## Program Schedule

| Time         | Presentation Title                                                                 | Speaker                                           | Student Level | Program Area                          |
|--------------|-------------------------------------------------------------------------------------|---------------------------------------------------|---------------|----------------------------------------|
|              | **Pre-symposium**                                                                  |                                                   |               |                                        |
| 8:30 - 9:30 AM | Research Seminar: Integrating Climate, Landscape, and Hydrological Processes with Quantitative Pedology | Dr. Daniel Hirmas (University of California-Riverside) |               |                                        |
| 9:30 - 10:00 AM | Coffee social                                                                      |                                                   |               |                                        |
| 10:00 AM     | PSS Student Research Symposium: Opening Remarks & Introductions                    |                                                   |               |                                        |

### Session 1

**Oral Session (Student Moderator: Billi Jean Petermann)**

| Time   | Presentation Title                                                                 | Speaker                                      | Student Level | Program Area                          |
|--------|-------------------------------------------------------------------------------------|----------------------------------------------|---------------|----------------------------------------|
| 10:05 AM | Understanding the Dynamics of Soybean Root Nodule Development Using Single Cell Transcriptome Technology | Leonidas D’Agostino                          | MS            | Institute of Genomics for Crop Abiotic Stress Tolerance |
| 10:20 AM | Crop Response and Control of *Amaranthus palmeri* in HPPD-tolerant Cotton usingloxalamine | Maxwell Smith                                | MS            | Weed Science                           |
| 10:35 AM | Development of tissue culture free genetic transformation and gene-editing platform in crops | Arjun Ojha                                    | PhD           | Institute of Genomics for Crop Abiotic Stress Tolerance |
| 10:50 AM | Comparison of Yields under Organic and Inorganic Vegetable Cultivation: Meta-analysis | Azeem Shafk                                   | PhD           | Horticulture                           |
| 11:05 AM | Break                                                                               |                                               |               |                                        |

### Session 2

**Oral Session (Student Moderator: Nathan Turner)**

| Time   | Presentation Title                                                                 | Speaker                                      | Student Level | Program Area                          |
|--------|-------------------------------------------------------------------------------------|----------------------------------------------|---------------|----------------------------------------|
| 11:20 AM | Simulating cotton growth and yield in different nitrogen rates using DSSAT in dryland cotton farming in West Texas | Bhalnu Ghimire                               | PhD           | Plant and Soil Science                 |
| 11:35 AM | Influence of legume inclusion on greenhouse gas emissions from pasture systems in the southern high plains of Texas | Raavi Arora                                   | PhD           | Soil Science                           |
| 11:50 AM | Microwave plasma pre-treatment: a promising approach to improve cotton cellulose dissolution | Shaida Rumi                                   | PhD           | Fibers & Biopolymers                   |
| 12:05 PM | Genomic interactions governing novel salinity tolerance mechanisms in chromosome segment substitution lines of *Oryza sativa x Oryza rufipogon* | Swarupa Mandal                               | PhD           | Crop Science                           |
| 12:45 PM | Lunch Break                                                                        |                                               |               |                                        |

### Session 3

**Poster Session**

| Time   | Presentation Title                                                                 | Speaker                                      | Student Level | Program Area                          |
|--------|-------------------------------------------------------------------------------------|----------------------------------------------|---------------|----------------------------------------|
| 1:30 - 3:00 PM | Exploring the Physicochemical Properties of Arsenic in Water Filtration Waste from Northwestern Costa Rica | Dania Garcia Gutierrez                       | BS            | Soil Science                           |
|         | Growth and Yield of Greenhouse Grown Lettuce in Response to Secondary Metabolite in Organic Soiless Production System | Fachal Lee                                  | BS            | Horticulture                           |
|         | Competitive Ability in Silverleaf Nightshade, an Invasive Weed                      | Justin Dawsey                                | BS            | Natural Resources Management           |
|         | Interactions between beneficial fungal symbionts in greenhouse tomatoes.           | Nicholas Wilson                              | BS            | Plant and Soil Science                 |
|         | How environmental conditions affect nutrient availability in soils treated with swine waste | Noah Harrell; Madison Hernandez             | BS            | Agriculture                            |
|         | Development of an efficient method for protoplast isolation, transfection, and gene editing form soybean roots | Chidimma Lois Nwoko                         | MS            | Institute of Genomics for Crop Abiotic Stress Tolerance |
|         | Evaluating the potential of hemp varieties in the West Texas conditions            | Preetaman Bajwa                              | MS            | Agronomy and Crop Science              |
|         | Biomass partitioning and water use efficiency of sweet corn under growth stage based irrigation and biochar rates in West Texas | Arjan Kaffe                                  | PhD           | Horticulture                           |
|         | Utilization of the landrace Hopi to identify novel genes regulating reduced gland formation in upland cotton (*Gossypium hirsutum*) | Avinash Sheetha                             | PhD           | Plant Breeding                         |
|         | Does biochar application affect soil properties and sweet corn production under deficit irrigation? | Manpeet Singh                                | PhD           | Plant and Soil Science                 |
|         | Ethanol Positively Modulates Photosynthetic Traits, Antioxidant Defense and Osmoprotectant Levels to Enhance Drought Acclimatization in Soybean | Md. Mezuar Rahman                           | PhD           | Institute of Genomics for Crop Abiotic Stress Tolerance |

**Abstract withdrawn**

| Time   | Presentation Title                                                                 | Speaker                                      | Student Level | Program Area                          |
|--------|-------------------------------------------------------------------------------------|----------------------------------------------|---------------|----------------------------------------|
| 3:00 PM | Awards Ceremony                                                                     |                                               |               |                                        |

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**Date:** April 18, 2022  
**Location:** MCOM 359
PSS Student Research Symposium

Date: April 18, 2022
Location: MCOM 359

Oral Session Abstracts
Student/presenter: Leonidas D’Agostino, Ms. student, Plant and Soil Science

Format: Oral presentation

Understanding the Dynamics of Soybean Root Nodule Development Using Single Cell Transcriptome Technology

Leonidas D’Agostino, Lenin Yong-Villalobos, Luis Herrera-Estrella and Gunvant B. Patil

Institute of Genomics for Crop Abiotic Stress Tolerance (IGCAST), Department of Plant & Soil Science, Texas Tech University, Lubbock, TX

Abstract: Beneficial microbes, especially rhizobium, offer a sustainable solution for improving nutrient uptake in legume crops and the research community understands a substantial amount about the processes involved in nitrogen fixation in legumes. Root nodules are exogenous organs formed through the symbiotic relationship between legume plants and the bacterial group rhizobium. Once formed, these nodules fix atmospheric nitrogen into usable ammonia for the plant, essentially replacing the need for nitrogen fertilizer application. However, the complexity of signal reception, metabolic-flux, nodule development, N-fixation, and nutrient uptake at the ‘sub-cellular level’ is elusive and not investigated in soybean or any other legume. In this project, we aim to capture the temporal and subcellular expression differences in relation to the nodule’s growth stages (immature, mature, post-maturity) through a process known as single-cell transcriptomics. To do so, soybean genotype (Williams 82, reference genome) is inoculated with rhizobia to induce nodulation. Nodules are then collected at three stages and nuclei are extracted. These nuclei are processed through the 10X genomics single cell pipeline in order to generate a barcoded library made up of the individual cells. The transcriptional map generated from this data will help us to understand the dynamics of the gene-regulatory network and nitrogen fixation processes at a single cell level. On a larger scale, this project will provide in-depth
understanding of symbiosis between rhizobium and soybean and will provide sustainable solutions to improve nutrient uptake in soybean and other legumes.
Crop Response and Control of *Amaranthus palmeri* in HPPD-tolerant Cotton using Isoxaflutole

Maxwell E. Smith¹, Peter A. Dotray¹,², and Adam Hixson³

¹Texas Tech University, ²Texas A&M AgriLife Research and Extension, ³BASF

**Abstract:** *Amaranthus palmeri* S Wats. (Palmer amaranth, pigweed, carelessweed) is one of the most troublesome weeds to cotton producers on the Texas High Plains. The development of glyphosate-resistance has complicated effective control of this weed species. *Amaranthus palmeri* has been shown to reduce cotton yield and creates harvest complications when escaped plants are left to compete with cotton. New HPPD-tolerant cotton from BASF allows for the use of a mode of action that has not previously been used in cotton. The objective of this study was to evaluate the crop response and control of *Amaranthus palmeri* in HPPD-tolerant cotton using the HPPD herbicide isoxaflutole. In 2021, a field study was conducted at the Texas Tech University New Deal Research Farm. In this study, cotton response and weed control were evaluated following preemergence and early postemergence applications of different herbicide programs, many of which included isoxaflutole. Crop response (injury) 21 days after the preemergence application was <12%. Average *Amaranthus palmeri* control 29 days after the preemergence application was >92% for all treatments that included isoxaflutole in the preemergence application and was ≤89% for all treatments that did not include isoxaflutole in the preemergence application. *Amaranthus palmeri* control was >80% for all treatments 14 days after the early postemergence application. *Amaranthus palmeri* control was >71% for all treatments 28 days after the early postemergence application. Cotton lint yields were >1,470 kilograms per hectare for all treatments, excluding the nontreated control. This study suggests that isoxaflutole is effective at controlling *Amaranthus palmeri* and will give cotton producers in the Texas High Plains another mode of action to use against glyphosate resistant weeds.
Student/Presenter: Arjun Ojha, PhD, Molecular Crop Improvement

Format: Oral presentation

Development of tissue culture free genetic transformation and gene-editing platform in crops

Arjun Ojha Kshetry¹, Luis Herrera-Estrella¹ and Gunvant B. Patil¹

¹Institute of Genomics for Crop Abiotic Stress Tolerance (IGCAST), Department of Plant & Soil Science, Texas Tech University, Lubbock, TX

Abstract:

Gene editing technologies, especially CRISPR/Cas have revolutionized crop engineering research. However, delivery of gene editing reagents is largely depending on genetic transformation and in vitro regeneration (tissue culture) of plants. Moreover, plant regeneration and genetic transformation are highly genotype-dependent. Therefore, the lack of efficient genotype-independent plant transformation methods in several recalcitrant crops including cotton, soybean, sorghum, common bean, etc. has been a major limitation in applying gene-editing technology in crop improvement. To overcome these challenges, we are creating a synthetic cascade to express developmental regulator genes involved in stem cell activity, rapid tissue differentiation, and the regeneration process. Importantly, these developmental regulators will be applied in vivo, and we envision the development of a robust regeneration and gene-editing methodology without a need for tissue culture. Currently, we are testing a series of developmental regulators in the model plant Nicotiana benthamiana (tobacco), and once successful, it will be applied to major recalcitrant crop species.
Presenter: Azeezahmed Shaik, Ph.D. Candidate, Department of Plant and Soil Science

Format: Oral presentation

Yield Comparison of Vegetables Grown in Organic and Inorganic Production Systems: Meta-analysis

Azeezahmed Shaik¹, Manpreet Singh¹, and Sukhbir Singh¹

¹Texas Tech University, Department of Plant and Soil Science

Abstract: Throughout the United States, demand for locally produced and organically grown vegetables is increasing. However, due to the lack of efficient organic fertilizers (OFs), the organic production of high-value vegetables seems challenging. Especially under-protected structures, limited research has been done to assess the efficacy of OFs compared to conventional inorganic fertilizers. Therefore, several experiments were designed to compare the use of liquid organic fertilizer (LOF) and inorganic fertilizer (IF) for different vegetable crops (tomato, cucumber, eggplant, lettuce, and other leafy greens) under three production systems (greenhouse, high tunnel, and open field). We subjected the yield results from these experiments to meta-analysis to quantify the overall effect of LOF and IF on vegetable production. The results indicate that the overall standard mean difference of yields decline in LOF compared to IF, the percentage decrease in the yield of organic was 5%. There was a 7% decline in open field yield due to LOF use compared to IF, followed by greenhouse (6.2%) and high tunnel yield (3.6%). Among different vegetables, the use of LOF resulted in a significant yield reduction in lettuce (11%) and eggplant (6%) whereas other vegetables produced a statistically similar yield as inorganic treatment. The organic yield reduction compared to inorganic was significantly higher in soilless conditions (6.2%) compared to the soil production system (4%). This meta-analysis suggests that organic vegetable cultivation could produce similar yields as inorganic cultivation, but the quality and economic feasibility of organic vegetable production need to be further investigated.
Simulating cotton growth and yield in different nitrogen rates using DSSAT in dryland cotton farming in West Texas

Bishnu Ghimire¹, Rupak Karn¹, Haibin Gu¹, Wenxuan Guo¹²

¹Texas Tech University, Department of Plant and Soil Science, and ²Texas A&M AgriLife Research

Abstract:

The Southern High Plains of Texas is a leading cotton (Gossypium hirsutum L) production region in the US. The depletion of the Ogallala aquifer necessitates dryland cotton cropping in this region. Optimization of nitrogen fertilizers is critical to making cotton production profitable and sustainable. Crop models are the dynamic tools that provide decision support in the enhanced management of cropping systems. The objective of this research was to predict cotton growth and yield under different rates of nitrogen using the Decision Support System for Agrotechnology Transfer Cropping System (DSSAT CSM) CROPGRO-cotton program for dryland conditions. Three different rates (0, 34, 67 kg/ha) of nitrogen were applied during the planting season. Plant biomass, plant height, Leaf Area Index (LAI), and cotton yield were measured along with soil texture, PH, and total nitrogen. The model was first calibrated with in-season data of 2020 and then evaluated using the 2021 field data. The model accurately predicted in-season biomass and cotton yield. The results showed that the DSSAT CSM CROPGRO-cotton model demonstrated the potential to predict the nitrogen effect on cotton growth and yield in dryland cotton farming.
Influence of legume inclusion on greenhouse gas emissions from pasture systems in the southern high plains of Texas

Raavi Arora¹, Lindsey C. Slaughter¹, Charles P. West¹, Sanjit K. Deb¹, and Veronica Acosta-Martinez²

¹Texas Tech University Department of Plant and Soil Science, Lubbock, TX, USA
²USDA-ARS Cropping Systems Research Laboratory, Wind Erosion and Water Conservation Unit, Lubbock, TX, USA

Semi-arid ecosystems, such as the Southern High Plains (SHP) of Texas, hold enormous potential for providing a variety of ecosystem services such as agricultural production, nutrient and water cycling, and extreme weather mitigation. Although these systems cover over thirty percent of the arable land area in North America, agricultural productivity is severely limited by water scarcity and degraded soils. The Ogallala Aquifer, which is the main source of irrigation in the SHP, is at a risk of extinction due to over-extraction and pollution, forcing the growers to switch from row crops to less soil disturbing and more water efficient perennial forages and livestock. Some studies have shown that incorporation of legume plants to these perennial grasses can potentially reduce methane emissions from the soil and nurture healthier livestock in addition to minimizing the need for external inputs. The information regarding the influence of these soil improving practices on soil greenhouse gas (GHG) emissions is currently lacking. Our objective is to quantify and comprehend the role of legume (alfalfa, *Medicago sativa* L.) presence and density on soil GHG flux in established long-term pastures (WW-B.Dahl Old World bluestem) as compared to N-fertilized monoculture pastures. Soil GHG samples (CO₂, CH₄, N₂O) were collected using static chamber method on a monthly basis (fall to spring), and on a bi-weekly basis (late spring to early fall) to see the greenhouse gas flux throughout the year. Microbial community structure, nitrate and ammonia in the soil will also be analysed. The results of our study will help producers make management decisions to increase profitability and reduce climate impacts with more efficient use of resources, as well as allow us to prepare a model that builds healthy and productive soils in regions facing water and nutrient scarcity.
Microwave plasma pre-treatment: a promising approach to improve cotton cellulose dissolution

Shaida S. Rumi, Sumedha Liyanage, Julia L. Shamshina, Noureddine Abidi
Fiber and Biopolymer Research Institute, Department of Plant & Soil Science, Texas Tech University

Abstract: Cellulose, the most abundant renewable natural polymer on earth with fascinating physicochemical and mechanical properties, is a suitable raw material for preparing sustainable and economically viable cellulosic products. However, the utilization of cellulose to its full potential is constrained by its recalcitrance to dissolution that results from the rigidity of polymeric chains, high crystallinity, high molecular weight, and extensive intra- and intermolecular hydrogen bonding networks. Therefore, we explored a new strategy to promote cellulose dissolution in this study. We investigated the use of microwave oxygen plasma as a pre-treatment step of cotton fiber before its dissolution in NaOH/Urea solvent system. FTIR, SEM, XRD analyses revealed structural and morphological changes in the cellulose surface due to plasma irradiation. According to the GPC result, the molecular weight of cellulose decreased by 36% and 60%, which led to a 34% and 68% increase in the dissolution of 1% (w:v) cellulose in NaOH/Urea, for 20 min and 40 min plasma pre-treatment, respectively. This study showed that microwave oxygen plasma pre-treatment is a promising approach to significantly enhance cellulose dissolution.
Genomic interactions governing novel salinity tolerance mechanisms in chromosome segment substitution lines of *Oryza sativa* x *Oryza rufipogon*

Swarupa Nanda Mandal, Oluwatobi C.M. Bello, Jacobo Sanchez, Ai Kitazumi, Coenraad R Van-Beek, Isaiah C.M. Pabuayon, and Benildo G. de los Reyes

Department of Plant and Soil Science, Texas Tech University, Lubbock, TX-79415, USA

Abstract

The Asian cultivated rices (*Oryza sativa* ssp. japonica, indica) were the outcomes of independent domestication events from *Oryza rufipogon* about 10,000 years ago. As progenitor, the *O. rufipogon* gene pool represents a rich reservoir of genetic novelties and cryptic functions that have been left behind in the wild. To explore the potential of this genetic system for the creation of genetic/epigenetic novelties for stress adaptive traits, we examined a set of 48 Chromosome Segment Substitution Lines (CSSL) harboring 97.6% of *O. rufipogon* genome in the background of japonica cultivar Curinga. Comprehensive physiomorphometric evaluation of the CSSL population showed that introgression of certain *O. rufipogon* genomic segments created transgressive (non-parental) phenotypes under salinity stress. Two introgression lines (CR-1, CR17) out-performed both their donor (*O. rufipogon*) and recurrent (*O. sativa*) parents in terms of survival under extreme salinity (EC = 12) at the vegetative stage. Among the many traits examined, cellular membrane stability and retention of K⁺ appeared to explain much of phenotypic variances. Interval mapping aided by a genotyping-by-sequencing approach delineated a 3.9-Mb region of *O. rufipogon* chromosome-4 as the culprit behind the transgressive nature of CR-1 and CR-17. Detailed analysis of such region, which encodes a total of 331 protein-coding gene loci, revealed that 162 genes within the interval were *O. rufipogon*-specific, while 156 other genes were novel alleles of evolutionarily conserved gene loci. Integration of physiomorphometric profiles with gene function enrichment within the introgressed genomic segment revealed that rewired networks for photosynthesis and respiration are crucial for transgressive salinity tolerance. This study supports a breeding paradigm based on interspecies genomic interaction and cryptic genetic/epigenetic effects hidden in wild progenitors to create adaptive phenotypic novelties. Analyses of transcriptome and methylome along with their networks will illuminate the regulatory mechanisms rewired by introgression from *O. rufipogon*. 

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**Student/Presentation:** Swarupa Nanda Mandal, Ph.D. Candidate, Crop Science

**Format:** Oral presentation
PSS Student Research Symposium

Date: April 18, 2022
Location: MCOM 359

Poster Session Abstracts
**Student/Presenter:** Danira Garcia Gutierrez  
**Format:** Poster Presentation

**Title:**  
Exploring the Physicochemical Properties of Arsenic in Water Filtration Waste from Northwestern Costa Rica

**Authors:** Danira Garcia Gutierrez, AmandaJo Zimmerman, Matthew Siebecker

**Abstract:** Arsenic (As), a known carcinogen, is present in drinking water in Northwestern Costa Rica. Filters are used to remove the arsenic, and the filtrate wastes are deposited on local soils. The filtrate waste is composed of anatase (TiO₂) and contains arsenic (As) in high concentrations (400-600 mg kg⁻¹). The introduction of this contaminant to the environment poses a potential threat to the food chain and the local community. The high wind environment of the region increases the mobility and inhalation risk of the contaminated soils. Little is known about the behavior of the As contaminated filtration waste, as there is little literature about the topic. This research will explore the concentration of As in the soil as well as its physicochemical properties such as mobility, morphology, behavior in anaerobic conditions, and desorption of As from the TiO₂ filtration waste. To accomplish this, portable X-ray fluorescence spectrometry (PXRF), X-ray absorption near edge structure (XANES), API Aerosizer, inductively coupled plasma optical emission spectroscopy (ICP-OES), and an anaerobic chamber were used. The PXRF data indicated the soil has 400-600 mg kg⁻¹ of As, 254-636 mg kg⁻¹ of vanadium (V), and 106,00-338,000 ppm of titanium (Ti). XANES was used to determine the species of As to be arsenate (As(V)). Analysis of particle size revealed an average particle diameter of less than one micron, which further increases the mobility and inhalation risk of nearby residents. The anaerobic behavior experiments were designed to test for As release and reduction. Desorption studies indicate the As is possibly associated with the inner and outer spheres of the TiO₂ filtration waste, but this will be confirmed with future EXAFS analysis.

Word Count: 271
**Presenter:** Lee Fischel, B.S. student, Department of Plant and Soil Science, Texas Tech University  
**Format:** Poster presentation

**Growth and Yield of Greenhouse Grown Lettuce in Response to Secondary Metabolite in Organic Soilless Production System**

Fischel Lee¹, Azeezahmed Shaik¹, Sukhbir Singh¹, Thayne Montague¹, and Vikram Baliga¹  
¹Department of Plant and Soil Science, Texas Tech University

**Abstract:** Compared to conventional systems, organic production systems are generally associated with a 20-50% reduction in yield. Within organic soilless production systems, the availability of nutrients from organic fertilizers is highly limited. This is due to a lower mineralization rate with less nitrogen supply, which leads to lower productivity. Therefore, a greenhouse study was conducted to test the combined effect of secondary metabolites (SM) and liquid organic fertilizer (LOF) to improve growth and yield of lettuce under a soilless production system. During the spring season of 2022, butterhead lettuce cultivar ‘Rex’ and iceberg lettuce cultivar ‘Crispino’ were evaluated with or without the application of SM, fertilized with LOF, and compared to an inorganic fertilizer (IF) control. SM was diluted with water to a ratio of 1:500 and applied to plants at ten-day intervals. Respective fertilizer treatments were applied at 2 dS.m⁻¹ every five days. The experimental design consisted of a split-split-plot design with eight replications. Compared to Rex, results indicate Crispino had greater fresh biomass (17%), and total leaf area (39%) for each plant. For SM, differences in growth parameters were not found between cultivars. Among fertilizer treatments, the use of LOF resulted in reduced fresh biomass and plant leaf area compared to plants fertilized with IF. This study demonstrates lettuce response to SM is to be inversely related to the growth and yield of lettuce. However, the use of LOF resulted in improved performance of lettuce in the organic soilless production system.
Competitive Ability in Silverleaf Nightshade, an Invasive Weed

Justin Dawsey¹ and Cade Coldren²
¹Texas Tech University, Department of Natural Resources Management and
²Department of Plant and Soil Science

Abstract: Silverleaf Nightshade (Solanum elaeagnifolium) (SLN) is a noxious, invasive weed that is responsible for lowering crop yields and invading disturbed sites across North America, Australia, and several other regions around the world. The objective of our study was to examine how SLN competes with other species at the Quaker Farm on the Texas Tech University campus. Plots were set up around individual SLN plants and plant height, cover, and distance and bearing were recorded for each individual plant, several times during the growing season. We found that increased rainfall and average temperature were drivers in the time of SLN emergence. Shortly after emergence, no pattern existed between density of non-SLN plants and their distance from each SLN plant. However, after one month of growth, few non-SLN plants were found close to SLN plants, and their density increased with distance away from SLN plants, reaching a peak at about 12 cm. This pattern held through the end of the growing season. Regarding cumulative rainfall, mean height by species tended to increase with increasing rainfall, but this was significant for only one species (Convolvulus arvensis), implying that water availability for growth was limited. Given these results, we suspect SLN is competitive via several non-mutually exclusive strategies: allelopathy, reliance on use of previous disturbance, and an inefficient but flexible use of water. More research will be needed to understand the role each may play in SLN invasion.
Student/Presenter: Nick Wilson, undergraduate student, Plant and Soil Science.

Format: Poster

Interactions between beneficial fungal symbionts in greenhouse tomatoes.

Nicholas Wilson (presenting), Jonathan Peters, Catherine Simpson, Lindsey Slaughter
Texas Tech University, Department of Plant and Soil Science.

Abstract:
Increased costs of agricultural inputs, such as fertilizer and irrigation, combined with increased demand for high-quality agricultural products has prompted many producers to adopt alternative nutrient and water management practices. One strategy to improve plant nutrient and water uptake is to add beneficial microbial symbionts, such as fungal inoculums, to growth media in greenhouse systems. However, the effects and potential ecological interactions between multiple added microbes that form different associations with plant hosts remains unknown, despite the myriad commercial inoculum products that are marketed to growers. Therefore, the objective of this study was to determine the establishment and production outcomes of two commercially-available products that contain two different mutualistic fungi: Trichoderma sp. (mix of Trichoderma harzianum and Trichoderma viride) which improves plant defense against pathogens, and arbuscular mycorrhizal fungi (AMF; mix of Rhizophagus irregularis, Rhizophagus aggregatus, Rhizophagus proliferum, Rhizophagus clarus, and Claroideoglobo mus etunicatum.), which colonizes plant roots and increases nutrient and water uptake. We hypothesized that adding these fungi individually would benefit plant growth and fruit yield, but that competitive interactions between the two fungi for plant resources may reduce efficacy when added together. We applied the following treatments to greenhouse tomato seedlings in a soilless media: 1) Trichoderma, 2) AMF, 3) Trichoderma + AMF, and 4) Untreated Control. At fruit harvest, whole aboveground (stem, leaves) and belowground (root) tissues were destructively collected and weighed for biomass. Mycorrhizal colonization rates were assessed in root samples by staining and microscopy. The results of this study help us understand the individual and combined effects of beneficial fungi with different mechanisms of plant symbiosis in tomatoes, and aid in decision-making for producers interested in applying biofertilizer products to greenhouse-grown tomatoes.
Student/Presenter(s): Noah Harrell, Madison Hernandez

Format: Poster presentation

Title: How environmental conditions affect nutrient availability in soils treated with swine waste

Authors: Noah Harrell\textsuperscript{a}, Madison Hernandez\textsuperscript{a}, Morgan Forbes\textsuperscript{a}, Haylee Gruben\textsuperscript{a}, Koy Stanley\textsuperscript{a}, Carson Payton\textsuperscript{a}, Sadie Sherburn\textsuperscript{a}, Tana Pierce\textsuperscript{a}, Jessica Colvin\textsuperscript{a}, Aakriti Sharma\textsuperscript{b}, Matthew G. Siebecker\textsuperscript{b}

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Affiliations:
\textsuperscript{a} Agriculture Department, Western Texas College, Snyder, TX
\textsuperscript{b} Department of Plant and Soil Science, Texas Tech University, Lubbock, TX

Abstract:

Swine waste can add significant amounts of nutritional benefits to soil. Often, it is applied to land to improve crop yield. However, addition of too much swine waste can be an environmental risk due to potential release of excess nutrients from the applied waste. Therefore, it is important to understand the chemical reactions that take place in soil that affect nutrient retention. The objective of this research was to examine how different factors affect the amount of nutrients released in the soil. Specifically, changes in temperature, presence of water (moisture levels), and oxygen availability on the release of nutrients and elements from land-applied swine waste were evaluated. Samples were collected from four different sites (“Rodeo”, “4Acre”, “Farrow”, and “Turf”) within <0.25 mile of each other, where each site had different amounts of swine waste applied. The Rodeo site was the control site with no land application of swine waste. The 4Acre site received application of swine waste for four months from nursery pens. The Farrow site received heavier application of waste from sows and piglets. The Turf site is turfgrass with occasional application of swine waste from the nursery pen. Rodeo, 4Acre, and Farrow fields are mainly planted with winter wheat. The treatments for each site included flooding and non-flooding, heating soil to 35 °C, and restricting oxygen intake (anaerobic conditions). Each of these treatments were reacted for four weeks, and post reaction the soils were dried and sieved. Soil samples (2 g) were then reacted with 20 mL of Mehlich III solution. Liquid sample extractions were then filtered and analyzed via X-ray fluorescence spectroscopy (XRF). Results are currently under analysis. It is hypothesized that the Rodeo site will have the least amount of available nutrients versus 4Acre, Farrow, and Turf, and the temperature-reacted samples will likely have the most nutrients released due to enhanced breakdown of swine waste. Flooding conditions are also anticipated to affect nutrient release.
Development of an efficient method for protoplast isolation, transfection, and gene editing from soybean roots

Chidinma Lois Nwoko, Arjun Ojha, Vikas Devkar, Gunvant B. Patil
Institute of Genomics for Crop Abiotic Stress Tolerance (IGCAST), Department of Plant & Soil Science, Texas Tech University, Lubbock, TX

Protoplasts are plant cells with degraded cell wall that behave like animal cells in vitro. Protoplast is a versatile system in modern plant biology that provides a platform for rapid analysis of diverse signaling pathways, studying functions of cellular machineries and functional genomics screening. Protoplast allows the direct delivery of DNA, RNA or protein into the plant cell and provides a high-throughput system to validate gene-editing reagents. However, this system is less exploited in several legumes crops (including soybean), and it is because of lower protoplast yields, transfection efficiencies and lack of working protocol for plant regeneration from protoplast. Moreover, protoplast isolation in several plant is mainly focused on leaf mesophyll tissues. Although, root tissues provide several advantages, root protoplast isolation, transfection and gene-editing have not been established in soybean. To overcome these bottlenecks, we are developing a new robust method for high quality protoplast isolation and transfection from soybean roots (including transgenic hairy roots). With our newly developed the highest yield, 1.3 x 10^6 and 7.3 x 10^5) of protoplasts were obtained from soybean roots and hairy roots respectively. More importantly, we also describe a method for gene-editing in soybean protoplasts isolated from root tissues.
Evaluating the potential of hemp varieties in the West Texas conditions.

Preetaman Bajwa¹, Sukhbir Singh¹, Manpreet Singh¹, Ved Parkash¹

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In the declining water situation of the Ogallala Aquifer and for increasing crop diversification, emphasis is growing on exploring alternative, water-efficient crops in the Southern High Plains (SHP). Industrial hemp (Cannabis sativa L.) is a summer annual multi-purpose crop grown for seeds, fibers, and cannabidiol oil. It is an excellent rotational crop that uses approximately 40-60% less water than cotton and corn. During the summers of 2020 and 2021, field experiments were conducted as an initial effort to evaluate the adaptivity and productivity potentials of several imported hemp cultivars. In 2020, three varieties (Henola, B-Lab, Jinma) were evaluated in a RCBD design. In 2021, two planting dates and six varieties (Fibranova, Carmagnola Selezione, Eletta Campana, Yuma, Jinma, Anka) were evaluated in a split-plot design. The highest biomass yield was recorded for Jinma in 2020, which was almost 180% higher than the average biomass of the two Polish cultivars Henola and B-Lab. In 2021, the highest biomass was recorded by Jinma, followed by Yuma, Eletta Campana, and fibranova, and results for biomass, plant height, and IWUE followed the same trend among varieties. The germination experiment was carried out to evaluate the effect of six temperatures (10, 15, 20, 25, 30, 35 °C) on seed germination capacity and results illustrated that percentage germination remained similar from 10 °C to 30 °C but decreased by 20% at 35°C compared to 30°C. Jinma, Yuma and Eletta Campana performed substantially better compared to other varieties but first two had high THC. Therefore, Eletta Campana can be a potential variety for the West Texas region. Despite the claims of hemp being a low water-demanding crop, there is a lack of fundamental knowledge about its planting time, planting density, weed management, and water requirements under highly variable weather conditions of the SHP.
Abstract: Efficient irrigation scheduling that target to meet water requirements at a critical period for crops like sweet corn can help to sustain yield as well as save water in water-scarce areas like West Texas. Biochar as a soil amendment has been used in agricultural production, however, the combined effects of reduced irrigation and biochar on crop growth and water-use efficiency (WUE) have not been fully understood. The experiment was conducted at Quaker farm of Texas Tech University, Lubbock, Texas from April through August 2021 to examine the effect of growth stage-based irrigation management and biochar rates on biomass partitioning and WUE of sweet corn. Experimental units were randomized four times in a split-plot design with irrigation levels I₁ [100% crop evapotranspiration (ETc) before 50% tasseling (55 DAP)-100% ETc after tasseling], I₂ [80-60% ETc], I₃ [60-80% ETc], I₄ [40-40% ETc] as main plot factor and biochar rates (0 t/ha as control, 15 t/ha and 20 t/ha) as sub-plot factor. Biomass partitioning was measured at 36 DAP (days after planting), 45 DAP, 60 DAP, and 75 DAP. Results showed that, in 36 DAP and 45 DAP, I₂ seems to accumulate more biomass to leaves and stems than other irrigation treatments. However, after tasseling, at 60 DAP, I₁ outnumbered on the total biomass accumulation with significantly higher accumulation in stem compared to other irrigations. At 75 DAP, the biomass accumulation to cob in and I₁ and I₃ were comparable providing a similar total biomass accumulation. At 60 DAP, biomass accumulation in tassel was significantly higher in biochar treatments than in control. The WUE was comparable between I₁ and I₃. Results suggest that high biomass accumulation and WUE in sweet corn can be achieved by stressing more at the vegetative stage and less at the reproductive stage in West Texas.
Utilization of the landrace Hopi to identify novel genes regulating reduced gland formation in upland cotton (Gossypium hirsutum)

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Gland formation in upland cotton serves as a double-edged sword. Gossypol, the major product from the glands, provides resilience to plants against biotic stress but at the same time is toxic to monogastric animals. Emphasis on the improvement of fiber-related traits alone has narrowed down the genotypic and phenotypic variation for gland development in upland cotton. In this study, quantitative trait loci (QTL) analysis for gossypol content using an F₂ population derived from Hopi, a landrace with reduced gossypol content, and the commercial line TM1, was performed. Genotyping of F₂ individuals using the CottonSNP63K array gave a total of 8,047 informative markers. A high-density genetic map generated using the informative markers for the array spanned 2,253.11 and 1932.21 cM for the A and D sub-genome, with an average marker interval of 1.14 cM for the overall genome. The genetic map showed a strong co-linearity with the physical map of cotton in terms of the order of markers. Seven QTLs with PVE ranging from 1.43 to 10.34% were identified for gland development. Two QTLs, qGL_IM_12A and qGL_IM_12D covered the paralogs for cotton gland formation 3 (CGF3) gene encoding for bHLH transcription factor. The functional annotation-based in silico analysis of the genes within the three novel QTLs identified a total of 14 candidate genes. The tissue-specific comparative gene expression of candidate genes showed reduced levels of expression of MYB2 and bHLH1 in leaf and MYB2 and ZF1 in seeds for Hopi. Exploiting the genetic variation for reduced gland formation in seeds of cotton will allow the utilization of cottonseed meal as a safe and rich source of protein for monogastric animals.
Student/Presenter: Manpreet Singh, Ph.D. student, Plant and Soil Science

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Does biochar application affect soil properties and sweet corn production under deficit irrigation?

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Studying the effects of biochar application on soil physical, chemical, and biological properties is important to understand the underlying mechanisms through which biochar can affect crop production. The present study was conducted to evaluate the effect of hardwood and softwood biochar application on soil chemical, physical and microbial properties, and sweet corn production under three deficit irrigation regimes, 100%, 70%, and 40% crop evapotranspiration (ETc) replacement in 2019 and 2020, in Lubbock, Texas, US. The experimental units were replicated four times using a split-plot design. Soil pH and EC remained unaffected by biochar application, but hardwood biochar decreased the bulk density and improved the soil porosity of the sandy clay loam soil in the experimental plots. As a result, hardwood biochar plots showed a marginal improvement in soil water retention compared to no-biochar plots. Biochar application did not affect the microbial community and elemental concentrations, but hardwood biochar improved the total carbon content of the soil after two years of application. Both deficit irrigations (70% and 40% ETc) increased microbial biomass compared to 100% ETc irrigation. The yield under 70% ETc did not differ significantly from 100% ETc while 40% ETc reduced the yield by 17% and 44% (compared to 100% ETc) in 2019 and 2020, respectively. Biochar application did not increase the ear yield but hardwood biochar application resulted in greater vegetative dry biomass than no-biochar plots. These results suggest that 70% ETc can be a water-efficient alternative to 100% ETc with a marginal yield penalty for sweet corn production in the West Texas region. A long-term study is required to test the effect of biochar on soil properties beyond two years, and its corresponding effect on crop yields under limited irrigation.
Ethanol Positively Modulates Photosynthetic Traits, Antioxidant Defense and Osmoprotectant Levels to Enhance Drought Acclimatization in Soybean

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Abstract: Drought is a major environmental threat to agricultural productivity and food security across the world. Therefore, addressing the detrimental effects of drought on vital crops like soybean has a significant impact on sustainable food production. Priming plants with organic compounds is now being considered as a promising technique for alleviating the negative effects of drought on plants. In the current study, we evaluated the protective functions of ethanol in enhancing soybean drought tolerance by examining the phenotype, growth attributes, and several physiological and biochemical mechanisms. Our results showed that foliar application of ethanol (20 mM) to drought-stressed soybean plants increased biomass, leaf area per trifoliate, gas exchange features, water-use-efficiency, photosynthetic pigment contents, and leaf relative water content, all of which contributed to the improved growth performance of soybean under drought circumstances. Drought stress, on the other hand, caused significant accumulation of reactive oxygen species (ROS), such as superoxide and hydrogen peroxide, and malondialdehyde, as well as an increase of electrolyte leakage in the leaves, underpinning the evidence of oxidative stress and membrane damage in soybean plants. By comparison, exogenous ethanol reduced the ROS-induced oxidative burden by boosting the activities of antioxidant enzymes, including peroxidase, catalase, glutathione S-transferase, and ascorbate peroxidase, and the content of total flavonoids in soybean leaves exposed to drought stress. Additionally, ethanol supplementation increased the contents of total soluble sugars and free amino acids in the leaves of drought-exposed plants, implying that ethanol likely employed these compounds for osmotic adjustment in soybean under water-shortage conditions. Together, our findings shed light on the ethanol-mediated protective mechanisms by which soybean plants coordinated different morphophysiological and biochemical responses in order to increase their drought tolerance.
Effects of glutathione on waterlogging-induced damage in sesame crop

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Abstract: Sesame (Sesamum indicum) is an important oil crop, occupying the seventh position in the edible oil industry; however, it is relatively sensitive to waterlogging (WL) stress. Reduced glutathione (GSH) is known to have mitigating effects against various abiotic stresses in plants; however, its exploration to improve WL tolerance in sesame is still elusive. In this study, we investigated the multiple effects of exogenously applied GSH in sesame plants subjected to WL for 3 days. Our results showed improvement in growth and biomass production of GSH-sprayed waterlogged sesame when compared with WL-stressed counterpart alone. The improved performance of GSH-sprayed WL-stressed plants was supported by the increased leaf area, the levels of photosynthetic pigments and gas exchange, and chlorophyll fluorescence parameters. Exogenous GSH treatment significantly increased the levels of total soluble sugars and total free amino acids in the leaves of sesame plants for the improvement of water balance under WL conditions. Accumulations of superoxide and hydrogen peroxide, enhancement of malondialdehyde level, and electrolyte leakage in sesame leaves indicated evident oxidative damage induced by WL. On the other hand, exogenous GSH application diminished oxidative stress by enhancing the activities of catalase, ascorbate peroxidase, peroxidase, glutathione peroxidase, and glutathione S-transferase, as well as total flavonoid and GSH levels in the leaf tissues. Furthermore, GSH supplementation to WL plants increased the transcript levels of numerous antioxidant defense-related genes, such as SiCAT1, SiCATX1, SiAPX3, SiPOD40, SiPOD44, SiGPX4, SiPHGPX1, SiGSTU23, and SiGSTU25 in shoots, corresponding to enhanced activities of respective antioxidant enzymes. Our results highlight the potential roles of GSH in modulating adaptive mechanisms of sesame plants for reduction of WL-induced damage, and this GSH-mediated effective strategy could be implemented at the field level to sustain sesame production under WL conditions.