, and convoluted areas. Please feel free to contact us for future partnerships.

SENSOR TECHNOLOGY RESEARCH

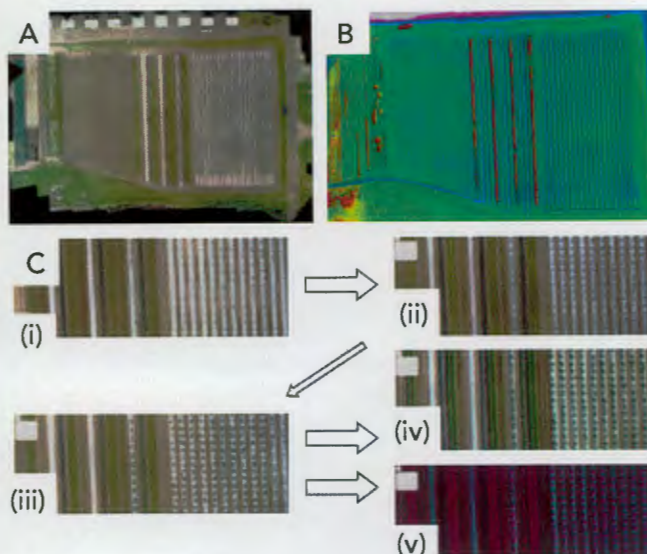


Figure 5. Analysis and interpretation of images obtained with unmanned aerial vehicles

Our research team is currently involved in a funded project titled "Development and Evaluation of Integrated Insect Vector Disease Management Strategies to Improve Vegetable Production in South Texas." The research consists of developing high-throughput phenotyping methods to accelerate introgression of insect-vector and pathogen-resistance traits into solanaceous crops. Two rotocraft platforms have been developed for this study, an eight-motor and a four-motor platform. Seamless orthomosaic images and 3D point cloud data for Digital Surface Model (DSM) were created (Fig. 5). Images are collected from the fields to monitor crop development over time with a four-motor rotocraft (Fig. 6).



Figure 6. Four-motor rotocraft platform

PLANT GENOMICS, MOLECULAR BIOLOGY, AND BIOTECHNOLOGY PROGRAM

Kranthi Kiran Mandadi, Ph.D., Assistant Professor
Department of Plant Pathology and Microbiology
Texas A&M AgriLife Research and Extension Center at Weslaco

RESEARCH

Pathogens, insects, and environmental stresses cause major losses in yield and quality of crops globally. At the Texas A&M AgriLife Research and Extension Center at Weslaco, we are using the latest "Omics," molecular and genetic approaches to advance the fundamental and translational research related to diverse agricultural crop stresses. Using high-throughput next-generation sequencing (NGS) and phenotyping technologies, we are establishing genotype-to-phenotype knowledge bases for diverse abiotic and biotic stress conditions. The knowledge bases are valuable resources for discovery of gene modules and molecular markers useful for crop improvement via biotechnology and breeding, as well as to advance the fundamental knowledge of plant stress phenology.



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IMPROVING BIOENERGY GRASSES THROUGH GENOMICS

Sugarcane, energycane, and switchgrass are important sources of sugar-based ethanol and lignocellulosic biomass feedstocks globally. However, diseases and environmental stresses such as cold, salinity, and drought can result in yield losses greater than 50% and are major impediments to attaining maximum bioenergy yield potential.

At the Weslaco Center, we employ the latest NGS, bioinformatics, and genetic tools to discover and study novel genes that confer resistance to diseases (viral, fungal, and bacterial) and environmental stresses (cold, salinity, and drought) in bioenergy grasses. We conduct fundamental studies to understand resistance mechanisms in model bioenergy grasses such as *Brachypodium* and *Setaria*, as well as translational research to improve sugarcane and energycane using biotechnology and breeding.



Brachypodium



Sugarcane smut

COMBATING INSECT-VECTORED DISEASES OF VEGETABLE AND FRUIT CROPS

It is estimated that 30%–40% of yield losses caused by plant diseases are due to the effect of pathogens transmitted by insect pests. For example, the tomato/potato psyllid, *Bactericera cockerelli*, is a vector of *Candidatus Liberibacter solanacearum* — a bacterial pathogen of solanaceous plants and the causative agent of the potato zebra chip disease, tomato vein-greening, and pepper variegated disease. Zebra chip disease is responsible for millions of dollars in losses to the potato industry. Similarly, citrus greening or huanglongbing (HLB) disease, caused by the *Candidatus Liberibacter asiaticus*, is the most devastating disease of citrus that is threatening citrus production worldwide. HLB is transmitted by an insect vector, the Asian citrus psyllid (*Diaphorina citri*).

At the Weslaco Center, through collaborations with breeders and entomologists, we are identifying novel sources of resistance against insect-vectored diseases. Using systems-biology approaches, we are studying the multi-component (host-vector-pathogen) interactions that occur during disease transmission, as well as interactions with the environment. The overall goal is to identify novel sources of resistance, genes, and markers that could be used to develop disease- and pest-resistant vegetables (tomato and potato) and fruits (citrus) using biotechnology and breeding approaches.



DEVELOPING NOVEL TECHNOLOGIES FOR DISEASE RESISTANCE AND ANTIMICROBIAL SCREENING

A major bottleneck in studying pathogens such as *Candidatus* spp. is the inability to culture them *in vitro*, outside the host plants, as they are obligate pathogens of plants. At the Weslaco Center, we are developing novel microbial hairy root systems to help propagate fastidious pathogens *in vitro*. Further, the microbial hairy root systems enable transformative, high-throughput screening and characterization of insect-resistance genes, anti-microbial genes, antibiotics, and small molecules.

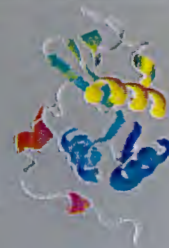


Hairy roots

EXTENDING CURRENT CAPABILITIES AND EXPERTISE

The goal of our program is to use the latest genomics, genetics, and phenotyping tools to speed discovery and characterization of plant stress resistance mechanisms toward crop improvement. The framework and technologies we established can be readily leveraged to improve several agronomic high-value crops and combat their diseases, pests, and environmental stresses. To fulfill these goals, we are open for multi-disciplinary and multi-institutional partnerships and collaborations.

Developing Sugarcane as a Biofactory for High-Value and Pharmaceutical Proteins



Sugarcane Is an Ideal Platform for Protein Production

Fast Growth Rate
 Very Efficient in Converting Sunlight and Water into Plant Fiber
 High Biomass Production Capacity

- ✓ Pollen Spread is Not an Issue
- ✓ Purification of Protein is Easy from the Sugar Juice
- ✓ The Sugar in the Sugarcane Juice Stabilizes the Protein



Objectives

Use sugarcane stalks as an ideal system for expression of high value proteins and enzymes at levels that allow for its economic

Target Protein to be Expressed in Sugarcane: Bovine Lysozyme

Potent broad spectrum antimicrobial enzyme: Enzyme (from bovine stomach mucosa) mostly associated with defense against bacterial infections - acting at concentrations as low as 25 ppm. Important applications as a preservative in the food, feed and cosmetic industries

Methodology

Production Pipeline

Promoter



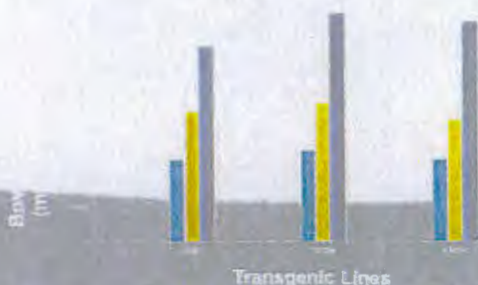
from the Shredded Stalks
 Roller Mill



of Proteins in the Juice through 5 kDa Membranes

Results

Determining the Yield of Bovine Lysozyme in Transgenic Sugarcane Stalks



Conclusion

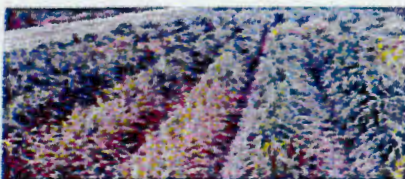
- There is a significant increase in Bovine Lysozyme yield of transgenic lines over time, and it is associated with an exponential increase in stalk biomass.
- Sugarcane stalks can be used as a biofactory to produce Bovine Lysozyme at commercial levels.

Biotechnology

Biotechnology, the ability to manipulate the characteristics of plants by adding or removing genes for specific traits, has revolutionized agriculture. The Biotechnology Program at the Weslaco Center develops advanced molecular tools and applies them to create more robust crop plants that resist disease, are more economical to grow, and that are capable of producing high-value products providing new, non-traditional markets for Texas agriculture. In addition, the many patents flowing from this research provide significant revenue generating opportunities for the TAMU System. Some examples:



- **Disease Resistant Citrus.** The nation's multibillion dollar citrus industry is under severe threat from diseases such as canker, tristeza, and greening that are spreading rapidly through citrus growing regions. Traditional breeding programs require decades to develop disease resistant varieties, so scientists in the Biotechnology Program developed the necessary technology to produce new disease resistant trees in the laboratory. These genetically modified versions of existing commercial varieties contain specifically introduced disease resistance genes. This groundbreaking program has produced the only fruit-bearing, genetically modified citrus trees in the world.



- **Herbicide Tolerant Sugarcane.** Sugarcane is an important crop in Texas and the US, and weed control is a significant part of its production cost. Scientists at the Weslaco Center have genetically modified commercial varieties of sugarcane to make them resistant to a common herbicide, eliminating the need for expensive, fuel-intensive tillage operations.
- **Sugarcane Bio-Factory.** Plants can be genetically engineered to produce a wide range of high-value substances that are difficult or expensive to manufacture by traditional means. In a pioneering program, scientists at the Weslaco Center have genetically modified sugarcane plants to produce high-value compounds with therapeutic and industrial uses at very low cost. Working with private sector partners, this technology has been scaled up to semi-commercial scale and was recently licensed by a private company for further commercial development.

