Armillaria Solutions Annual Project Report

Annual Meeting, October 13, 2022

USDA NIFA
United States Department of Agriculture
National Institute of Food and Agriculture

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Thursday October 13, 2022		
8:30	**Welcome and Introduction Ksenija Gasic**	
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		Alejandro Calle
		Pratima Devkota
		Jeff Adelberg/John Lawson
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9:50	11:00	Obj. 2: Discovery genomics
		Chris Saski
		Alejandro Calle
		Kendra Baumgartner
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11:00	11:15	Break
11:15	12:00	Obj. 3a: Short- and long-term solutions
		Greg Reighard
		Pratima Devkota
		Alejandro Calle, Ksenija Gasic
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12:00	**1:00**	**Lunch (Provided)**
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3:30	4:00	Obj. 5: Outreach
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What is Armillaria Solutions?

Armillaria Solutions is a trans-disciplinary, multi-crop, multi-institutional team of researchers, and growers and nursery representatives, dedicated to providing short- and long-term solutions for Armillaria Root Rot replant issue affecting the U.S. stone fruit industry.

The Standard Research and Extension Proposal is funded through the Specialty Crop Research Initiative grant 2020-51181-32142.

Problem

Armillaria root rot (ARR) is a major threat to the long-term productivity of stone-fruit and nut crops across the major production areas in the U.S. There are no efficient methods of eradicating the long-lived inoculum buried in the soil before replanting, nor are there therapeutic methods to offset reduced productivity and tree death.

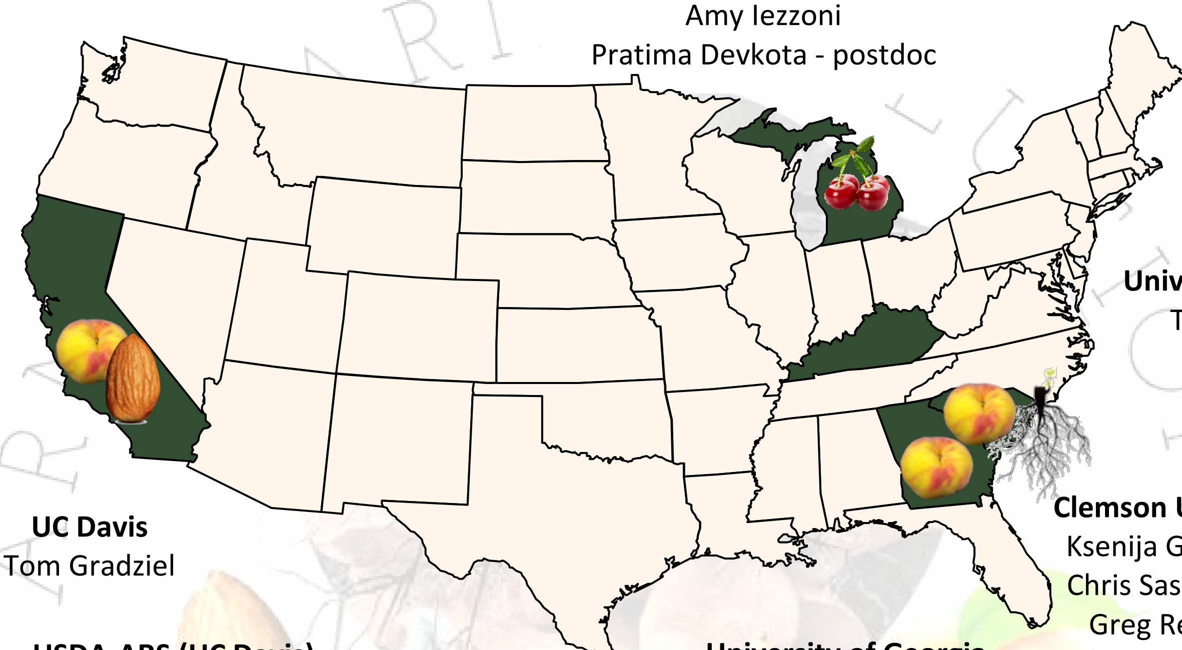
Loss of productive land for the stone fruit and nut producers due to ARR is already happening; without immediate short- and long-term actions, prime *Prunus* orchard land will be permanently out of production, resulting in a devastating effect on the industries and local communities.

Solution

The most economical and sustainable approach to prevent the loss of peach, cherry, and almond production due to *Armillaria* infection is to develop ARR-resistant, horticulturally acceptable rootstocks. This project will provide the 'building blocks' needed to enable and accelerate on-going *Prunus* breeding programs, as well as support the testing of cultural practices as short-term solutions to increase tree longevity on replant sites.

Project Collaborators

Michigan State
Ray Hammerschmidt
Amy Iezzoni
Pratima Devkota - postdoc



Univ. of Kentucky
Tyler Mark

UC Davis
Tom Gradziel

USDA-ARS (UC Davis)
Kendra Baumgartner

University of Georgia
Dario Chavez
Phillip Brannen
Jeff Cook

Clemson University
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SG Sierra Gold Nurseries

Fowler NURSERIES, INC.

CVN inc. EST. 1902 Cumberland Valley Nurseries, Inc.

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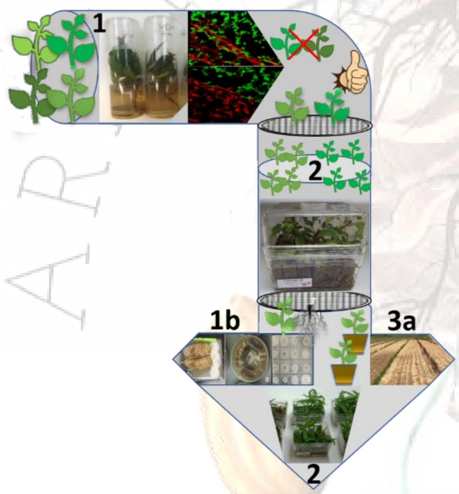
OBJECTIVE 1

Identify, Characterize, and utilize Sources of Resistance to Armillaria/Desarmillaria

Prunus germplasm exhibits various modes of resistance to Armillaria root rot (ARR). *Prunus* breeders collaborating with pathologists will evaluate germplasm from four sources (nurseries, USDA-ARS NCGR, wild collection, and hybrids from directed crosses) for resistance to *Armillaria solidipes, A. mellea or Desarmillaria tabescens* by implementing a resistance screening pipeline (Fig below). All resistant germplasm will be further characterized for its anatomical and biochemical response to infection and used in breeding and field evaluations.

Methods overview: Participating teams of *Prunus* breeders and pathologists will:



1a Identify sources of resistance in the germplasm

1b Characterize the anatomical and biochemical responses of root tissue to infection

Timeline: 1a and **1b** will be initiated in Year 1 and completed at the end of Year 4. Resistant material will be used in breeding past project completion.

Objective 1. Identify, characterize, and utilize sources of resistance to Armillaria/Desarmillaria

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1a Year 2 Goals:

- Identify sources of resistance in the germplasm
- Include wild collected (MI) sources of resistance to ARR in screening pipeline

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Year 2 Accomplishments:

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- 65 confirmed hybrid seedlings from five different crosses made in spring 2021 were screened *in vitro* with *Armillaria mellea*, and root microscopy was used to evaluate presence/absence of fungal penetration. Eight hybrids with confirmed absence of fungus penetration were identified and entered in multiplication and subsequently co-cultivation step.
- Four putatively resistant hybrids screened in Y1 were multiplied (>100 plants, each) and are ready for co-culture with *A. mellea* and *Desarmillaria tabescens*.
- Crosses of ARR resistant genotypes (*P. munsoniana* #4; *P. cerasifera* DPRU.2101 and *P. cerasifera DPRU.*2314) and commercial rootstocks 'Guardian®' and *P. avium* 'NY54' were performed. One seed of *P. cerasifera* DPRU.2314 × *P. avium* (NY54) from MSU; 370 seeds of *P. cerasifera DPRU.*2101 × 'Guardian®' from UC Davis, and 99 seeds of *P. munsoniana* × 'Guardian®' from Clemson University (CU) were stratified in the *in vitro* culture. One seed obtained from the cross *P. cerasifera* DPRU.2314 × mazzard sweet cherry is currently at CU where germination is being attempted.
- 21 seeds from the cross *P. cerasus* cv. 'Montmorency' × DPRU.2314 were obtained at MSU and sent to CU for germination and subsequent screening. No successful germination was obtained.
- Wild *Prunus* seeds collected by MSU were germinated at CU and entered in ARR screening pipeline.
- *P. cerasifera* DPRU.2101 and DPRU.2314 were propagated in pots at Prunus NCGR and included in screening in a tissue culture with a combination of commercial rootstocks, known resistant/susceptible controls, and experimental rootstocks at USDA-ARS & UC Davis.

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Challenges

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- KASP DNA test developed to confirm peach-plum hybrids revealed none of seedlings from 'Guardian®' trees were hybrids. In 2022 we repeated the pollination and caging the trees with flagging single branch on each mother tree that was emasculated but not pollinated. Fruit development on unpollinated branches confirmed wind pollination through the net used for preventing bee entrance to the cage. That is why there are no hybrid seedlings with 'Guardian®' as a mother in 2022. We will use pollination bags in 2023 to cover targeted branches to prevent pollination with undesirable pollen.
- Low or no germination was observed for some interspecific crosses between *P. cerasifera* and *P. avium*. Embryo rescue will be attempted next season to try to obtain hybrid plants from those crosses.

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Year 3 Goals

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- Repeat crossing scheme from previous year and initiate crossing of *P. cerasifera* cv. Coheco trees (i.e., DPRU.2314) and sweet cherry.
- Continue to evaluate for disease incidence/severity *in vitro* and in field and add additional material to the pipeline. New germplasm will include accessions and/or interspecies hybrids of some of the species presented above as well as new plantings representing *P. scoparia*, *P. orthosepala*, *P. webbii*, and *P. argentea* and *P. dulcis* × *P. cerasifera* DPRU.2101. The hybrid is being rapidly multiplied *in vitro* to include in the co-culture screening with *Desarmaillaria tabescens* (Year 2).

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1b Year 2 Goals: • Characterize the anatomical and biochemical responses of additional *Prunus* genotypes that showed tolerance in vitro (1a).
Year 2 Accomplishments:

• Conducted antifungal assays for rootstock material provided by Fowlers Nursery. Correlation between constitutive antifungal compounds, barrier zone formation and host susceptibility to ARR were observed.
• Utilized rapid *in-vitro* method to screen susceptibility of four *Prunus* genotypes to *Armillaria solidipes*, *Desarmillaria tabescens*, and *A. mellea*.
  ○ *P. cerasifera* accessions 14-4, 20-4, and 20-3, and *P. munsoniana* accession 59-1, provided by CU were screened.
  ○ All accessions showed reduced susceptibility to *A. solidipes*, *D. tabescens*, and *A. mellea*. No genotype and fungal interaction was observed.
  ○ Root periderm tissue of all four accessions responded by forming barrier zone to deter fungal invasion.
• Conducted thin layer antifungal bioassay of commercially available possible antifungal compounds from *Prunus maackii*. Compounds like pinocembrin, taxifolin, galangin, cinnamic acid, and trans-cinnamaldehyde showed antifungal activity against the standard test fungi *Cladosporium cucumerinum*.

Challenges
• Explore possibility of ARR screening approach using whole live plant growing in soil under controlled conditions in growth chamber to better understand the fungal defense response.
Year 3 Goals
• Confirmation of resistance for 4 hybrids with 40 *in vitro* plants of each genotype will be conducted. For those with confirmed resistance create clonal plants for field nursery planting. • Generate cherry × plum hybrids to breed for *Armillaria* tolerance and graft compatibility with cherry. • Screen more *Prunus* genotypes in the screening pipeline to characterize the anatomical and biochemical responses.

OBJECTIVE 2

Discovery genomics to enable breeding solutions for ARR resistance/tolerance

Comprehensive understanding of the molecular basis of ARR resistance will facilitate the discovery of genetic resistant mechanisms and development of biomarkers. *Prunus* breeders will use molecular tools to precisely track and predict ARR resistance in germplasm screenings and directed crosses.

Methods overview: The molecular mechanism(s) that confer ARR resistance will be investigated with:

2a Genome characterization of ARR resistant germplasm

2b Characterization of the transcriptomic response to infection, and

2c Characterization of the metabolic response to infection

Timeline: 2a – 2b will be initiated in Year 1, completed in Year 2. **2c** will be initiated in year 2 completed in Year 3 or 4.

Chris Saski **Ksenija Gasic** **Jeff Adelberg** **Amy Iezzoni**

Tom Gradziel **Kendra Baumgartner** **Lichun Cai** **Nishanth Tharayil**

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Objective 2. Discover Genomics to Enable Breeding Solutions for ARR Resistance/Tolerance (Team Lead Saski)

2a Y2 Goals:
• Prepare genomic DNA and collect whole genome sequences from 6 *Prunus* genotypes with putative ARR resistance as verified in root co-cultures.
Year 2 Accomplishments:
• High molecular weight genomic DNA was obtained and purified from the ARR resistant peach/plum hybrid rootstock, 'MP-29', and the PTLS resistant (ARR susceptible) rootstock 'Guardian®'. • Single-molecule data (pacbio HiFi), deep coverage illumina, and Hi-C nucleosome contact sequences were collected and a haplotype resolved genome assembly was generated. • Phenotypic information on homothallic putative-3N isolate from Africa (Africa470) was gathered and reproductive compatibility between 'Africa470' and homothallic putative-3N isolate 'Japan384' were evaluated. • Mating behavior indicated two mating-type loci in homothallic *A. mellea*.
Challenges
• Genomic resources for *Armillaria mellea* are lacking.
Year 3 Goals
• Finalize genome assemblies for 'MP-29' and 'Guardian®', annotate genes and determine function. • Released genomes to the public domain with a scientific publication. • Integrate these genome assemblies with data from 2a and 2c. • Obtain genome sequence of *A. mellea* isolates

2b Y2 Goals: • Analyze transcriptome data of 'MP-29' (ARR resistant), 'Guardian®' (ARR susceptible), and DPRU.2214_14-4 (*P. cerasifera* ARR resistant) under control and infected conditions with *A. mellea* and *D. tabescens* over 4 time points. • Interpret ideal timing from RNAseq to survey primary and secondary metabolites.
Year 2 Accomplishments:
• Transcriptomic data was analyzed from ARR resistant and susceptible germplasm that were challenged with 2 Armillaria species (*D. tabescens* and *A. mellea*) over a time course. • *De novo* transcriptomes were assembled, and candidate genes underlying the infection response were determined. Data are finalized and are being prepared for publication.
Challenges
• Many genes discovered to be involved in the resistance response • Genetic resistance seems to be rare in *Prunus* germplasm which confounds traditional genetic mapping approaches
Year 3 Goals
• Collect additional transcriptomic data paired with metabolomic data from 2c to further resolve biochemical pathways and genes driving ARR resistance.

2c Y2 Goals: • Survey primary and secondary metabolites in fungus, plant and plant co-cultivated with fungus.
Year 2 Accomplishments:
• A slurry-based inoculation approach for transcriptomic/metabolomics analyses was developed using two genotypes (*Prunus cerasifera* 14-4 and 'Guardian®'). • Inoculum density was tested to maximize root contact with pathogen (*A. mellea* and *D. tabescens*) in the co-culture system. • Number of plants per vessel was adjusted in preliminary tests to obtain adequate quantities of root tissue for metabolomics and transcriptomic analyses. • Sample preparation test (washed vs unwashed) was conducted and preliminary primary and secondary metabolites of *A. mellea* fungus were obtained. • We are generating fungal and plant tissue for baseline metabolome data and initiating co-culture experiments.
Challenges
• Instrument break down in the CU metabolome facility caused prolonged times for obtaining metabolomic data. Samples are in queue, and we expect to have the results of the sample preparation test run by the end of the October 2022.
Year 3 Goals
• Collect additional transcriptomic data paired with metabolomic data from 2c to further resolve biochemical pathways and genes driving ARR resistance.

OBJECTIVE 3

Implement Short- and Long-Term Approaches to Manage ARR

Newly discovered and/or developed rootstocks will be evaluated for desirable horticultural traits on replant sites. Cultural practices have the potential to reduce the financial burden of ARR to producers by extending the long-term productivity of *Prunus* orchards until ARR resistant compatible rootstocks are developed.

Methods overview: Horticulturalists, pathologists and nurseries are joining forces to come up with the short-term solutions and long-term approaches to extend orchard productivity on ARR replant sites.

3a Resistant germplasm will be evaluated in nursery settings for horticultural characteristics by direct use as a rootstock, and with or without an interstem.

3b Binary sectoral rootstocks will be developed and evaluated as a complimentary biological version of the root collar excavation (RCE) strategy to increase almond orchard longevity on ARR sites

3c Root-collar excavation planting strategy on ARR replant sites will be evaluated as a short-term cultural practice and early deliverable to extend orchard life in peach and cherry.

Timeline: 3a and **3b** will be initiated in Year 1 and completed Year 4. **3c** will be initiated in Year 1 and completed in Year 3.

Greg Reighard **Ksenija Gasic** **Guido Schnabel** **Bulent Koc**

Tom Gradziel **Pratima Devkota** **Dario Chavez** **Phil Brannen**

Objective 3. Implement Short- and Long-Term Approaches to Manage ARR

3a Year 2 Goals:
• Maintain and observe the 2021 plantings of new rootstock releases possessing complex species backgrounds to evaluate for *Armillaria* resistance or tolerance (Clemson) • Obtain, propagate, bud and plant out new rootstock releases possessing complex species backgrounds to evaluate their response to *Armillaria* (Clemson). • Evaluate *Armillaria* tolerance of peach and sweet cherry scions on 'MP-29' and 'Krymsk® 86' in Michigan
Year 2 Accomplishments:

• 3 field screening trials of new rootstocks and selections were planted in 2021 on *Armillaria* and PTSL replant sites at the Sandhill Research and Education Center in Pontiac, South Carolina and at Titan Farms (2 trials) in Ridge Spring, South Carolina. One Ridge Spring trial included new rootstocks from private breeding programs in California.
    ○ First year survival was excellent at Titan Farms (<1% tree death).
    ○ Tree death was higher at the Sandhill REC due to number of cultural issues, and tree growth was poor.
    ○ Results of several earlier rootstock trials containing some of the rootstocks being tested here were published or submitted.
• Clonally propagated putative ARR tolerant material identified in 1a was split between the Cumberland Valley Nursery and CU nursery to test their horticultural performance in nursery and field setting.
• Peach trees on 'K-86' and 'MP-29' rootstocks planted in nursery at the Southwestern Michigan Research and Extension Center (SWMREC) in 2021 did well. They were planted in *Armillaria* infected grower's location in west central Michigan in spring 2022. Ten peach trees each on rootstocks 'MP-29' and 'Krymsk® 86' were planted in a non-ARR site at SWMREC to assess horticultural performance.

Challenges
• Sweet cherry grafted on 'MP-29' and 'K-86' with Adara interstem are not viable commercial options due to weak, dying trees. Therefore, the sweet cherry trial was discontinued. This indicates that finding a tolerant rootstock for cherry will require new genetics – either cherry × plum hybrid or tolerant cherry species. • The peaches on 'MP-29' and 'K-86' are showing good compatibility and will help answer the question of whether these rootstocks are tolerant to *Armillaria* spp. in Michigan. • Discussions to find possible approach for grafting cherries to 'K-86'; and 'MP-29' with experts have been initiated, in case these rootstocks show tolerance to *Armillaria* species in Michigan.
Year 3 Goals
• Continue evaluation of current rootstock trials and seek/obtain additional promising germplasm to test as rootstocks (Clemson). • Continue to monitor and assess horticultural performance and mortality associated with *Armillaria* root rot in potential rootstocks for cherry in MI (MSU).

3b Year 2 Goals: • Improve methods of obtaining sectoral rootstock • Establish field trial with the sectoral rootstocks to test their performance.
Year 2 Accomplishments:

- Continued monitoring of oak root fungus disease evaluation plot established at the UCD Wolfskill Experimental Orchard in Winters California.
  a. Replicated plantings comprising reportedly resistant species and/or interspecies hybrids of a diverse germplasm including
     - *P. dulcis*, *P. persica*, *P. davidiana*, *P. cerasifera*, *P. americana*, *P. tangutica* and almond as susceptible control.
     - Susceptible controls are starting to show disease, but no clear diseases are evident in the experimental plantings at this early stage.
     - Evaluated rootstock selections include sectoral chimeras generated through modified approach grafting techniques.
  b. Additional resistant germplasm was added for evaluation in 2022.
     - This germplasm includes accessions and/or interspecies hybrids of some of the species presented above as well as new plantings representing *P. scoparia*, *P. orthosepala*, *P. webbii*, and *P. argentea*.
     - In addition, approximately 200 interspecies hybrid seed resulting from crosses between parent species showing good disease resistance and/or commercial rootstock characteristics are now being stratified in preparation for fall, 2022

Challenges

- Shipping live or dormant *Prunus* from South Carolina to California is very difficult therefore the establishment of the potted trees was initiated to use as source of material (USDA).
- We will explore shipment of invitro unrooted plants as an alternative.

Year 3 Goals

- Fall-winter, 2022-transplant newly developed binary sectoral rootstocks to UCD ARR disease screening block in Winters California.

3c Year 2 Goals:

- Conduct experiments at producers' fields in smoothing berms between trees to determine the efficiency and performance of the developed tool. (Clemson)
- Analyze tree health and mortality data and collect more data in 2022
- Continue deployment of the levee plow for planting in berms across the Georgia peach production area.
- Continue data collection in Armillaria demonstration trial established in 2018 at Southern Orchards.

Year 2 Accomplishments:

- The efficiency of RCE was evaluated in three different commercial orchards of South Carolina. Tree decline was recorded and comparative statistical analyses between different planting systems (berm planting with RCE, berm planting without RCE, regular planting with no berm and RCE, and regular planting) were performed.
- Field trials at locations in South Carolina were monitored for the impact of berming and root collar excavation on tree health on replant sites with a history of ARR problems.
    - Tree health was estimated on a scale 0-5 (where 0 = dead tree, 1 = 20% productive canopy, 2 = 40% productive canopy, 3 = 60% productive canopy, 4 = 80% productive canopy, and 5 = entire canopy productive) at three locations in SC (REDW, GJoll and MFRC).
    - Bermed and unbermed tree performance comparison of the 225 trees at the REDW location showed no difference in tree health,
    - For 296 trees at the GJoll location a significantly better tree health rating (4.9) was assigned to excavated than non-excavated trees (4. 7).
    - At the MFRC location, trees at both the grower standard (1.1 rating) and RCE (1.5 rating) treatments experienced significant decline and significant differences between treatments were not detected.
- A total of 1300 acres of peaches on berms were planted in 2022 across Georgia.
    - RCE using air spade will be performed at Southern Orchards this fall/winter.
    - Tree performance (tree mortality, trunk cross sectional area, and canopy size) were measured in subsample trees across the rows per treatment.
- Berms around the cherry trees selected for root collar excavation in an *Armillaria* infected cherry trial plot were pushed down.
- Root-collar excavation of trees were performed using a 105-cfm air-spade powered by a commercial 185 cfm compressor. The electronic control box, pressure transducers, and flow meter along with the RTK GPS receiver were tested at the Musser Farm and at the Hyder Farm (Test 1). The UAV aerial images before and after de-berming operations were used to evaluate performance of the tool.
    - The paddle wheel size was not large enough to knock down the berms with two passes, thus paddle wheel was modified by increasing the diameter and height of the paddles. The new paddle wheel was tested on berms that were created for this test at Musser Farm and at Hyder Farm (Test 2).

Challenges
• At MHOO location the grower had pushed up a significant number of the trees and a comparison between treatments was no longer possible. (SC) • Identifying locations with *Armillaria* incidence in Georgia was problematic. We are currently working to make sure that we can access those locations to set demonstration plots. • The soil removal using air spade is not being implemented by growers in GA. • Due to sandy soil trees at MI experimental plots had to be staked up for stability as they began falling to the ground after RCE. (MI)
Year 3 Goals

• Continue to monitor field trials (Clemson and MI)
• Equip the debermer system with sensing mechanism to automate the paddle wheel extension and retraction motions to avoid tree trunks while deberming.
  o Integrate an electronic flow control valve to adjust the flow rate of the hydraulic fluid to the paddle wheel to vary the paddle wheel RPM in different operating conditions (soil type and soil conditions).
  o Measure the torque paddle wheel is facing and adjust the flow rate to adjust the paddle wheel RPM.
  o Experiment brush mechanisms for soil removal around tree trunks.
• Identify new demonstration plots across the Georgia peach producing area.
  o Target locations with known Armillaria presence, availability of multiple rootstocks, and planting of plots has occurred 2 years ago.
  o Deploy new tractor implement designed by Clemson for RCE in comparison with non-excavated controls at different locations.

OBJECTIVE 4

Determine the Economic Effect of ARR and Cost-Benefit of Cultural Practice Adoption

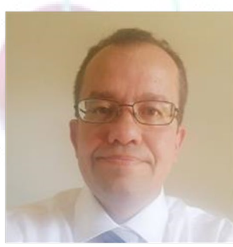
The proposed cultural practices and newly developed/discovered rootstocks promise to reduce the economic and social impacts of ARR on stone fruit production. An understanding of how increased tree cost impacts the long-term profitability is an essential component of an overall production budget, decisions, and long-term viability of the industry.

Methods overview: A baseline information towards the cost of ARR, current practices being used to manage ARR, and the potential benefits of the proposed cultural practices, will be provided to the industry.

4a Survey will be developed and deployed via USDA NASS to determine the impact of the ARR on replant for each stone fruit crop.

4b A template to input and calculate the effect of the ARR solution will be provided to every state/grower.

Timeline: 4a will be initiated in Year 1 and completed in Year 3. **4b** will be initiated in Year 2 and completed in Year 4.



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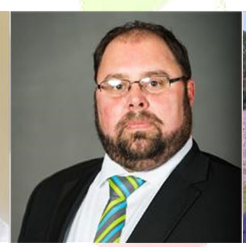

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Objective 4. Determine the Economic Effect of ARR and Cost-Benefit of Cultural Practice Adoption

Year 2 Goals: • Distribute the survey instrument by the end of year 2
Year 2 Accomplishments:

• A pre-test of the survey instrument was completed with the focus groups, for cherries and peaches.
• Survey instrument was distributed to 55 peach growers across US, using a phone survey.
    ○ Conducted by professional interviewers from Qualtrics. The sample of the growers was also from the panel of farmers that Qualtrics has.
    ○ Phone survey helped identify potential issues with the survey instrument, that we did not identify with the focus groups.
• The data from this sample are currently analyzed by the graduate student.
• Working on a simulation model to evaluate the economic impact of Root Collar Excavation for peach orchards.

Challenges
• Originally, we were planning to distribute the survey in year 2 using USDA NAAS services. During survey development we realized that even though USDA NAAS might reach more participants we had no control over who those participants would be, and that responses collected might not be relevant. The decision was made to re-budget the consultant funds to support travel of the socio economics team to the key grower meetings for each of the crops to administer the survey. As most of the regional growers' meetings are happening during fall and winter and the discussion with the focus groups and pre-testing survey instruments were completed in February of 2022, we decided to distribute the survey in person during the 2023 meetings. • During the pre-test phase we noticed limitation in the peach yield data availability.   ○ Will work with producers to get an estimate of yields as the model is developed.
Year 3 Goals
• Administering survey at the regional almond, peach and cherry grower meetings. • Analysis of the data from the survey(s) • Completion of the simulation model to evaluate the economic impact of Root Collar Excavation

OBJECTIVE 5

Conduct Outreach and Extension Activities to Facilitate the Adoption of Results

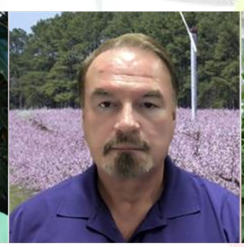
Stakeholder education on benefits of adopting new cultural practices and planting resistant rootstocks will improve profitability and ensure sustainability of the U.S. stone fruit and affiliated nursery industries.

Methods overview: Outreach activities will target peach, cherry, and almond growers affected by ARR so that new knowledge can be quickly disseminated, and feedback obtained. In addition, outreach efforts will also target tree-fruit nurseries, as they are key partners in delivering genetic solutions to producers.

- Regional and local growers' meetings will be utilized for direct interaction with the stakeholders and nurserymen to facilitate the adoption of resistant rootstocks and root-collar excavation.

- County agents and members of the Advisory Panel will communicate directly with growers.


Juan Carlos Melgar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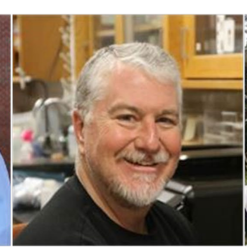
Phil Brannen


Kendra Baumgartner

Objective 5. Conduct Outreach and Extension Activities to Facilitate the Adoption of Results.

Year 2 Goals:

- Organize annual project meeting
- Attend and present at the regional growers' meetings and field days
- Produce video documentaries

Year 2 Accomplishments:

- Annual project meeting was organized virtually in October 2021.
- The first newsletter was developed (spring 2022) and shared with stakeholders, extension specialists and researchers.
- Project website was updated with the current information and twitter account created
- Project was presented at regional and national grower, stakeholder, and scientific meetings. Round table and lunch discussions with growers as well as demonstrations and trainings were carried out at these meetings.
- The RCE system was promoted to SC growers and students as one strategy to manage the ARR disease during two extension talks and two student field days.
- Video documentaries related to ARR management, including root collar excavation, and de-berming were shown at the Southeastern Professional Fruit Workers Conference

Challenges

- None noted

Year 3 Goals

- Continue video documentaries and newsletters
- Obtain grower feedback via round table discussions
- Present at the regional growers' meetings and organize field demonstration days
- Make video documentaries and presentations accessible via project website

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Armillaria Solutions Advisory Panel

Armillaria Solutions Advisory Panel members represent relevant and diverse fields of the stakeholders and researchers, including growers, nurserymen, and representatives of crop specific professional organizations and councils for almond, cherry, and peach.

INDUSTRY

Chalmers Carr	Titan Farms
Yougjian Chang	North American Plants
Chuck Fleck	Sierra Gold Nurseries
Julie Gordon	Cherry Marketing Institute
Josette Lewis	Almond Board California
Denise Moore	Fowler Nurseries
Jim Nugent	Michigan Tree Fruit Commission
Lawton Pearson	Pearson Farms
Phillip Pelham	Cumberland Valley Nursery
Kay Rentzel	National Peach Council
Chris Yonce	South Carolina Peach Council

SCIENTIFIC

María Ángeles Moreno	Research Scientist Pomology
Veronica Guajardo	Rootstock Geneticist
Courtney Hollender	Asst. Professor Molecular Genetics
Daniel Kluepfel	Research Leader USDA ARS
Stephen Kresovich	Geneticist and Sorghum Breeder
Michael Parker	Professor Horticulture Ncsu
John Preece	Retired USDA Research Leader
Astrid Volder	Professor Plant Science

NOTES

Participating Institutions

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