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FNGLA Endowment 2018-2019 Funding Reports

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ABOUT THE FNGLA ENDOWMENT

The Florida Nursery, Growers and Landscape Association (FNGLA) created an endowment in 2005 to address problems and questions that are important to the Florida nursery industry.

The FNGLA Endowed Research Fund (#F003129/30) provides awards up to $5,000 each to supplement and extend existing research projects. The principal balance of the endowment is more than $1.45 million, and 10 projects were funded for a total of $46,874 and involved 18 faculty members.

The following priorities were determined for the selection of the 2018-19 projects:

1. Enhance Floridians' Quality of Life
2. Enhance Quantities and Diversity of Plant Material
3. Improve Environmental and Resource Management
4. Improve Pest Management Practices and Strategies
5. Improve Production System Practices and Strategies

The selection process included a review by the following FNGLA committee members:

- Ed Bravo
- Joe Cialone
- Van Donnan
- Sylvia Gordon
- Nate Jameson
- Sherry Larkin
- Stefan Liopris
- David Liu
- Mike Marshall
- David McDonald
- Nancy McDonald
- Linda Reindl
- Paul Wiggins
- Will Womack

A MESSAGE OF THANKS

To the Florida Nursery, Growers and Landscape Association:

We want to thank you for your continued support of the research conducted this year at UF/IFAS, both on campus in Gainesville and at five Research and Education Centers (RECs). The additional funding your organization raised, and the time given by the selection committee, are truly appreciated.

Through the endowment, our faculty members will continue the important research and discovery needed by Florida's nursery industries, and we are thrilled to continue this collaboration.

Sincerely,

Robert A. Gilbert
UF/IFAS Dean for Research
Director of the Florida Agricultural Experiment Station

Sherry L. Larkin
UF/IFAS Associate Dean for Research
Associate Director of the Florida Agricultural Experiment Station

ENHANCE FLORIDIANS' QUALITY OF LIFE

Determining Root Space Requirements for Florida Street Trees

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ABSTRACT

Urban street trees provide many benefits to the community, but managers must balance these benefits with the costs of maintaining the trees and the surrounding infrastructure. When large shade trees are planted in small spaces, damage can be caused to adjacent sidewalks and streets, as well as to the trees. Despite knowing the typical heights and diameters at breast height for common street trees, researchers and practitioners do not know the usual sizes of the base of such trees, which is where conflict between trunk, roots, and infrastructure occurs. One way to estimate the size of the base of the tree is to directly measure the trunk flare diameter, but this is a difficult measurement to obtain and too time-intensive for typical municipal street tree inventories. We hypothesized that a significant allometric relationship exists between the diameters at breast height and at the trunk flare for two common, large street trees in Florida: live oak (*Quercus virginiana*) and laurel oak (*Quercus laurifolia*). We collected data on 205 trees total, measuring the diameters at the two locations on the trunk, as well as recording planting space dimensions, tree defects, infrastructure damage, and environmental characteristics like groundcover and crown light exposure. After analyzing the data, we produced equations for estimating trunk flare diameter and planting space requirements for both species. These findings can guide future tree planting and management decisions and potentially reduce some of the conflicts that occur between these trees and the built landscape.

OBJECTIVES AND METHODS

1. Investigate the relationship between trunk diameter at two different heights by creating models for estimating trunk flare diameter based on diameter at breast height.
2. Create an equation that can be used to estimate root space requirements for these species.

We randomly selected live oaks (*Quercus virginiana*) and laurel oaks (*Quercus laurifolia*) from an existing inventory dataset of street trees in Tampa, Florida. We collected data on 104 live oaks and 101 laurel oaks. To measure trunk flare diameter, we used flags to delineate the points at which trunk tissue transitioned to root tissue and to guide a measuring tape around the base of the tree in an approximately circular shape **(Figure 1)**. We converted the circumference to diameter afterwards. In addition to measuring diameters, we recorded planting space dimensions, tree defects, infrastructure damage, and environmental characteristics like groundcover and crown light exposure. We also noted whether the trunk flare shape was circular or not to check for any variance in trunk flare diameters during analysis.

Figure 1. Image of the field method for measuring the circumference of the trunk flare. The same person took this measurement each time to ensure precision.

To analyze the data, we ran linear regression models of the relationship between trunk flare diameter and diameter at breast height for each species. Early models included additional factors like trunk flare shape, groundcover, presence of root defects, and distance to closest infrastructure in order to test for interactions. After analyzing the data, we produced equations for estimating trunk flare diameter and used these findings and those from the literature to develop planting space requirements for both species.

RESULTS

We found 42 instances of cracked infrastructure (roads, sidewalks, and curbs), 41 instances of sidewalk lifting or curb pushing, and 12 instances of recently repaired or replaced infrastructure adjacent to the tree. We found 37% of the live oaks and 38% of the laurel oaks were associated with damage of some kind. Most factors did not significantly affect the size of trunk flare diameter in the models. Groundcover, crown light exposure, irrigation, and distance to infrastructure only increased the R^2 value in the models by 0.01 or less, so we concluded that the simplest models including only trunk flare diameter and diameter at breast height were the optimal ones for use in this study.

After checking for these interactions, we further investigated the simple relationship between TFD and DBH. We found a strong relationship between TFD and DBH **(Figure 2 and 3)**, meaning we can confidently estimate TFD from DBH using the equations derived from the models, which are listed below:

Live oak: TFD = 1.48 + 1.68 x DBH

Laurel oak: TFD = 7.55 + 1.91 x DBH

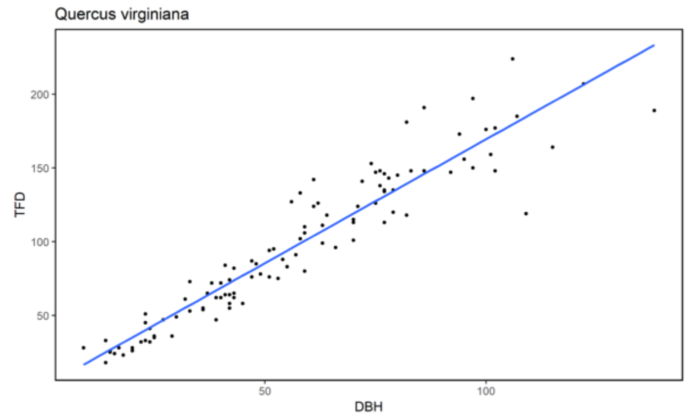

Figure 2. Simple linear regression showing the relationship between live oak (Q. virginiana) diameter at breast height (DBH) and trunk flare diameter (TFD). $R^2 = 0.89$, $p < 2e^{-16}$.

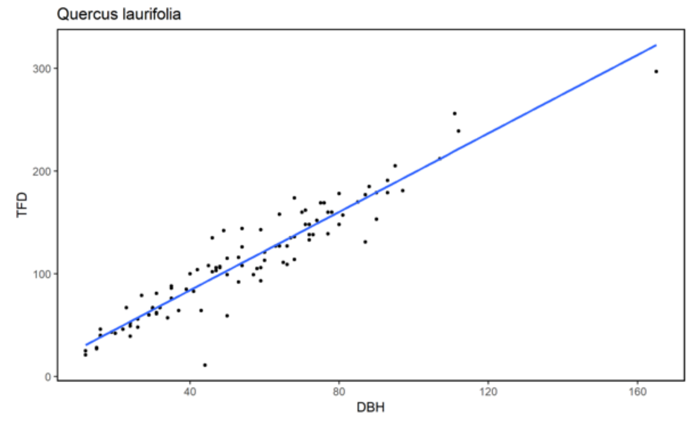

Figure 3. Simple linear regression showing the relationship between laurel oak (Q. laurifolia) diameter east height (DBH) and trunk flare diameter (TFD). $R^2 = 0.89$, $p < 2e^{-16}$.

In addition to these equations, we developed an equation for estimating planting space requirements for the large oak species in our study based on the assumptions that we want the oaks to live to maturity with no conflict with infrastructure **(Figure 4)**. We looked at the largest DBH values observed in the field and used this to estimate maximum TFD. The results were similar for both species, so we were able to use one equation for both trees. Based on literature on conflict between large trees and infrastructure, we used a safe minimum distance between trunk flare and infrastructure of 4 feet. Overall, we determined the minimum planting strip requirement for our oaks is 15 feet.

$$\text{Planting strip width requirement} = \frac{\text{TFD}}{12\ \text{in/ft}} + 8\ \text{ft}$$

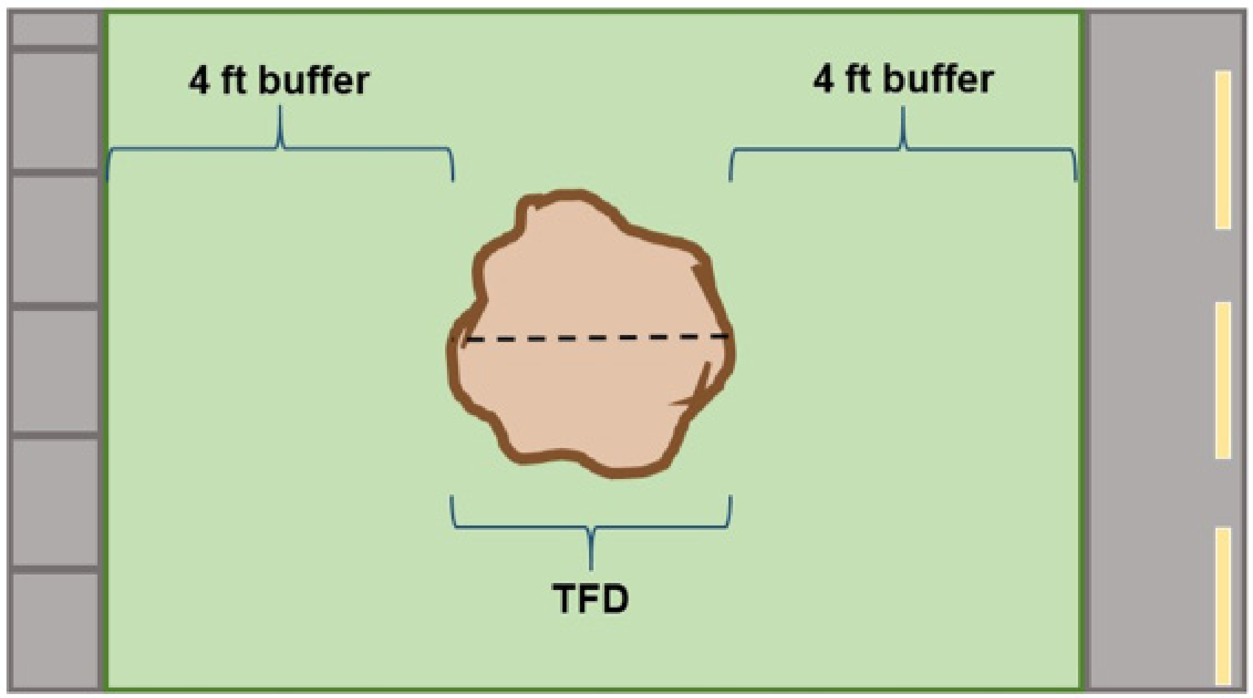

Figure 4. Schematic of how to derive a planting space requirement using the maximum TFD and a recommended 4 feet between the trunk flare and infrastructure.

CONCLUSIONS

We are currently drafting a manuscript for publication in a peer-reviewed journal. In the meantime, we have been able to share our results with a local urban forestry working group comprised of city arborists, urban foresters, and municipal and county natural resource specialists. The group provided positive feedback on the presentation, as they were eager for science-backed information to help them make urban tree management decisions. One member even said there is the potential to codify the planting space requirement for their county, meaning this project could be quickly translated into research-based changes in local laws. Having the information from this study will also help practitioners communicate with other departments when planning planting projects and construction work around trees.

Practitioners can apply these equations to determine planting space requirements, identify locations where conflict could be happening, and even estimate stump sizes for grinding after removals. We found that the recommended planting space for the studied oaks is 15 feet, yet many planting strips in Tampa and throughout Florida are far under 15 feet. These oaks are regularly planted in small planting spaces, only to cause damage in the future and/or to be removed right as they are reaching the size at which they provide maximum benefits and return on investments. This research supports what arborists and urban foresters already suspected and could provide a talking point for changing the way urban plantings are designed, resulting in more sustainable urban forests.

Finally, this project created the momentum for our group to work with researchers in other states to look at trees in their regions. The project has also provided Ms. Hilbert with invaluable experience leading a research project from start to finish. This project has given her the opportunity to conduct applied research with many opportunities for extension and collaboration with professionals from diverse backgrounds.

Identifying the Impacts of Opioids on Florida Nursery, Growers and Landscapers

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ABSTRACT

The rising instances of opioid misuse and their aftermath have been termed a public health crisis in the U.S. (e.g., Center for Disease Control and Prevention (CDC), 2017a; Hodge, Wetter, & Noe, 2017). An unfortunate result of high levels of opioid abuse are the number of associated deaths. The majority of drug overdose deaths in the U.S. in 2015, approximately 63%, were associated with opioid use, accounting for over 33,000 deaths (CDC, 2017a). According to the Center for Disease Control and Prevention, the number of deaths associated with opioid use more than tripled from 2000-2015 (Rudd, Seth, David, & Scholl, 2016). In the state of Florida alone there was a nearly 23% increase in opioid related deaths just from 2014 to 2015 (CDC, 2017b). Non-fatal overdoses are also worrisome. Opioid overdose led to 92,000 emergency room visits, and caused 53,000 hospitalizations in 2014 (CDC, 2017a). There is also evidence that ability to work, as well as the quality of work is significantly impacted by opioid abuse (Perlmutter, et al., 2017; Sansone, Leun, & Wiederman, 2012; Van Hasselt, Keyes, Bray, & Miller, 2015). Further, there are additional, significant societal costs associated with opioid abuse, such as trauma to children and families, fiscal costs related to accidents, wage loss and absenteeism, burden on the medical and penal systems, and costs for drug treatment (Birnbaum, et al., 2011; Meyer, Patel, Rattana, Quock, & Mody, 2014). Estimates place costs in the billions (Birnbaum, et al., 2011; Inocencio, Carroll, Read, & Holdford, 2013).

In August, 2017, leaders from the Florida Nursery, Growers and Landscape Association (FNGLA) identified opioid misuse as a problem within their industries, and contacted the Southeastern Coastal Center for Agricultural Health and Safety (SCCAHS) to gain assistance with addressing the issue of opioid misuse. SCCAHS created a resource section dedicated to opioids in order to help support FNGLA. However, it was unclear the extent to which opioids are a problem for FNGLA, what the economic impact might be, how individuals and families are affected, and what resources or programs might be useful for these industries. This project sought to document the impact that opioid abuse has had on Florida's nursery, grower and landscaper industries, as well as their families, and determine how best to help them.

OBJECTIVES AND METHODS

1. Determine the extent of use of opioids among Florida's nursery and landscape industries, and how this compares with other industries
2. Document the impact of opioid use on Florida nursery and landscape businesses, workers and families
3. Determine whether there are ways that the FNGLA can support its constituents in dealing with the

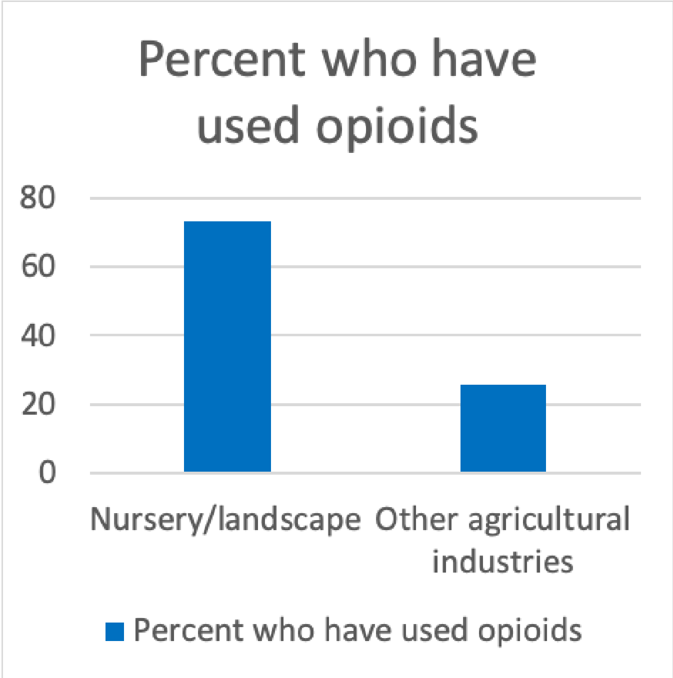
The first step involved the development and administration of a quantitative survey that assessed opioid usage in the Florida nursery, grower and landscaper industries, economic impact of opioid usage for these industries in Florida, personal and family impact, and needs for assistance.

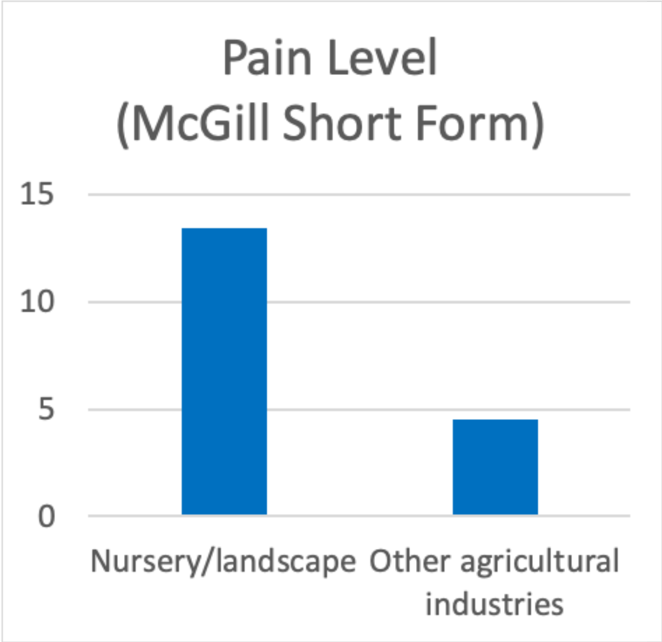
This survey was developed in the survey platform Qualtrics, which is available at no cost to faculty at the University of Florida. The survey was administered online, and took approximately 10 minutes to complete. Participants were recruited through FNGLA and the Southeastern Coastal Center for Agricultural Health and Safety, and both owners and workers were recruited to participate in this online survey. A total of 80 participants from nursery and landscape industries completed the survey, and comparisons have been made with other agricultural industries, which comprised 52 participants. Measures used included information on industry and owner/worker; opioid-related questions; the Center for Epidemiological Studies Depression Scale, Revised; Perceived Stress Scale; and the Short Form McGill Pain Questionnaire. Gift cards in the amount of $10 were offered to participants in the quantitative study.

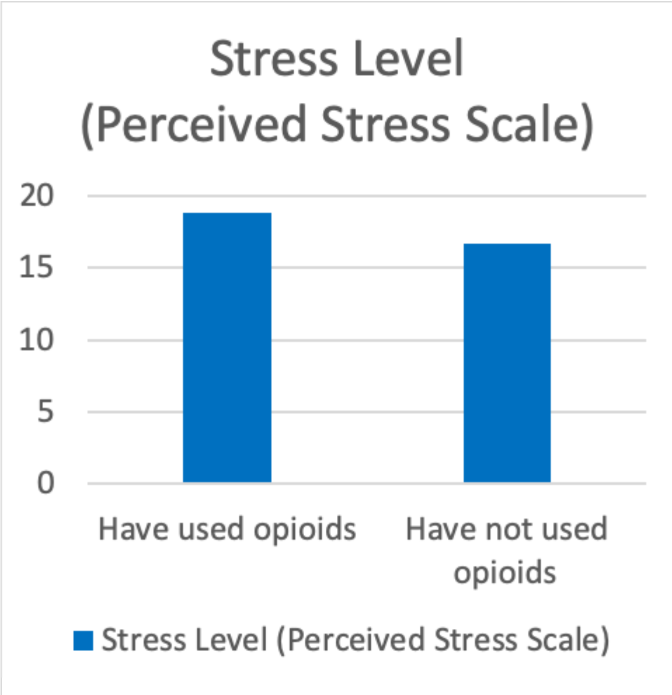
After the quantitative interview was conducted, the questions for a qualitative interview protocol were developed, and have been approved by the Institutional Review Board. It is anticipated that the qualitative interviews will take place this Fall and Spring via phone or in person interviews. Gift cards in the amount of $25 will be offered to participants who complete the interview, which should take approximately 20-30 minutes. Interviews will be recorded and transcribed, and then qualitative analysis will take place.

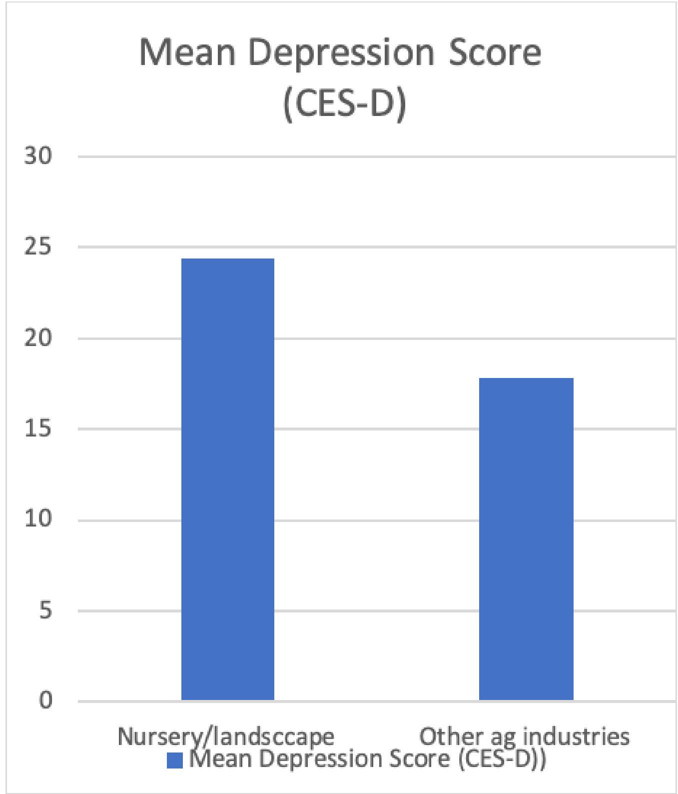
RESULTS

For this sample, opioid use was found to be quite high, particularly among participants in the nursery and landscape industry. Over 70% of those who identified themselves as working in the nursery or landscape industries reported having used opioids, and over 70% of those people reported that they had received a diagnosis of addiction from a health professional. In other agricultural industries, about 25% reported using opioids, and of those, fewer than 30% reported diagnosis of addiction. Opioid use was highly associated with reports of pain and depression, and about 75% of those who used opioids reported that they used them due to a work injury. Those in the nursery and landscape industries reported higher levels of depression, higher amounts of pain, and slightly higher levels of stress than those in other agricultural industries. There has also been a lot impact on the workforce: over 91% of owners said that opioids have impacted their workforce, and 85% knew of at least 1 employee who had overdosed on opioids. There were also high reports of difficulty doing daily tasks while taking opioids (62.5%), getting injuries at work while using opioids (67%), getting fired or quitting due to opioid use (46%), and needing to miss work due to opioid use (54%). Owners also reported high levels of workplace absences related to employees getting drug treatment, opioids leading to less workplace productivity, and high rates of worker turnover.









CONCLUSIONS

While the study has not yet completed, survey information to date suggests that the Florida nursery and landscape industry has been significantly affected by the opioid crisis, and the impact is much higher than for other agricultural industries in Florida. Opioid use was high in the nursery and landscape industries and was associated with high levels of pain and depression. It is clear that the Florida nursery and landscape workplace has been significantly impacted in many respects, with reductions in the available workforce, increased safety hazards at the worksite, increased worker turnover, and increased health issues for workers and their families. This information can be useful to educate legislators, inform policy, guide community action, and encourage the development of new resources and programming to support FNGLA businesses. It is recommended that FNGLA provide resources to educate members about the addictive nature of prescription opioid medications and encourage efforts to prevent workplace injuries. Encouraging members to seek treatment for depression may also be beneficial; however, it is notable that there is a bi-directional relationship between depression and opioids.

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IMPROVE ENVIRONMENTAL AND RESOURCE MANAGEMENT

Development of Salinity Tolerant Petunia Through CRISPR/Cas9 GeneEditing

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Linchi Nguyen, Mid-Florida REC

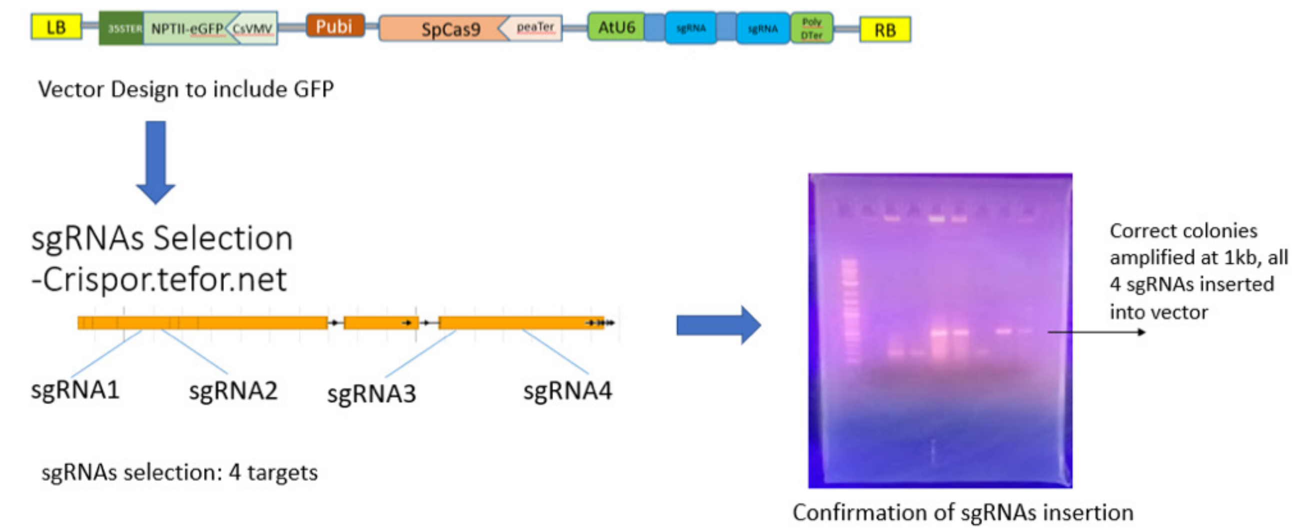
ABSTRACT

Florida's beaches are among the most popular vacation destinations for visitors. Likewise, more than three quarters of Florida's population lives in coastal counties. Due to extreme conditions such as salt spray, wind, poor soil, storms and salt-water intrusion; landscaping is difficult around coastal areas. Additionally, the use of recycle water for irrigation is becoming more common for nursery plant production as well as many neighborhoods. The high concentration of salt in the soil cause significant adverse effects in plant growth thus limiting plant production for landscaping. Petunia (*Petunia × hybrid*) is one of the most popular bedding plants nationwide owing to its colorful flowers. Current petunia cultivars cannot be utilized for bedding plants in Florida coastal regions; and the lack of salinity-tolerant germplasms greatly hinders the development of salinity-tolerant petunia through conventional hybridization method. Therefore, the purpose of the project is to create mutation in the *GIGANTEA* (*GI*) gene which has been reported to increase salt tolerance in other plant species. In this study, CRISPR/Cas9 was successfully used to knock out *GI* gene. With the unique design of our CRISPR/Cas9 vector to include NPT-GFP, newly regenerated T0 plants as well as T1 seedlings were easily screened by visualizing GFP to select high Cas9 endonuclease activity and increased gene editing efficiency. Sanger sequencing results showed two out of four lines sequenced are carrying heterozygous and homozygous mutations at the sgRNA loci of *GI* gene. Currently, the homozygous *pegi* mutants are subjected to further investigations on their sensitivity to NaCl treatments and alteration of their flowering in response to photoperiods. We expect that a transgene-free salt tolerant petunia mutant can be released once we have fully characterizing their phenotypic parameters under saline conditions, and we believe that this novel germplasm may generate a substantial impact on petunia breeding.

OBJECTIVES AND METHODS

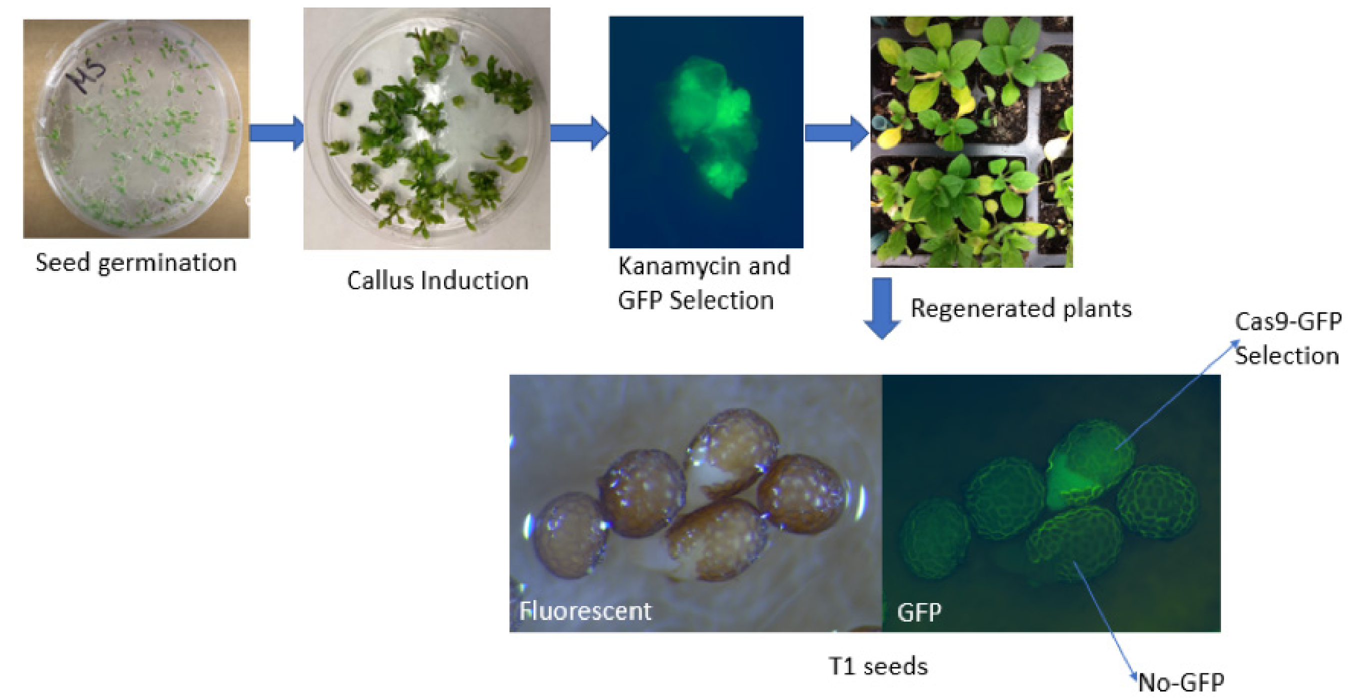
Objective 1: To design sgRNAs targeting GIGANTEA (GI) gene and insert them into CRISPR/Cas9 vector for knockout mutation.

Method: By using NCBI BLAST and Crispor.tefor.net, four sgRNAs were selected to target GI gene and they were inserted into CRISPR/Cas9 Vector via Gateway method. Q5 PCR was used to confirm the correct size at 1kb, where all four sgRNAs were successfully inserted into the vector



Objective 2: To regenerate Petunia var. Mitchell gene edited plants through *Agrobacterium-mediated* transformation.

Method: Petunia seeds were surface sterilized and germinated on MS media. Cotyledons were excised and dipped in EHA105 harboring the CRISPR/Cas9 GI knockout vector for 5 mins and were co-cultivated for 3 days. Afterward, transformed explants were placed on callus/shoot induction media containing Kanamycin and Timetin antibiotics for 3 weeks and longer to regenerate new shoots. Two-inches or longer shoots were placed on Rooting media with the same antibiotics to select transgenic plants that rooted. Rooted plants were grown in the greenhouse and T1 seeds were collected. Germinated seeds were screen for GFP fluorescent signals, seeds showing GFP signals were considered as CRISPR/CAS9 carrying seeds for further analysis.



Objective 3: To determine the LD50 of Petunia var. Mitchell WT

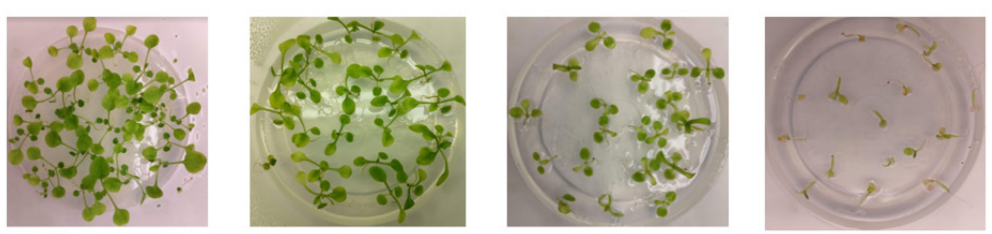
Method: WT petunia seeds were surface sterilized and germinated on MS media, five days after germination, seedlings were placed on new MS media with 0, 150, 250, or 350mM of NaCl. Pictures were taken after 2 weeks of treatment.

Objective 4: To determine gene edited plants in T1 seedlings.

Method: T1 seeds were germinated and DNA were extracted from cotyledon using the SDS method (Edward's Buffer). Q5 enzyme was used to amplify specific region covering the targeted sites and the PCR products were sent for Sanger sequencing through GENEWIZ. Sequencing data was analyzed using ice.synthego.com.

RESULTS

1. Since the petunia is a hybrid of *Petunia axillaris* and *Petunia inflata*, we have obtained the GI sequences from both genomes. Vector construction: we have successfully made a CRISPR/Cas9 vector containing four sgRNAs for targeting different copies of PeGIs in the petunia Mitchell.
2. Agrobacterium transformation: Transgenic plants were successfully regenerated and monitored using GFP and Kanamycin selection.
3. NaCl LD50 of Petunia WT: It was determined visually that at 250mM NaCl, petunia seedlings growth was stunted, and their leaves were noticeably narrowed due to stress. At 350mM NaCl, petunia seedlings were not able to grow, and their cotyledon was completely bleached **(Figure 1)**. Therefore, we concluded that 250mM NaCl would be the concentration to test gene-edited plants vs. WT.
4. Gene edited T1 plants: 2 out of 4 lines are gene edited based on Sanger DNA Sequencing which is 50% of gene editing efficiency. Homozygous lines will be grown in the greenhouse for seed collection and testing. Sequencing results from non gene-edited **(Figure 2)** vs. heterozygous gene edited **(Figure 3)** vs. homozygous gene edited **(Figure 4)** plants.



MS + 0mM NaCl   MS + 150mM NaCl   MS + 250mM NaCl   MS + 350mM NaCl

Figure 1. Effect of different concentrations on growth of petunia WT seedlings.

Figure 2. No sequencing differences between the control (bottom) and non-edited plants (top) in the chromatogram. The PAM and sgRNA were underlined in black and red dots.

Figure 3. A 4 bp deletion occurred to only one strand of DNA in gene edited plant (top), resulting in double chromatogram peaks around vertical black dashed line.

Figure 4. A base pair deletion occurred to both strand in the gene edited plant (top), resulting in clean shifted chromatogram peaks around vertical black dashed line, which suggested this gene edited mutation is homozygous.

CONCLUSIONS

We have accomplished our research goal of creating gene-edited petunia plants that have the knockout mutation in *GIGANTEA* (*GI*) gene. Due to the long processes of regeneration in tissue culture (3 months) and flowering/seed collection in the greenhouse (6 months), we were not able to fully examine the sensitivity of these gene edited seedlings to salt stresses at this moment; we will continue to endeavor our effort to characterize the phenotypic changes of these petunia mutants including salt tolerance and circadian rhythm alternation. Ultimately, we hope to select petunia mutants with improved salt tolerance to serve as a new germplasm for petunia breeding.

PUBLICATION

Nguyen LD and Heqiang Huo, Circadian Alteration and Salinity Tolerance Caused by Gene-Editing of *GIGANTEA* Gene in Petunia, ***in preparation***

Use of Reclaimed Water in Production Nurseries

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ABSTRACT

Reclaimed water (processed and disinfected sewage sludge) is a potential irrigation water source for commercial nurseries. A demonstration is proposed to evaluate reclaimed water use at a nursery and determine container plant growth responses compared with those of plants irrigated with well water currently used by the nursery. This report expounds on the process of getting reclaimed water transferred from the municipal system to the nursery for irrigation.

INTRODUCTION

The Southwest Florida Water Management District (SWFWMD) personnel were in the process of renewing the consumptive use permit for Mid-Florida Nurseries in Plant City when discussion ensued with the nursery owner about the use of reclaimed water for irrigation. A reclaimed water distribution pipe is located adjacent to property border. The nursery owner contacted UF/IFAS Extension personnel and indicated he was concerned about the reclaimed water damaging plants. UF/IFAS personnel suggested a demonstration be established to evaluate plant responses to reclaimed water used for overhead sprinkler irrigation. Funding from the FNGLA Endowed Research Fund was received to conduct the demonstration.

OBJECTIVES AND METHODS

The objective was to evaluate on the nursery site the impact of reclaimed water on the growth of container-grown plants. After obtaining the results of the evaluation, the nursery owner would be able to confidently decide about converting the irrigation water source for the nursery to reclaimed water. Thus, the consumptive use permitted well water could be placed on standby with the District and reclaimed water would be the primary source for irrigation.

We were unaware of the challenges for getting a reclaim water connection at the nursery even though Plant City personnel were willing to add reclaim water users. Thus, we have experienced a delay; however, our experiences will be documented and made available to FNGLA membership so that nursery personnel can be apprised of what is expected and needed for the process of connecting their irrigation to municipal reclaimed water. In addition, after we complete the connection and conduct the demonstration, our results will provide a list of container-grown plants produced with reclaimed water applied with overhead sprinklers. Our results will note any difficulties encountered as well as any plants that did not respond favorably.

Present Status

An overview of activities involving Plant City personnel, UF/IFAS personnel, and Mid-Florida Nurseries' personnel is presented in **Table 1**. The Plant City Water Resources Department agreed to connect and transfer via a 6-inch diameter pipe the reclaimed water onto the nursery property at no charge. However, various infrastructure items are needed, and fees will be collected — possibly from Plant City Building Department and Engineering.

Table 1. Summary of activities completed as part of process to establish reclaimed water connection at Mid-Florida Nurseries in Plant City.

Date	Action Items
Sept. 18, 2018	UF/IFAS and Mid-Florida Nurseries' representatives met with Plant City personnel, presented objective of project and reason for project. Discussed reclaimed water use cost per gallon and physical separation of well water and reclaimed water.
Nov. 16, 2018	UF/IFAS representative met with Mid-Florida Nurseries' representative and established reclaimed water entry point and location of irrigation zones.
Dec. 20, 2018	UF/IFAS and Mid-Florida Nurseries' representatives met with Plant City personnel, presented diagram of connection, and discussed procurement of meter and backflow device with approximately 3000 gal/day for the proposed demonstration.
Feb. 18, 2019	UF/IFAS phone call with Plant City representative to determine actions needed to proceed.
May 3, 2019	UF/IFAS representative met with Mid-Florida Nurseries' representatives and reviewed progress.
June 5, 2019	UF/IFAS and Plant City personnel met at Mid-Florida Nurseries and discussed establishing reclaimed water connection and confirmed location of 6-inch connection.
July 18, 2019	UF/IFAS phone discussion with Plant City representative regarding clarification of actions and fees mentioned in summary of June 5 meeting received by email from Plant City representatives.
July 19, 2019	Conference call with Mid-Florida Nurseries' representative and UF/IFAS representatives regarding potential costs including fees to establish reclaimed water connection.
Aug. 7, 2019	UF/IFAS personnel met with Mid-Florida Nurseries' representative and confirmed the need for development of detailed costs analysis proposal for presentation to SWFWMD, FDACS, and NRCS regarding cost share funds.

We are currently in the process of determining the cost of the infrastructure and what fees will be imposed along with who will have the financial responsibility for the fees.

A backflow device and meter are required on the reclaimed water pipe entering the property. The backflow and meter will be located on the east side of the property near County Line Road as seen in **Figure 1**. We are currently conducting a water use and flow audit of the current nursery irrigation system so that we can size and appropriately justify the meter and backflow size. Each irrigated zone is 40 x 300 feet and irrigated with 16 Mini-Wobblers® (Senninger®) on 4-feet high risers spaced 20 feet down the zone and 26 feet across the zone. Output from each lavender nozzle is projected to be 2 gallons per minute (gpm). Irrigation is usually applied using four zones per event (128 nozzles) for a total flow of 256 gpm. Water from the well is currently distributed to irrigation zones by 4-inch pipes. Based on flow, distance, elevation, and pipe size, it is anticipated that a 6-inch pipe with meter and backflow will be used for reclaimed water. The pipe transferring reclaimed water across the property will be terminated at current pump station approximately 1200 feet from where reclaimed water entered the property **(Figure 1)**. An adapter will be used to separate reclaimed water use from well water use. Approximate costs for infrastructural items are given in **Table 2**.

Nursery owner would like to seek cost share funds from SWFWMD, Florida Department of Agriculture and Consumer Services (FDACS), and Natural Resources Conservation Service (NRCS). Meetings with the representatives from these agencies are planned. Agency support for implementation of a BMP, such as use of reclaimed water for irrigation that has been evaluated by UF/IFAS personnel, is common in the nursery industry.

Methods to Conduct Demonstration and Obtain Results

After reclaimed water is connected to the nursery irrigation system, the demonstration will be conducted and the impact of reclaimed water irrigation on plant growth will be determined. This impact will be determined by growing the same plants in adjacent production zones. One zone will use the nurseries' current irrigation water (well) and the other adjacent zone will have reclaimed water irrigation. Plant data from both zones will be monitored. Plant sizes will be measured monthly and container substrate electrical conductivity monitored. In addition, irrigation water (reclaimed and well) will be analyzed for nutrient constituents. Aberrant growth or foliage will be documented with photographs. It is anticipated that within a year, twenty species can be evaluated in each irrigated zone. Species selected for evaluation will be plants commonly grown in central Florida.year, twenty species can be evaluated in each irrigated zone. Species selected for evaluation will be plants commonly grown in central Florida.

RESULTS

Project has not gotten far enough for definitive results due to the delay encountered in establishing a reclaimed water connection to the nursery irrigation system. Progress has been made and effort will continue to establish the connection and conduct the demonstration for plant evaluation as stated in the objective. A summary of activities in pursuit of accomplishing the objective is presented in **Table 1**.

CONCLUSION

Work on this project will continue to overcome the challenges needed to evaluate plant responses to reclaimed water. The immediate need is to accomplish tasks required by the Plant City Water Resources Department to transfer reclaimed water to the nursery property. Once the transfer or connection is complete, plants will be irrigated with reclaimed and well water to demonstrate the usefulness of reclaimed water.

Table 2. Items needed to establish reclaimed water connection at Mid-Florida Nurseries in Plant City.

Items	Approximate Cost $
Water meter 6-inch	$4,500
Double check valve assembly backflow device 6-inch	$10,000
Reclaimed pipe 6-inch x 1200 feet	$4,800
Reclaimed pipe fittings L's	$300
Total	$19,600

Figure 1. Reclaimed demonstration site is located adjacent to plants irrigated with well water. Purple line denotes proposed reclaimed water distribution pipe.

IMPROVE PEST MANAGEMENT PRACTICES AND STRATEGIES

Evaluating Vector Potential of Haplaxius Crudus and Idioderma Virescens

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ABSTRACT

Lethal bronzing disease (LBD) is a lethal phytoplasma infection of various ornamental palms in the state of Florida. Of paramount importance is identifying the insect vector of this pathogen so that appropriate management protocols can be developed for nursey personnel to implement and reduce the impact of LBD. Following one year of preliminary data collection, the planthopper *Haplaxius crudus* was identified as a vector candidate due to the isolation of the phytoplasma from insects collected in the field. In addition, specimens of the treehopper *Idioderma virescens* tested positive. Both species had salivary glands tested and only *Haplaxius crudus* salivary glands tested positive for the phytoplasma, indicating that it is the likely vector of the pathogen.

OBJECTIVES AND METHODS

1. Screen salivary glands of *Haplaxius crudus* for the 16SrIV-D phytoplasma
2. Screen salivary glands of *Idioderma virescens* for the 16SrIV-D phytoplasma

Insects were collected from areas where disease was actively spreading and frozen directly until processing. Specimens had salivary glands dissected in 10X PBS with 1% toluidine blue for staining. Salivary glands were subsequently processed by extracting total DNA using the Qiagen Blood and Tissue kit following the manufacturer's instructions. dPCR assays were performed on samples processed to detect and quantify phytoplasma levels. Parameers for the dPCR assay are those presented by Bahder et al. (2018). Data was collected and analyzed using the Quantstudio 3D analysis suite available at the ThermoFisher website.

RESULTS

A total of 28 specimens of *Haplaxius crudus* were collected from diseased palms and 8 specimens of *Idioderma virescens* were also collected. Of the specimens of *H. crudus* tested, 4 individuals had the salivary glands test positive for phytoplasma **(Figure 1)** while all specimens of *I. virescens* tested negative **(Figure 1)**. Blue pixels in dPCR assays represent positive wells while yellow represent negative wells.

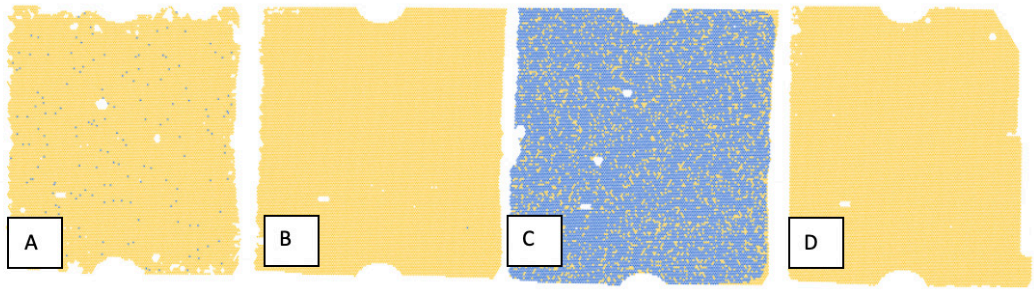

Figure 1. Digital PCR chip data representing positive salivary glands from H. crudus (A), negative salivary glands from Idioderma virescensi (B), positive control (C), and negative control (D).

CONCLUSIONS

These results provide the first data that support *H. crudus* as a vector of the LBD phytoplasma. While it is clear that any insect with a pathogen in the salivary glands is a competent vector, the efficacy of the *H. crudus* to transmit the pathogen in the field remains unknown and is the subject of future studies. This study only included two species and provided evidence that one (*H. crudus*) is the vector while the other (*I. virescens*) is not. While other species still are of interest in their potential role to transmit the phytoplasma, based on the pilot study that found the phytoplasma in only these two species, the emphasis was on species that had been demonstrated to carry the phytoplasma. Based on these results, it is believed that *H. crudus* is the vector of the LBD phytoplasma in Florida and is currently the focus of future research efforts.

Measuring the Impact of a New Invasive Ant Species (Plagiolepis Alluaudi) on Plant Feeding Insects in South Florida Nurseries

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ABSTRACT

Plagiolepis alluaudi, the little yellow ant **(Figure 1)**, is an invasive species from Madagascar that was recently discovered in west Fort Lauderdale in 2017. The ant is noted to be a pest in floricultural and residential areas in parts of the world where it has invaded, but little has been studied about the species' biology and economic impacts. In order to determine how much of a threat this new invasive poses to Florida and what can be done to control it, experiments and surveys have been initiated to determine where and how far the species has spread in South Florida, what effect *P. alluaudi* has on populations of mealybugs and similar plant feeding insects, and which over-the-counter bait could be effective in controlling the species. Initial results suggest that *P. alluaudi* is spreading at a slower rate than previously anticipated, and that a bait formulation of boric acid and sugar seems to be the most effective in reducing the incidence and abundance of the ant species.

OBJECTIVES AND METHODS

1. Evaluate area-wide control methods to minimize the direct and indirect negative impact of the *P. alluaudi* on nursery ecosystems.
2. Survey the ant diversity in selected Broward County nurseries and neighborhoods, to monitor for *Plagiolepis alluaudi,* and to create a record of the ant community that future studies can compare to in the case of a widespread invasion.
3. Determine the impact of the *P. alluaudi* on mealybug populations and their negative impact on overall plant health.

Figure 1. Workers of *Plagiolepis alluaudi* interacting with mealybugs

METHODS

1) Control methods

Four common over-the-counter ant baits were chosen to be evaluated in this project, Terro®, Optiguard®, Max Force®, and Advion®. These baits were chosen as they are used exceeding frequently in ant control, are available for purchase throughout the state of Florida, and can be legally bought and administered by individuals without pest control certifications. Three independent assays were performed.

1.1) Laboratory non-choice bait assay

A non-choice assay was conducted to examine the efficacy of commercial baits in eliminating *P. alluaudi*. Six 10×10×0.2cm planar arenas were prepared and contained a small amount of cat kibble and a cotton filter pad, saturated with deionized water, to prevent starvation or dehydration. One of each commercial bait was added to four of the arenas, a 1:1 mixture of sucrose and deionized water was added to the fifth (positive control), while the sixth arena had no additional component added to it (negative control). Ants were collected from the field, and a population of approximately 200 ants was transferred into each of the six arenas. Live ants in each arena were counted every 24 hours for 12 days. This procedure was replicated three times. This experiment was then repeated but baits and controls were diluted by 50% and 75% with water in order to determine if thinner baits would be easier for the notably small ants to consume, but still retain the potency required to eliminate then.

1.2) Field bait recruitment choice assay

A choice assay was conducted in the field to determine which commercial bait *P. alluaudi* would readily forage for when applied in the field. Five 1.5ml vials containing one of the commercial baits and a positive control were placed on a plain sheet of paper near known field populations of *P. alluaudi*. Photos were taken of the vials every five minutes for 1 hour to count for the number of ants foraging on baits over time. This assay was replicated five times.

1.3) Field bait consumption choice assay

Two 1.5ml vials of each of the commercial baits and controls were prepared and weighted. One copy of each bait and control vial was left near a field population of *P. alluaudi*. The remaining copies of the vials were used to take into account evaporation, and were placed in proximity of the experiment, but isolated from the ants. The test was run for 4 hours, all vials were collected afterwards and returned to the lab to be weighted. Bait consumption by *P. alluaudi* was determined through the difference in mass.

2) Ant surveys in South Florida

2.1) Presence in nurseries

Broward County nurseries associated with the FNGLA were approached and asked to participate in this survey. Participating nurseries were surveyed in total by a UF graduate student and a technician. Four to five sugar baits were laid at each nursery to attract ants, which were checked after 1.5h. During this time the nurseries were surveyed by hand. Samples were then taken back to the laboratory, where each ant species was identified and recorded, creating a catalogue of species encountered at each location.

2.2) Presence in residential areas

Surveying was continued towards neighborhoods in Fort Lauderdale centering around the first recorded location of *P. alluaudi.* Public areas were surveyed at random and encountered ant species were recorded. Surveying was typically done by hand, however baits were laid in larger areas such as public parks. Time spent surveying varied depending on the size of the location. Surveying of neighborhoods is still in progress.

3) Mealybug interactions

Interactions between *P. alluaudi* and plant feeding Hemipterans were monitored in the field; it was observed that *P. alluaudi* interacts with *Paracoccus marginatus*, Papaya Mealybugs. Populations of *Pa. marginatus* were reared in a greenhouse on *Hibiscus* plants to create a source of mealybugs to use for the experiments. Four store bought *Hibiscus rosa-sinensis*, red hibiscus, were purchased and placed in a two by two grid near known field populations of *P. alluaudi*. Two of the plants were placed into a water filled container to exclude ants; the other two were placed on the bare soil to include ants. Two plants, one excluding ants and one including them, were inoculated with an ovisac of *Pa. marginatus*, containing approximately thirty nine eggs. This will determine differences in mealybug population growth in the presence or absence of *P. alluaudi*, as well as the spread of mealybugs to new plants in the presence or absence of *P. alluaudi*. All plants were examined three times per week and ovisacs present on the plants were counted and recorded. This process was replicated five times, and the experiment is still in progress. It is expected to be completed by the end of December 2019.

RESULTS

1.1) Laboratory non-choice bait assay

Results **(Table 1)** of the non-choice assays show that Optiguard® completely eradicated every treatment of ants it was applied to, even when diluted 75%. Advion® proved largely ineffective and failed to eradicate more than 50% of ants in any treatment. Terro® and Max Force® had limited impact, depending on the dilution factor. Undiluted Terro® eliminated around 90% of ants by the end of the assay, and undiluted Max Force® eradicated all ants after the first day of study. When diluted, neither formulation was able to completely eradicate treatments of ants.

Table 1. Percent survivorship of populations of *P. alluaudi* exposed to bait formulations over a period of twelve days. Values are average survival percentage (n=5)

	Percent survivorship of *P. alluaudi* exposed to undiluted bait formulations						**Percent survivorship of *P. alluaudi* exposed to 50% diluted bait formulations**						**Percent survivorship of *P. alluaudi* exposed to 75% diluted bait formulations**					
Day	**Blank**	**Control**	**Terro**	**Opti guard**	**Max Force**	**Advion**	**Blank**	**Control**	**Terro**	**Opti guard**	**Max Force**	**Advion**	**Blank**	**Control**	**Terro**	**Opti guard**	**Max Force**	**Advion**
1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
2	98.61	98.42	66.41	47.48	0	93.04	96.97	97.34	92.21	83.00	40.73	95.02	99.12	99.77	99.44	95.02	56.30	97.77
3	97.78	97.33	61.84	10.89	0	81.21	95.46	96.20	77.10	77.18	33.01	88.11	98.14	98.84	93.75	39.16	51.90	95.73
4	96.76	96.05	56.01	2.29	0	77.28	94.35	95.01	62.22	34.11	27.35	79.892	95.06	95.50	92.11	19.27	46.42	93.12
5	95.01	95.31	46.15	0.57	0	71.78	92.83	92.84	60.06	6.413	23.76	70.37	93.72	93.96	78.64	5.41	40.47	79.99
6	94.63	94.96	20.68	0	0	68.32	91.37	91.27	55.39	2.15	20.83	68.83	91.93	92.15	69.12	4.96	37.27	76.26
7	92.49	93.73	17.96	0	0	66.72	89.21	90.27	51.65	1.07	19.09	65.95	90.27	91.27	63.88	3.19	34.81	66.475
8	91.11	92.15	15.76	0	0	64.73	87.93	88.45	42.30	0.80	17.62	63.63	89.05	89.43	60.90	2.01	34.16	63.05
9	90.55	91.36	13.96	0	0	63.13	87.04	87.41	36.13	0.26	16.21	61.05	87.57	87.15	58.99	0.88	31.18	57.90
10	88.89	89.93	13.51	0	0	61.61	84.92	85.01	31.81	0.26	14.26	58.72	86.64	86.47	56.15	0.20	29.95	56.04
11	87.51	88.74	12.61	0	0	56.58	83.83	83.03	27.38	0	13.03	56.92	85.03	83.59	51.48	0.20	27.04	53.75
12	84.55	86.48	12.162	0	0	45.19	83.15	81.83	24.97	0	10.44	51.95	83.78	82.01	50.07	0.20	25.06	51.75

1.2) Field bait recruitment choice assay

Results of the first choice assay **(Figure 2)**, examining foraging preference via counting ants at bait stations, showed that all commercial baits were foraged on more than a sugar control and all could potentially used in the field. However, this experiment did not measure bait consumption.

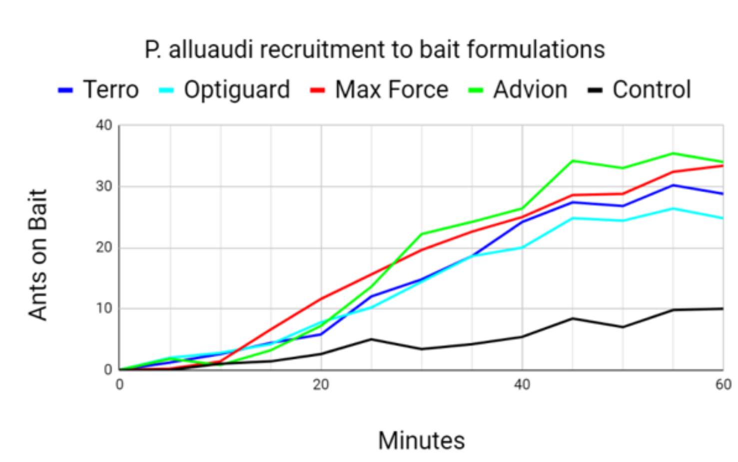

Figure 2. Recruitment of *P.alluaudi* to different bait formulations over a sixty minute period

1.3) Field bait consumption choice assay

Pilot data from the second choice assay, examining preference via measuring the amount of bait consumed by ants, suggest that the ants consumed the same amount of Advion®, Max Force®, and Terro® in the field. Optiguard® and the control were consumed less than the other three baits, and in the same amounts. This experiment is still ongoing.

2.1) Presence of *P. alluaudi* in nurseries

As of this report, no *P. alluaudi* have been detected in any plant nursery within Broward County. This result is preliminary, as surveys were not exhaustive, but indicates that this species is not ubiquitous in this area. Interestingly, ant species that were found at these sites include: *Wasmannia auropunctata* (little fire ant), *Tapinoma melanocephalum* (ghost ant), *Technomyrmex difficilis* (white footed ant), *Paratrechina longicornis* (longhorn crazy ant), *Hyponera punctatissima* (Roger's ant), *Brachymyrmex sp.* (rover ant), *Solenopsis invicta* (red imported fire ant), *Pheidole megacephala* (big headed ant), *Pheidole navigans* (navigating big headed ant) *Camponotus planatus*, (compact carpenter ant), and *Nylanderia bourbonica* (robust crazy ant). While it is good news that *P. alluaudi* was not found at any of these locations, it should be noted that every species encountered is exotic, and not a single native species was found.

2.2) Presence *P. alluaudi* in residential areas

Residential surveys revealed one new locality where *P. alluaudi* is established; in the Riverside Park neighborhood of Fort Lauderdale, 1.9 miles away from the initial point of discovery for the species. The population discovered was large and robust. Surveys are in progress to determine if other populations occur in this neighborhood and elsewhere in Broward County. We are in communication with pest control companies to help the detection of this new invasive ant species throughout southeast Florida.

3) Mealybug interactions

The mealybug experiments have been initiated, but as they are still in progress. Preliminary data suggest that the presence of *P. alluaudi* may improve the growth of the mealybug population, but it is still too early to confirm. Final mealybug growth data will be acquired in December 2019.

CONCLUSIONS

Although preliminary, this study provides new insights on the biology, the potential pest status, and the control of *P. alluaudi*. While Optiguard® was the most effective bait in eliminating *P. alluaudi* in the laboratory, the ants did not consume it the field as much as other commercial baits. Advion® was the least effective bait in eliminating population of the ant in the laboratory, but ants seemed to prefer it the most in the field. Max Force® appeared to be preferred in the field, but eliminated the ant extremely quickly, in many observations the ants simply become stuck in the syrupy formulation and die on the spot. The speed at which this bait kills the ants may not be ideal as the ants may not have time to share the bait with nestmates and spread the pesticide. Terro® was actively consumed in the field, and was effective in eliminating ants, albeit not the most effective. Although all commercial baits have some level of efficacy, when considering all of this information, it appears that Terro® would be a compromise choice for control of these ants. The bait appears to be consumed in the field, and kills ants slow enough to be shared. A new location of established *P. alluaudi* in Fort Lauderdale, confirmed that this invasive ant is slowly spreading. However, this survey may be under representative of the current ant distribution because of its small size and its putative misidentification with other ants. It could also be attributed to the species appearing to have a strong association with flora, and areas with dense tree canopy, which are often inaccessible on private properties. It is also possible that the intense competition between the numerous invasive ant species in the area is preventing the establishment of *P. alluaudi*, and that less disturbed areas may be more susceptible to invasion from the species. More surveying will be conducted to attempt to find the species at additional locations. Mealybug experiments are still in progress at this time.

Improving Nursery Weed Control by Choosing Herbicides Based on Application Timing Flexibility and Formulation

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ABSTRACT

Research trials were conducted in 2018 and 2019 to evaluate five different herbicides including indaziflam, flumioxazin, prodiamine, prodiamine + isoxaben, and dimethenamid-P + pendimethalin for control of spotted spurge (*Euphorbia maculata*) and bittercress (*Cardamine flexuosa*) based on their formulation (granular vs. spray-applied) and seeding date relative to the herbicide treatment.

Overall results showed formulation was the most significant factor in control of spurge or bittercress. In most cases, dimethenamid-P + pendimethalin, prodiamine, and prodiamine + isoxaben tended to perform similarly regardless of formulation. However, significantly better control was observed with spray-applied formulations of flumioxazin or indaziflam.

OBJECTIVES AND METHODS

This research is part of a multi-year project focused on developing improved herbicide rotation programs and schedules for Florida container growers. Funds from FNGLA allowed us to conduct a study to investigate both current herbicide efficacy protocols utilized by weed scientists and evaluate different herbicide active ingredients in terms of how efficacy is influenced by formulation (granular or spray-applied) and seeding date.

In recent years, container nursery growers have reported different results with many granular preemergence herbicides compared to results developed from small-plot research trials. This problem has begun to emerge over the past three years. At recent meetings and conferences, different results have been reported with the same herbicides. Upon closer inspection of the data and different procedures, the reason for these differences is possibly due to 1) the use of new carrier technologies that could be influencing herbicide release, and 2) inherit differences in research trials and real-world nurseries relating to seeds present in the container substrate.

While poor herbicide control in nurseries could be a result of application/calibration errors, growers may still report poor control of certain weed species after correcting these issues (and other factors such as resistance are determined to not be a factor). Weed species in which poor control have been observed are often fast germinating species, such as bittercress, which germinates in 3 or 4 days in ideal environments. Herbicides applied on new carriers have been shown to provide effective control of bittercress in research trials, but this could be due to differences in nursery environments and in standard herbicide efficacy protocols. Researchers following general procedures will place weed seeds onto clean and sterile substrates 1 to 3 days after herbicide application to evaluate efficacy. In this scenario, excellent weed control is often observed. However, in nurseries, growers may only have weed-free substrates immediately after potting. During production, weeds will inevitably escape control and go to seed before they can be hand pulled. Consequently, later in production cycles, growers will have substrates containing weed seeds at various stages of germination and development. If an herbicide, specifically those applied with these new carriers, are only effective on seeds that are introduced to the substrate 1 to 3+ days after application, they would not be as effective at certain times and other products should be chosen.

The objective of these experiments was to compare efficacy of common nursery preemergence herbicides based on their formulation and application timing relative to seeding spotted spurge (*Euphorbia maculata*) or bittercress (*Cardamine flexuosa*).

Methods

All trials were conducted at the Mid-Florida Research and Education Center in 2018 and 2019. On November 21, 2018, 1.68 L nursery pots were filled with a pinebark:peat:sand (80:20:10 v:v:v) substrate containing incorporated fertilizer and amendments, and placed inside a greenhouse, and received 0.3 inches of overhead irrigation per day. On November 27, herbicides were applied **(Table 1)**. Granular herbicides were applied using a hand-shaker while spray-applied herbicides were applied using a CO_2 backpack sprayer calibrated to deliver 50 gallons per acre. All herbicides were applied at manufacturer label rates and the amount of active ingredient applied with granular and spray-applied herbicides was the same. A non-treated control group was also included for comparison.

Table 1. Herbicides evaluated for control of bitterness and spotted spurge.

Trade name	Active ingredient	Formulation	Rate product	Rate of active ingredient
Marengo G	indaziflam	granular	200 lbs./acre	0.04 lbs./acre
Marengo SC		suspension concentrate	9 fl. oz./acre	
Broadstar	flumioxazin	granular	150 lbs./acre	0.375 lbs./acre
SureGuard		suspension concentrate	12 fl. oz./acre	
Gemini G	prodiamine + isoxaben	granular	200 lbs./acre	0.8 + 0.5 lbs./acre
Gemini SC		suspension concentrate	43 fl. oz./acre	
RegalKade G	prodiamine	granular	300 lbs./acre	1.5 lbs./acre
Barricade		liquid	48 fl. oz./acre	
FreeHand	dimethenamid-P + pendimethalin	granular	200 lbs./acre	1.5 + 2.0 lbs./acre
Tower + Pendulum EC		emulsifiable concentrates	32 + 78 fl. oz./acre	

Bittercress seeds were surface sown onto pots on 5 different dates relative to the herbicide application including 2 days before the application (2DBT), and 0, 2, 4, and 7 days after treatment (DAT). Evaluating herbicide efficacy across different seeding dates allowed us to compare which herbicide active ingredient and/or formulation provided the greatest control across multiple seeding dates and to determine which herbicides are most affected by seeding date and formulation. This trial was repeated for bittercress following the same experimental protocols in 2019 with treatments being applied on February 21. Trials with spotted spurge were also conducted in 2019 with the first experimental run being treated on May 6, and the second experimental run on June 24. All trials contained eight single pot replications per treatment for each weed species and experimental run. After seeding, weed counts were taken in each pot at 4 and 10 weeks after treatment. At 10 weeks, shoots were clipped at the soil line and dried in a forced air oven until reaching a constant weight. All data were converted to percent control relative to the non-treated by using the formula [(non-treated – treated)/non-treated)] × 100. Data were arcsine transformed and then subjected to analysis of variance (ANOVA) using JMP software (SAS Institute). Means and standard errors are reported for significant main effects and interactions. For the sake of brevity, only dry weight data are discussed for each species separately.

Table 2. Effects of herbicide, formulation, seeding time, and interactions.

Variable	Bittercress D.W.	Spurge D.W.
	P-value[a]	
Herbicide (H)	**<0.0001**	**<0.0001**
Formulation (F)	0.0791	**<0.0001**
Seeding time (ST)	0.3101	0.0975
H × F	**<0.0001**	**<0.0001**
H × ST	**0.0432**	0.0867
F × ST	0.1001	0.1378
H × F × ST	0.1017	0.6795

[a]Analysis of variance was performed to test fo significant main effects and interactions. Variables were considered significant at <0.05

RESULTS

Bittercress. Herbicide was the only significant main effect, but interactions for herbicide and formulation, as well as the interaction between herbicide and seeding date **(Table 2)**. Bittercress control differed by formulation for pendimethalin + dimethenamid-P with the granular (FreeHand) providing better control than the spray-applied formulation (Tower + Pendulum), but both formulations provided approximately 90% control **(Figure 1)**.

The spray-applied formulation of flumioxazin (SureGuard) provided better control than the granular (Broadstar), but similar to dimethenamid-P + pendimethalin, both formulations provided over 90% control. Similar results were observed with indaziflam, but only 83% control was observed with the granular formulation (Marengo G) compared with 99% control with the spray-applied formulation (Marengo SC). No difference in formulation was observed for prodiamine + isoxaben (Gemini G and Gemini SC) or prodiamine alone (RegalKade or Barricade), but only the isoxaben + prodiamine combination provided acceptable control.

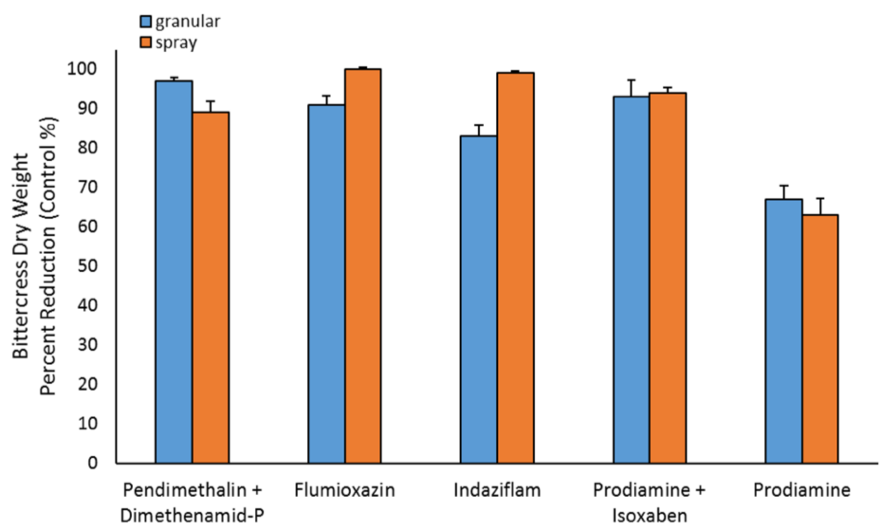

Figure 1. Comparison of five different herbicides by formulation for control of bittercress.

Averaged over both formulations, there was no difference in seeding time for dimethenamid-P + pendimethalin. Flumioxazin and indaziflam both provided better control of bittercress when seeds were sown on the day of (0DAT) or after treatments were applied (2 to 7 DAT) **(Figure 2).** Prodiamine + isoxaben and prodiamine results were variable depending on seeding date, but overall, the combination tended to provide at least 80% control regardless of seeding date while 77% or less control was observed with prodiamine alone.

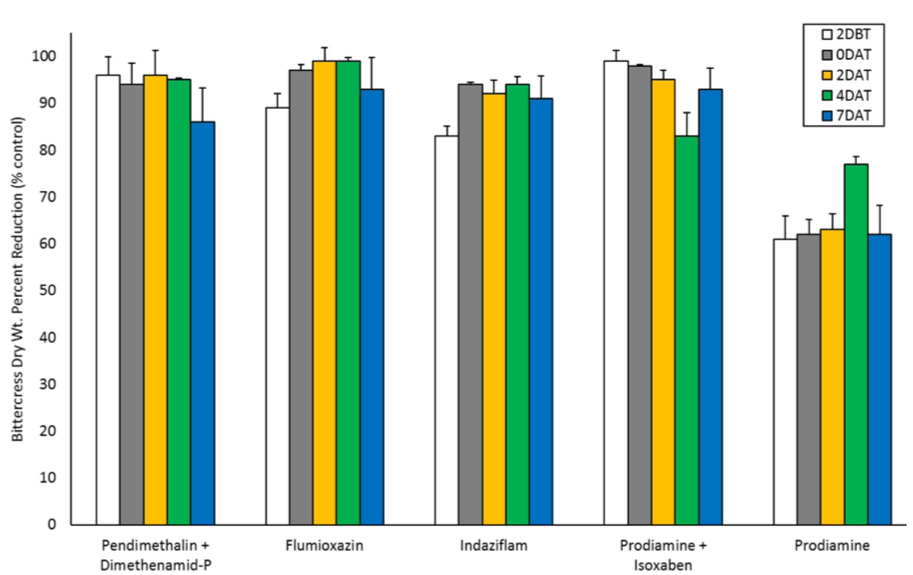

Figure 2. Comparison of five different herbicides by seeding date for control of bittercress.

Spurge. Herbicide, formulation, and the interaction between herbicide and formulation were significant **(Table 2)**. There was no difference in formulation for dimethenamid-P + pendimethaline and both formulations provided over 90% spurge control. For both indaziflam and flumioxazin, better control was observed with the spray applied formulations (100 and 95% control with flumioxazin and indaziflam, respectively) compared with the granular products (79 to 70% control for flumioxazin and indaziflam, respectively). No difference in formulation was observed with prodimaine + isoxaben and prodiamine alone.

CONCLUSIONS

Results from these trials indicate that for the five preemergence herbicides evaluated in these experiments, formulation is more important than seeding date with respect to spotted spurge or bittercress control. Some differences in seeding times were observed with bittercress, notably with flumioxazin and indaziflam, but acceptable (>80% control) was achieved with these herbicides. For both bittercress and spurge, there was no difference in formulation for any herbicide that can be applied over-the-top of ornamental plants including dimethenamid-P + pendimethalin, prodiamine + isoxaben, or prodiamine alone. If proper application procedures are followed, growers should achieve similar control of bittercress or spurge with either granular or spray-applied formulations of these herbicides. Seeding date also had little influence on control with these herbicides, so they should continue to perform well in nursery environments if timely applications are made during regular application schedules.

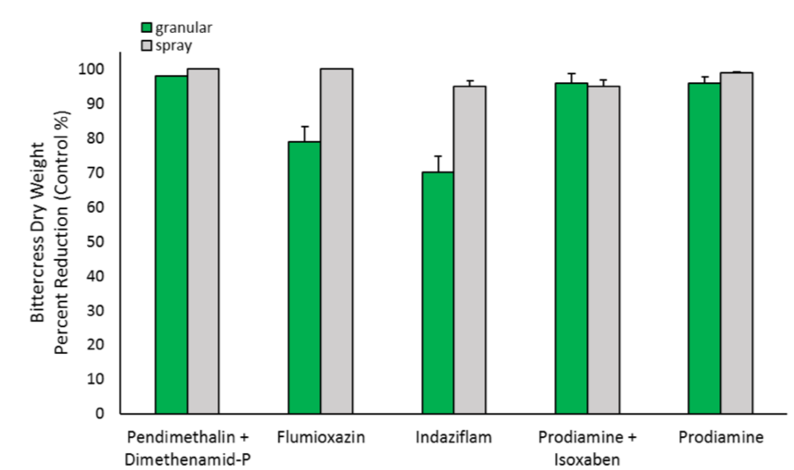

Figure 3. Comparison of five different herbicides by formulation for control of spurge.

Greater spurge and bittercress control was observed with the spray-applied formulations of indaziflam and flumioxazin compared with the granular formulation applied at the same rate. However, neither of these two herbicides can be applied over-the-top of ornamentals due to phytotoxicity concerns. In non-crop areas, growers would likely see better control from a spray-applied formulation compared with a granular formulation applied at a similar rate.

Overall, results suggest that seeding dates ranging from 2 days before application to up to 7 days after application should have little to no influence on control of these herbicides. Growers should expect similar control of bittercress or spurge regardless of formulation for dimethenamid-p + pendimethalin, isoxaben + prodiamine, or prodiamine alone, but greater control would likely be achieved with spray-applied formulations of flumioxazin or indaziflam. As these herbicides could not be applied over-the-top of ornamentals, granular formulations could be used as part of an overall rotation program. Growers could still expect to observe 91 to 79% control of bittercress and spurge with flumioxazin and 83 to 79% control of bittercress and spurge with indaziflam. Results could possibly differ depending upon production practices, seed pressure, weather, and other environmental conditions.

Developing Postemergence Weed Control Strategies for Nonturf Groundcovers in Florida

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ABSTRACT

Ten postemergence herbicides were evaluated for use on Asiatic jasmine 'Minima' and Perennial Peanut 'Golden Glory'. Herbicides including Lontrel (clopyralid), Sceptor T/O (imazaquin), Fusilade II (fluazifop-P-butyl), Basagran T/O (bentazon), Certainty (sulfosulfuron), Dismiss (sulfentrazone), Finale (glufosinate), Ranger Pro (glyphosate), SedgeHammer (halosulfuron), and Segment (sethoxydim) were all generally applied at 2× their maximum labeled rate to newly planted liners. After two applications, Fusilade II, Segment, Dismiss, and SedgeHammer caused no significant injury on either groundcover species. Basagran T/O also caused no significant injury on Perennial peanut and Sceptor T/O no noticeable injury on asiatic jasmine. Ranger Pro, Finale, Lontrel, and Certainty caused unacceptable injury on both species.

OBJECTIVES AND METHODS

Turfgrass is the most widely planted irrigated crop in the United States and occupies the vast majority of most residential and commercial landscapes in Florida. However, the common mantra of landscape design is "right plant right place". In many neighborhoods, parks, and other areas containing significant tree canopy, turfgrass is not suitable due to limited sunlight. Additionally, many homeowners may opt for more low maintenance groundcovers if they do not want to install irrigation, mow, or make regular fertilizer applications. Topography, drainage, soil health, and other factors may also make it difficult for some to have healthy and sustainable lawns in all or part of their landscape.

While these groundcovers offer many advantages over turfgrass in certain scenarios, the biggest disadvantage is that there are few labeled options for weed control in non-turf groundcovers. Over the past two years, we have been working to develop preemergence and postemergence control options for non-turf groundcovers in landscapes. Funds from FNGLA allowed us to first test postemergence herbicides to try to find safe, effective options for landscape professionals trying to manage weeds in these groundcovers. The objective of this research is to evaluate the safety of common postemergence herbicides for use in groundcovers including Asiatic jasmine 'Minima' (*Trachelospermum asiaticum* 'Minima') and perennial peanut (*Arachis glabrata* 'Golden Glory').

Methods

All experiments were conducted at the Mid-Florida Research and Education Center in Apopka, FL in 2019. Asiatic jasmine and perennial peanut liners (2 inch) were obtained from a local nursery and potted into 3 L nursery containers on April 5 using an pinebark:peat:sand (80:20:10 v:v:v) substrate with incorporated fertilizer and amendments. Pots were placed on a nursery container pad in full sun and received 0.5 inches of overhead irrigation daily. On April 12, herbicides **(Table 1)** were applied using a CO_2 backpack sprayer calibrated to deliver 50 gallons per acre application volume. Herbicides were generally applied at twice the highest manufacturer labeled rate to determine tolerance in a worst-case scenario. Approximately six weeks later on May 20, a second application was applied following the same experimental procedures.

A second experimental run was conducted following the same protocol with the first treatment being applied on May 20 and the second application applied on July 1.

The trial was a completely randomized design with 8 single pot replications per treatment for both species. Data collected including injury ratings at 2, 4, and 6 weeks after the first herbicide treatment (WAT) and at 2, 4, and 8 weeks after the second herbicide treatment. Injury ratings were taken on a 0 to 10 scale with 0 indicating no injury or similar to non-treated controls, and 10 indicating complete death and no visible green tissues. Ratings of 3.0 or higher were considered commercially unacceptable. At 8 weeks after the second application, shoots were collected for dry weight determination by clipping shoots and the soil line and drying shoots in a forced air oven until reaching constant weight. Data were subjected to analysis of variance using JMP (SAS Institute) and differences between treatment means were determined using Fisher's Protected LSD (0.05).

RESULTS

Asiatic jasmine. Finale (glufosinate) caused the highest injury ratings at 2 WAT followed by Lontrel (clopyralid), while some minor injury was noted with Sceptor T/O (imazaquin), Basagran T/O (bentazon), and Dismiss (sulfentrazone) **(Table 1)**. Only Finale treated plants were considered unacceptable. Similar results were observed at 4 WAT, with some recovery noted in the Finale treatment. At 6 WAT, injury ratings increased in many treatments and unacceptable injury was noted in plants treated with Lontrel, Basagran T/O, Finale, Ranger Pro (glyphosate), and also Certainty (sulfosulfuron). It is important to note that Certainty is labeled for use on Asiatic jasmine but only on established plants in the landscape.

Following the second application at 2 WAT2, Lontrel, Basagran T/O, Certainty, Finale, and Ranger Pro all resulted in unacceptable injury. This trend continued at 4 and 8 WAT with the highest injury being observed in plants treated with Basagran T/O (ratings of 7.8) followed by plants treated with Lontrel and Finale (ratings of 5.3 and 5.1, respectively). Unacceptable injury was also noted with Certainty and Ranger Pro. Throughout all evaluations, only minor injury was observed with Sceptor T/O and Dismiss. While some minor injury was noted in some cases, plants were considered marketable/acceptable throughout the trial. Segment, SedgeHammer, and Fusilade II also caused no noticeable injury on any evaluation date (injury ratings of 0 throughout the trial).

Dry weight (biomass) data showed that all treatments with the exception of Segment, Fusilade II, and Sceptor T/O caused some growth reduction. Growth reduction was most evident in plants treated with Basagran T/O, Finale, and Ranger Pro. While SedgeHammer caused no injury or visible growth reduction, dry weight data indicated that plants were stunted in comparison with non-treated plants. Similar to SedgeHammer, only minor injury was noted in plants treated with Dismiss, but some minor growth differences were observed.

Perennial Peanut. At 2 WAT, unacceptable injury was noted in plants treated with Lontrel (4.1), Certainty (3.5), Finale (7.8) and Ranger Pro (7.3) **(Table 2)**. Minor injury with mean ratings below 3.0 was observed in all other treatments. At both 4 and 6 WAT, unacceptable injury was noted again in plants treated with Lontrel (10.0), Certainty (9.6), Finale (9.5) and Ranger Pro (10.0). Sceptor T/O also caused unacceptable injury at 6 WAT (4.1).

Following the second application, all plants treated with Lontrel, Certainty, Finale, or Ranger Pro had injury ratings of 9.9 to 10.0 on all evaluation dates, indicating complete plant death. Sceptor T/O did not result in plant death but plant foliage was severely distorted and stunted, typical of an ALS inhibiting herbicide. At 8 weeks after the second application, no noticeable injury was observed in plants treated with Fusilade II, Basagran, Dismiss, SedgeHammer, or Segment.

Dry weight data showed that all treatments with the exception of Segment and Basagran T/O caused some stunting.

While dry weight data showed that Fusilade II Sedgehammer resulted in minor stunting, reducing growth by 9.6% and 21.7%, respectively, no stunting could be observed by visually inspecting plants and all plants in these treatments remained aesthetically acceptable throughout the trial.

CONCLUSIONS

A summary of trial results are included in **Table 2** and examples of plant injury at 8 weeks after the second application are included in **Figures 1 and 2**. Graminicides including Fusilade II and Segment were found to be safe on both species with no reductions in plant growth and no noticeable injury. These herbicides could be used to control a broad range of annual and perennial grasses in these groundcovers.

Sceptor T/O is currently a labeled option for use in Asiatic jasmine beds. We observed no significant injury or growth reduction on Asiatic jasmine following two applications at twice the labeled rate to young, newly planted liners. This herbicide would be a good option in jasmine beds to control some sedges and certain broadleaf weed species. Sceptor T/O caused unacceptable injury on perennial peanut and would not be recommended. While Basagran T/O caused unacceptable injury on Asiatic jasmine, only minor injury and full recovery was observed in perennial peanut. Similar to Sceptor use in jasmine, Basagran could be used in perennial peanut for sedge control and to control certain broadleaf weed species.

Certainty would likely be a safe option for mature and fully established jasmine beds, but we observed injury following two application at twice the labeled rate. Further, unacceptable injury was noted after only one application. We would advise applicators to use caution with this product in jasmine and to only spot-spray weeds, avoiding broadcast applications. Dismiss (sulfentrazone) is not currently labeled for use in either groundcover but we found only minor injury following two applications. This could potentially be a future option for sedge control in these beds. Dismiss would also provide control of certain broadleaf species. Similarly, SedgeHammer caused no noticeable injury to either groundcover. It could be used in a similar manner as Dismiss for sedge and control of certain broadleaf species. Lontrel caused unacceptable injury to both species. As expected, Ranger Pro and Finale also caused unacceptable injury.

Based on results from this trial, Sceptor T/O, Fusilade II, and Segment would be safe for use in Asiatic jasmine and are currently labeled options in Asiatic jasmine in landscape beds. In addition to these three products, we found a high degree of Asiatic jasmine tolerance to Dismiss and SedgeHammer. Similarly, perennial peanut showed a high degree of tolerance to Segment, Fusilade II, Basagran, Dismiss, and SedgeHammer.

For products in which safety was noted but the herbicide does not list Asiatic jasmine or perennial peanut on product labels, applicators should note that they would assume all liability if injury occurred in a landscape setting. All trials were conducted in Florida during the summer months under a worst-case scenario setting, but injury could still be observed in some instances under different environmental conditions or if plants were stressed due to abiotic or biotic factors. We will continue to assess tolerance of these groundcovers to both preemergence and postemergence herbicides with the goal of adding these species to herbicide labels in the future.

Table 1. Tolerance of Asiatic jasmine 'Minima' and Perennial Peanut 'Golden Glory' to sequential applications of selected postemergence herbicides in Florida in 2019.

		First application[a]			Second application[b]			
		2 WAT[c]	4 WAT	6WAT	2 WAT	4 WAT	8 WAT	Dry
Herbicide (active ingredient)	Rate[d]	Asiatic jasmine injury ratings (0 to 10)[e]						Weight (g)[f]
Lontrel (clopyralid)	2.7 pts.	2.0 b[g]	2.4 b	3.4 bc	3.5 b	5.4 ab	5.3 b	10.6 def
Sceptor T/O (imazaquin)	22.6 fl. oz.	0.4 c	0.4 c	0.5 d	0.4 c	0.0 d	0.0 d	13.1 abc
Fusilade II (fluazifop-P-butyl)	48 fl. oz.	0.0 c	0.3 c	0.0 d	0.0 c	0.0 d	0.0 d	14.0 ab
Basagran T/O (bentazon)	64 fl. oz.	1.1 bc	2.1 b	4.0 ab	6.0 a	6.0 a	7.8 a	8.6 g
Certainty (sulfosulfuron)	4 oz.	0.0 c	2.6 b	4.6 a	3.6 b	3.3 c	3.8 bc	10.0 efg
Dismiss (sulfentrazone)	24 fl. oz.	1.1 bc	0.5 c	0.0 d	0.4 c	0.6 d	0.0 d	12.4 bcd
Finale (glufosinate)	8 qts.	4.3 a	3.5 a	3.4 bc	4.5 b	5.1 abc	5.1 b	8.2 g
Ranger Pro (glyphosate)	6 qts.	0.0 c	2.3 b	2.9 c	3.3 b	3.6 bc	3.4 c	9.7 fg
SedgeHammer (halosulfuron)	2.7 oz.	0.0 c	0.3 c	0.0 d	0.0 c	0.0 d	0.0 d	11.9 cde
Segment (sethoxydim)	7.5 pts.	0.0 c	0.0 c	0.0 d	0.0 c	0.0 d	0.0 d	14.8 a
Control	NA	0.0 c	0.0 c	0.0 d	0.0 c	0.0 d	0.0 d	15.1 a
		Perennial Peanut injury ratings (0 to 10)						
Lontrel (clopyralid)	2.7 pts.	4.1 b	5.6 b	10.0 a	10.0 a	10.0 a	10.0 a	0.0 e
Sceptor T/O (imazaquin)	22.6 fl. oz.	0.3 e	2.6 c	4.1 b	4.1 b	4.9 b	5.6 b	28.2 d
Fusilade II (fluazifop-P-butyl)	48 fl. oz.	1.0 de	0.4 d	0.0 c	1.4 c	1.5 c	0.0 c	39.6 b
Basagran T/O (bentazon)	64 fl. oz.	1.3 de	0.8 d	0.0 c	0.0 d	0.0 d	0.0 c	40.3 ab
Certainty (sulfosulfuron)	4 oz.	3.5 bc	6.1 b	9.6 a	9.9 a	10.0 a	10.0 a	0.0 e
Dismiss (sulfentrazone)	24 fl. oz.	2.6 bcd	0.9 d	0.1 c	0.1 d	0.0 d	0.0 c	39.5 b
Finale (glufosinate)	8 qts.	7.8 a	9.8 a	9.5 a	10.0 a	10.0 a	10.0 a	0.0 e
Ranger Pro (glyphosate)	6 qts.	7.3 a	9.9 a	10.0 a	10.0 a	10.0 a	10.0 a	0.0 e
SedgeHammer (halosulfuron)	2.7 oz.	1.6 cde	0.5 d	0.0 c	0.0 d	0.0 d	0.0 c	34.3 c
Segment (sethoxydim)	7.5 pts.	0.1 e	0.1 d	0.0 c	0.0 d	0.0 d	0.0 c	41.8 ab
Control	NA	0.0 e	0.0 d	0.0 c	0.0 d	0.0 d	0.0 c	43.8 a

[a]The first application was applied on 11 Apr. and 20 May for experimental runs 1 and 2 respectively.

[b]The second application was applied on 20 May and 1 June for experimental runs 1 and 2, respectively.

[c]WAT = weeks after treatment.

[d]Rate is expressed in amount of formulated product applied on a per acre basis. Surfactants were added to Lontrel, Sceptor, Fusilade II, Basagran, Certainty, and Segment based on manufacturer recommendations. All rates are approximately 2 × the maximum labeled rate.

[e]Injury ratings were taken on a 0 to 10 scale, 0 = no injury, 10 = dead plant and no visible living tissue.

[f]Shows shoot dry weights collected at 8 weeks after the second application.

[g]Means within a column and species followed by the same letter are not significantly different according to Fisher's Protected LSD (0.05).

Table 2. Results summary for herbicide tolerance of Asiatic jasmine and perennial peanut to selected postemergence herbicides.

Herbicide	Asiatic jasmine	Perennial peanut
Lontrel	Unacceptable injury after one application, severe injury after two applications.	Severe injury/death after one application.
Sceptor T/O	Very minor injury after two applications. Labeled option for established jasmine in the landscape.	Unacceptable injury after one application. Leaf distortion and stunting was observed.
Fusilade II	No injury after two applications. Labeled option for jasmine.	Only minor injury after two applications, complete recovery observed. Minor growth reduction.
Basagran T/O	Unacceptable injury after one application, severe injury after two applications.	Only minor injury and full recovery observed. No growth reduction.
Certainty	Unacceptable injury observed. Labeled option for established plants in the landscape.	Severe injury/death after one application.
Dismiss	Only minor injury and stunting after two applications. Complete recovery observed.	Only minor injury and stunting after two applications. Complete recovery observed.
Finale	Unacceptable/severe injury after two applications.	Unacceptable/severe injury after one application.
Ranger Pro	Unacceptable injury after two applications and significant stunting observed.	Unacceptable/severe injury after one application.
SedgeHammer	No injury observed observed. Some stunting was evident from dry wt. data but not noticed visually.	No injury observed observed. Some stunting was evident from dry wt. data but not noticed visually.
Segment	No injury or growth reduction observed.	No injury or growth reduction observed.

***Red cells show where unacceptable injury was observed and applications would not be recommended. Green cells show where only minor injury or growth reductions were observed. Yellow cells indicate more research is likely needed due to differences between trial results and product label instructions. These differences are likely due to the fact that trials were performed in containers using young plant liners and were not conducted on mature landscape plants as instructed on product labels. For safety, applicators should avoid making applications to newly planted areas.

Figure 1. Asiatic jasmine injury at 8 weeks after the second application. A = Lontrel, B = Sceptor T/O, C = Fusilade II, D = Basagran T/O, E= Certainty, F = Dismiss, G = Finale, H = Ranger Pro, I = SedgeHammer, J = Segment, K = handweeded Check.

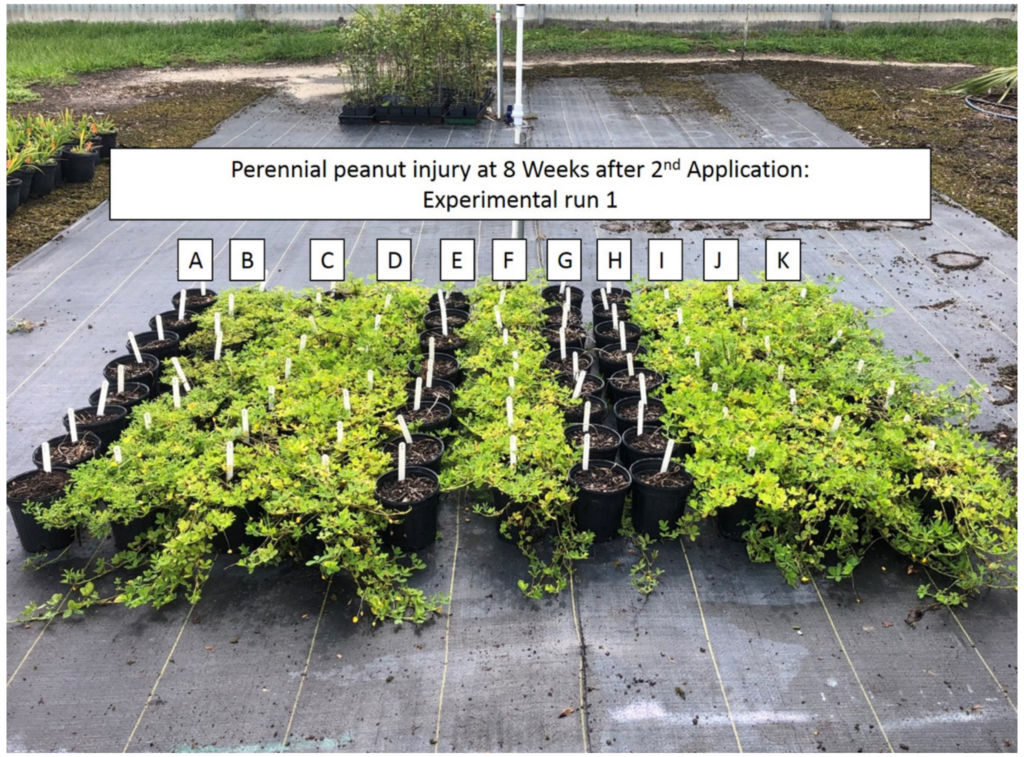

Figure 2. Perennial peanut injury at 8 weeks after the second application. A = Lontrel, B = Sceptor T/O, C = Fusilade II, D = Basagran T/O, E= Certainty, F = Dismiss, G = Finale, H = Ranger Pro, I = SedgeHammer, J = Segment, K = handweeded Check.

IMPROVE
PRODUCTION SYSTEM
PRACTICES AND STRATEGIES

Introduction of New Native Plants to Florida's Green Industry

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ABSTRACT

Over the last two decades, we have assessed the invasive potential of nearly 20 ornamental species and their cultivars. This research has helped steer new breeding initiatives to develop improved and non-fruiting ornamental varieties of lantana, nandina, privet and Mexican petunia. The overall goal of this project was to identify and promote non-invasive cultivars as safe alternatives to popular ornamental invaders in Florida. Field trials were similarly established in Quincy, Citra and Balm, FL. Containerized plants of eight trailing lantana (Lantana montevidensis) varieties eight heavenly bamboo (Nandina domestica) varieties, and three privet (Ligustrum sinense and Ligustrum xvicaryi) varieties were planted in replicated plots and monitored for growth, landscape performance, flowering, and fruiting. Results from the trailing lantana study provide evidence that the U.S. varieties are morphologically and cytologically distinct from the Australian weedy form. The Australian weedy form is a tetraploid and highly fertile in terms of male (pollen) and female fertility, and the U.S. varieties examined in this study are triploids and highly male and female sterile. Results from the nandina and privet studies are ongoing but show clear promise for select cultivars to meet UF/IFAS infraspecific taxon protocol requirements for recommended use in Florida.

OBJECTIVES AND METHODS

1. To collect and evaluate sources of new cultivars (not yet assessed by our team) for growth, landscape performance, fruiting, and seed viability in north, central and south FL.
2. To determine how they are morphologically and/or cytologically distinct from their wildtype forms.
3. If approved by UF/IFAS's infraspecific taxon protocol, to promote and recommend their use in Florida.

Plant Material. Eight sources of trailing lantana were identified for use in this study. Four of the plant sources were nurseries based in Florida, one was a commercial breeding company, one was a naturalized area in Houston, Texas; and one was a naturalized area in Queensland, Australia. All varieties were trailing lavender with the exception of one trailing white variety from Hatchett Creek Farms, Gainesville. Under Permit P37-17-01621 (USDA APHIS), vegetative plant material from Australia was shipped overnight from the Queensland Herbarium to Gainesville, FL. Plants were vegetatively propagated and finished in 4" pots filled with Fafard 2P soilless medium.

For the nandina and privet study, eight varieties of nandina and three varieties of privet were obtained as finished 2-3 gal plants from various nurseries. Nandina varieties included 'Seika' Obsession™, 'Murasaki' Flirt™, 'Lemon Lime', 'Twilight', Greray sunray ®, 'Chime', and 'Emerald Sea'. These were compared to the wild type or resident taxon. Privet varieties included variegated privet (Ligustrum sinense 'Variegatum'), sunshine privet (L. sinense 'Sunshine'), and golden privet (L. ×vicaryi 'NCLXI' Golden Ticket™).

Study Sites. Fields were fumigated or herbicided at least one month prior to planting. For trailing lantana, six uniform 4" plants of each variety were installed under full sun conditions in north (Quincy; USDA cold hardiness Zone 8b) northcentral (Citra; USDA cold hardiness Zone 9a) and west central Florida (Balm; USDA cold hardiness Zone 9b) on 16, July 2018. Plants were placed 6.0 ft on center in beds in each of six plots covered with white on black polypropylene plastic. Plants were drip irrigated 3-5 days per week as needed; topdressed with 9 grams (0.5 Tbs) of 12-month 15N-3.9P-10K Osmocote Plus, and fertigated twice a month. Daily temperature and rainfall were recorded on site by the Florida Automated Weather Network (FAWN, https://fawn.ifas.ufl.edu).

Nandina and privet landscape trials were performed similarly to lantana trials but beds were covered with a black semipermeable landscape fabric. On 22 May 2019, 3-gallon plants of each variety were randomly placed in one of five plots with 4' and 6' spacing on center (for nandina and privet, respectively), and topdressed with 84 grams of slow release fertilizer.

Data Collection. Trailing lantana leaf and flower morphology were assessed from plants of each variety grown under the same conditions and of the same age. Measurements included leaf blade length, peduncle length, corolla tube length, inflorescence diameter, number of flowers per umbel, and number of serrations per lamina. For each of six plant replicates, two measurements were taken from opposite leaves 3 to 4 nodes from the apex and averaged. Data was analyzed using a one-way analysis of variance in JMP®, Version 13 (SAS Institute Inc., Cary, NC) with significant means separated by a Tukey's HSD at $P \leq 0.05$.

To determine trailing lantana pollen stainability, anthers were collected from field-grown plants of each variety and stained in a 1.5-mL microcentrifuge tube containing 50 μL of acetocarmine (4%) overnight. Pollen from anther sacs was released on slides and observed under a bright field microscope at 10× and 200× magnification. For each variety, more than 600 pollen grains (if produced and available) were examined from four replicate samples.

The ploidy level of trailing lantana varieties was determined using an advanced CyFlow® Cube 6 flow cytometer that was equipped with laser light and could also report absolute nuclear DNA contents. This was calculated as sample nuclear DNA content (pg/2C) = internal reference nuclear DNA content (1.69) × (mean fluorescence value of sample / mean fluorescence value of internal reference).

Landscape performance was assessed by observing plant growth, flowering, and visual quality every month (trailing lantana) or three months (nandina and privet). Flowering was assessed on a scale from 1-5 where 1=no flowering, 2=a few flower buds present, 3=a few flowers open, 4-good flowering, 5=abundant flowers, possible peak. Visual quality was assessed on a scale from 1-5 where 1=dead or very poor quality, 2=fair quality, 3=good color and form, 4-very good color and form, 5=excellent color and form. Plant growth was determined by measured the height and two perpendicular widths of each plant in order to calculate the growth index.

Female fertility of trailing lantana was determined by sampling 20 random peduncles from each plant at each site every month. Drupes were separated as immature (green) and mature (purple), counted, manually cleaned and air dried. Seeds were surface sterilized with a 2.4% sodium hypochlorite solution for 10 min and then triple-rinsed with autoclaved distilled water. Pre-germination viability was examined on a subsample of 100 seeds using a 1% Tetrazolium staining test. To determine female fertility, four replicates of 100 cleaned seed were placed in 11x11x4 cm transparent polystyrene germination boxes containing one sheet of germination paper on top of one sheet of blotter paper moistened with 15 mL of autoclaved distilled water. Germination was counted when the radicle emerged from the seed once a week for 63 days.

RESULTS

Plant Morphology. The Australian plants were morphologically distinct compared to the U.S. varieties **(Figure 1)**. Plants had leaves with 54-78% shorter leaf blade lengths and 43-59% fewer leaf serrations. Flowers were smaller in inflorescence diameter, with fewer florets per inflorescence, and shorter corolla tube lengths. Australian plants were smaller in habit, produced abundant fruit, had distinct serrate-crenate leaf margins and less appressed hairs. Peduncle length was similar among all cultivars.

Landscape Performance. Throughout the 24-week trailing lantana study, mean flowering was between 4.08 and 4.48 (very good to abundant flowering) among U.S. varieties and 3.45 for the Australian form. Mean plant quality was between 4.37 and 4.66 among U.S. varieties and 3.88 for the Australia form. After 16 weeks the visual quality of Australian plants began to decline and after 20 weeks the flowering declined as well, likely due to colder temperatures. Regardless of location, Australian plants were smaller in height, width, and growth index compared to other varieties. Australian plants were similar in height among Balm and Citra locations but grew twice as wide in Balm compared to Citra. It was estimated that a single plant in Citra produced a total of 1,517 fruit in 24 weeks.

Female Fertility and Pollen Stainability. Throughout the 24-week study, the only trailing lantana variety that produced fruit from 20 random peduncles was the Australian form. Plants in Balm produced 1.7 times more fruit on 20 peduncles than plants in Citra. Seeds collected from Balm and Citra were 59% and 77% viable, respectively as determined by TZ staining. Seeds from Balm and Citra were 70% and 91% filled, respectively. X-ray analysis showed that 18% of seeds contained a second viable embryo. After 63 days, seed germination (4 reps of 100 seed) was 24% (Balm) and 72% (Citra). A prechilling treatment of 28 days did not improve germination. This suggests that cold stratification is not effective in alleviating physiological dormancy in trailing lantana.

Pollen stainability has been used as an indicator of lantana's male fertility (or sterility) and hybridization potential. The presence of pollen in the anther sacs was only observed for the Australian plants. Hence, the U.S. varieties had empty anther sacs. Average pollen stainability of Australian plants was 58.83%.

Nuclear DNA Content and Ploidy Analysis. The average nuclear DNA content of Australian trailing lantana plants was determined to be 3.98 pg/2C, using tomato as the internal reference. All U.S. varieties had the nuclear DNA content ranging from 2.80 to 2.85 pg/2C. This study represents the first report of the nuclear DNA content of trailing lantana. By comparing the nuclear DNA content of these varieties with that of a triploid lavender trailing lantana with $2n = 3x = 36$, it was determined that the Australian trailing lantana is a tetraploid and all the U.S. varieties are triploids.

Nandina and Privet. The landscape evaluation of nandina and privet varieties is an ongoing, longer-term study, necessary for woody shrubs. To date, visual quality of nandina ranged from 4.0 to 5.0 (scale 1-5) with flower initiation occurring for 'Sunray', 'Flirt', 'Obsession', 'Twilight' and the wild type within the first 8 weeks after planting. Variegated privet showed signs of green reversion as early as 0-4 weeks after planting. Fruit initiation was observed for 'Flirt', 'Obsession', 'Twilight', and the wild type nandina. Fruit will be wrapped with mesh bags and allowed to mature on the plants for future seed germination studies. Mature, immature and abnormal fruit will continue to be categorized and counted at each of the three locations. Varieties with little or no fruit production and good landscape performance will be subjected to the UF/IFAS infraspecific taxon protocol for non-invasive status consideration.

CONCLUSIONS

In summary, results from this study provide evidence that two forms of trailing lantana exist. The Australian plants were morphologically, cytologically, and reproductively distinct compared to the U.S. varieties. Plants had leaves with shorter blade lengths, fewer leaf serrations, and less flowers per inflorescence. The Australian form appears to be tetraploid and highly fertile and the U.S. varieties appear to be highly male and female sterile. To our knowledge the Australian variety is not grown in the U.S. Measures should be taken to prevent its introduction.

Figure 1. Representative comparison of U.S. cultivated (top) and Australian naturalized (bottom) trailing lantana. Note differences among leaf serrations, flower number, fruiting and form. Field picture taken 20 weeks after planting. Leaf photo credit B. Schutzman.

Figure 2. Representative pictures of trailing lantana (left) and nandina and privet (right) variety field trials conducted at north, north central and west central Florida. Photos taken at Citra, FL.

List of FNGLA Funded Projects Since 2005-06

2005-2006

PI NAME	HOME UNIT	LOCATION	TITLE
Thomas Yeager	Environmental Horticulture	Gainesville Campus	Statewide Expansion of South Florida BMP Effort
William Crow	Entomology & Nematology	Gainesville Campus	Biological Control of Root-Knot Nematodes on Woody Ornamentals
Forrest Howard	Environmental Horticulture	Ft. Lauderdale REC	Biology and Management of West Indies Mahogany Scale, Conchaspis cordiae (Hemiptera: Conchaspididae)
Zhanao Deng	Environmental Horticulture	Gulf Coast REC	Genetic Sterilization of Lantana
David Clark	Environmental Horticulture	Gainesville Campus	Development of New Coleus Cultivars for Better Foliage Color Stabiliy and Use as Groundcovers
James Gibson	Environmental Horticulture	West Florida REC	Consumer Purchase Patterns in Florida (3-year study) Study 1 (completed): The Impact of In-House Displays on Impulse Buying Behavior; Study 2 (ongoing project): The Impact of Display Gardens on Identifying Consumer Needs, Trends, and Preferences; Study 3: (Proposed): Developing Employee Plant Knowledge to Effectively Educate Consumers and Increase Sales

2006-2007

PI NAME	HOME UNIT	LOCATION	TITLE
James Barrett	Environmental Horticulture	Gainesville Campus	Evaluating Flowering Annuals and Herbaceous Perennials for the Florida Climate
Monica Elliott	Plant Pathology	Ft. Lauderdale REC	Determine the etiological agent for a new disease affecting Syagrus romanzoffiana (queen palm) in landscapes and nurseries
Kati Migliaccio	Agricultural & Biological Engineering	Tropical REC	Designing Irrigation BMPs Considering Capillary Rise for Production Cost Savings
Kimberly Moore	Environmental Horticulture	Ft. Lauderdale REC	Fertilization Effects on Water Requirements of Container Grown Ornamentals during Establishment in the Landscape
Wagner Vendrame	Environmental Horticulture	Tropical REC	Potential Horticultural and Disease Management Benefits of Silicon Fertilization of Potted Orchids
Tom Yeager	Environmental Horticulture	Gainesville Campus	Expanded BMP Education

2007-2008

PI NAME	HOME UNIT	LOCATION	TITLE
Kimberly Moore	Environmental Horticulture	Ft. Lauderdale REC	Organic Matter and Irrigation Frequency Effects During Shrub Establishment
Tom Yeager	Environmental Horticulture	Gainesville Campus	BMP Workshops for Field-Grown Plant Producers
Michael Dukes	Agricultural & Biological Engineering	Gainesville Campus	Development of Programming Recommendations for Smart Irrigation Controllers
Gurpal Toor	Soil & Water Sciences	Gulf Coast REC	Characterization of Organic Compounds in Nursery Reclaimed Water
Monica Elliot	Plant Pathology	Ft. Lauderdale REC	Fusarium Decline of Palms: Pathogen, Hosts, Diagnosis and Control
Zhanao Deng	Environmental Horticulture	Gulf Coast REC	Toward Sterilizing Nandina: Inducing Tetraploids for Development of Sterile, Non-Invasive Triploid Nandina
Francisco Escobedo	School of Forest Resources & Conservation	Gainesville Campus	The Benefits of Florida's Urban Forests on Environmental Quality

2008-2009

PI NAME	HOME UNIT	LOCATION	TITLE
Richard Beeson	Environmental Horticulture	Mid-Florida REC	Commercial Evaluation of Automated Irrigation Control for Overhead Irrigation Based on Daily Weather
Geoffrey Denny	Environmental Horticulture	Gulf Coast REC	Validation of Nitrogen Fertilizer Recommendations for Florida Landscape Plants
Michael Dukes	Agricultural & Biological Engineering	Gainesville Campus	Irrigation Controller Programming Guidelines by Multimedia Methods
Paul Fisher	Environmental Horticulture	Gainesville Campus	Onsite Monitoring of Water Treatment Technologies in Recycled Irrigation Water for Florida Nurseries
Paul Monaghan	Agricultural & Biological Engineering	Gainesville Campus	Using Community Based Social Marketing to Evaluate Homeowner Attitudes Towards Florida Friendly Waterfront Landscapes
Brian Pearson	Environmental Horticulture	Mid-Florida REC	Quantification of Stormwater Nutrient Runoff in the Environment
Amy Shober	Soil & Water Sciences	Gulf Coast REC	Effects of Organic Matter and Tillage on Plant Establishment and Nutrient Losses in an Residential Landscape
Thomas Yeager	Environmental Horticulture	Gainesville Campus	Production Strategies for Water Savings in the Landscape

2009-2010

PI NAME	HOME UNIT	LOCATION	TITLE
Jianjun Chen	Environmental Horticulture	Mid-Florida REC	Improving the Quality of Recycled-Irrigation Water by Minimizing Algal Density Using Plant-Friendly Chemicals
Geoffrey Denny	Environmental Horticulture	Gulf Coast REC	Validation of Nitrogen Fertilizer Recommendations for Florida Landscape Plants
Rosanna Freyre	Environmental Horticulture	Gainesville Campus	Breeding of Sterile and Non-Invasive Ruellia Cultivars
Jason Keith Kruse	Environmental Horticulture	Gainesville Campus	Determining Required Width of Unfertilized Buffer Strips to Limit Fertilizer Movement Into SurfaceWater Bodies
Amy Shober	Soil & Water Sciences	Gulf Coast REC	Evaluation of Soil Physical and Chemical Properties at Newly Constructed Residential Home Sites to Improve Plant Growth and Environmental Quality
Tom Yeager	Environmental Horticulture	Gainesville Campus	Developing a BMP Manual for Field-Grown Plant Producers
Tom Yeager	Environmental Horticulture	Gainesville Campus	Automatic Irrigation Control Based Upon Plant Need

2010-2011

PI NAME	HOME UNIT	LOCATION	TITLE
David Clark	Environmental Horticulture	Gainesville Campus	The University of Florida Sensory Gardens
Catharine Mannion	Entomology & Nematology	Tropical REC	Impact of Insecticides and Method of Application on Natural Enemies in the Landscape
Kimberly Moore	Environmental Horticulture	Ft. Lauderdale REC	Use of Reclaimed Waste Water to Grow Greenhouse Ornamental Plants
Kati Migliaccio	Agricultural & Biological Engineering	Tropical REC	Interactive Tool for Improving Water Management in Landscapes
Robert Stamps	Environmental Horticulture	Mid-Florida REC	Evaluation and Identification of Effective and Safe Herbicides, Herbicide Formulations and Application Rates for Landscape and Nursery Use
Tom Yeager	Environmental Horticulture	Gainesville Campus	Development of an Economic Decision Support Tool for Container Nursery Management
Tom Yeager	Environmental Horticulture	Gainesville Campus	Enhanced Decision Capabilities for Irrigation of Container Plants

2011-2012

PI NAME	HOME UNIT	LOCATION	TITLE
Gul Shad Ali	Plant Pathology	Mid-Florida REC	Development of a Rapid and Sensitive Diagnostic Kit for Ornamental Plant Pathogens Using Loop-Mediated Isothermal Amplification and Recombinase Polymerase Amplification
Erin Alvarez	Environmental Horticulture	Gainesville Campus	The University of Florida Sensory Gardens
Eileen Buss	Entomology & Nematology	Gainesville Campus	Gall-Maker Management in Live Oak Nurseries
Aaron Palmateer	Plant Pathology	Tropical REC	Management of High Consequence Bacterial
Amy Shober	Soil & Water Sciences	Gulf Coast REC	Evaluation of Nutrient Leaching From Mixed Landscapes
Tom Yeager	Environmental Horticulture	Gainesville Campus	Continued Development of an Economic Decision Support Tool for Container Nursery Management

2012-2013

PI NAME	HOME UNIT	LOCATION	TITLE
Tom Yeager	Environmental Horticulture	Gainesville Campus	Evaluating the Effect of Plant Species on Water Usage to Improve Container Nursery Irrigation BMPs
James P. Cuda	Entomology & Nematology	Gainesville Campus	Mass Rearing of the South American Psyllid Calophya terebinthifolii (Hemiptera: Calophyidae), a Candidate Biological Control Agent for Brazilian Peppertree
Gary Knox	Environmental Horticulture	North Florida REC	New Crapemrytle Cultivars for the Southeastern U.S. An Extensive Evaluation of Field Resistances to Fungal, Bacterial and Abiotic Disorders and Plant and Flower Characteristics
Tesfamariam Mengistu	Entomology & Nematology	Gainesville Campus	Development of a New Molecular Method to Detect Major Root-Knot Nematodes (Meloidogyne spp.) Occurring in Florida Nurseries
Gul Shad Ali	Plant Pathology	Mid-Florida REC	Implementation and Field Testing of a Rapid and Sensitive Diaignostic Kit for Ornamental Plant Pathogens Using Loop-Mediated Isothermal Amplification Integrated with Lateral Flow Devices
Monica Elliott	Plant Pathology	Ft. Lauderdale REC	Fungicide Movement, Distribution and Persistence in Palms
Robert Stamps	Environmental Horticulture	Mid-Florida REC	Development of Control and Eradication Methods for a Weed Posing a Nursery Quarantine Risk and a Weed Posing Human Health and Environmental Risks
Zhanao Deng	Environmental Horticulture	Gulf Coast REC	Developing Superior Native Plant Varieties for the Florida Nursery and Landscape Industry

2013-2014

PI NAME	HOME UNIT	LOCATION	TITLE
Steven Arthurs	Entomology & Nematology	Mid-Florida REC	Processed Coffee Grounds to Manage Cycad Aulacaspis Scale in Landscapes
Jianjun Chen	Environmental Horticulture	Mid-Florida REC	Developing Color-Leaved Ficus Plants Through Biotechnology Approaches
Huangjun Lu	Horticultural Sciences	Everglades REC	Enhancing St. Augustinegrass for Drought Tolerance
Paul Monaghan	Agricultural & Biological Engineering	Gainesville Campus	Increasing Tree Sales and Survivability in Urban Areas Community Tree Stewardship Programs
Kimberly Moore	Environmental Horticulture	Ft. Lauderdale REC	Determination of Salt Tolerance of Container Grown Ornamental Shrubs
Quisto Settle	Agricultural & Biological Engineering	IFAS Center for Public Issues Education	Understanding Public Opinion of Issues Facing the Nursery and Landscape Industry in Florida
Thomas Yeager	Environmental Horticulture	Gainesville Campus	Enhancing Irrigation in Container Nurseries Using Mobile Device App
Thomas Yeager	Environmental Horticulture	Gainesville Campus	Develop Video to Promote BMPs

2014-2015

PI NAME	HOME UNIT	LOCATION	TITLE
Bala Rathinasabapathi	Horticultural Sciences	Gainesville Campus	Toward a Novel Biopesticide to Control Fall Armyworms: Beebalm Phytochemicals
Tom Yeager	Environmental Horticulture	Gainesville Campus	A Mobile Device App for Enhancing Irrigation in Container Nurseries
Aaron Palmateer	Plant Pathology	Tropical REC	Using Plant Diagnoistic Reports as a Tool for Preventative Disease Management in Florida Nurseries and Landscapes
Ronald Cave	Entomology & Nematology	Indian River REC	Biological Control of Green Croton Scale on Ornamental Plants
Stephen Marble	Environmental Horticulture	Mid-Florida REC	Increasing the Accuracy and Effectiveness of Herbicide Applications in Florida Nurseries
Mathews Paret	Plant Pathology	North Florida REC	Rose Mosaic: Management of Destructive Rose Virus Complex Using Early Detection and Novel IPM Strategies
Nathan Boyd	Horticultural Sciences	Gulf Coast REC	Weed Management Options for Tropical Ornamentals
Erica Goss	Plant Pathology	Gainesville Campus	New Method to Detect Hybrid Phytophthora in Nursery Production
Catharine Mannion	Entomology & Nematology	Tropical REC	Contributing Factors in Ficus benjamina Decline

2015-2016

PI NAME	HOME UNIT	LOCATION	TITLE
Mace Bauer	Horticultural Sciences	Gainesville Campus	Improve Environment and Resource Management
Nathan Boyd	Horticultural Sciences	Gulf Coast REC	Weed Management Options for Tropical Ornamentals
Paul Fisher	Environmental Horticulture	Gainesville Campus	Delivering Adequate Oxygen for Rooting of Plant Cuttings
Paul Fisher	Environmental Horticulture	Gainesville Campus	Lowcost and Automated Sensorbased Technology for Improving Irrigation Strategies
Stephen Marble	Environmental Horticulture	Mid-Florida REC	Determining the Impact of Metsulfuron a Turf Herbicide on Growth and Establishment of Ornamental Trees and Shrubs in Florida's Landscapes
Kimberly Moore	Environmental Horticulture	Ft. Lauderdale REC	Varying Leaching Fractions and Waste Water Blends to Grow Containerized Foliage Plants
Bart Schutzman	Environmental Horticulture	Gainesville Campus	Expansion andqw Enhancement of the Gardens at Fifield for Research, Teaching and Extension
Tripti Vashisth	Horticultural Sciences	Citrus REC	Evaluate the Use of Plant Growth Regulators and Different Growing Media to Accelerate the Rate of Germination and Growth in Citrus Rootstock Seedlings and Budded Trees
Tom Yeager	Environmental Horticulture	Gainesville Campus	Using Leaching Fraction to Achieve Appropriate Irrigation Application Amounts

2016-2017

PI NAME	HOME UNIT	LOCATION	TITLE
Brian Bahder	Entomology & Nematology	Ft. Lauderdale REC	Evaluation of Insects in Areas Impacted by Texas Phoenix Palm Decline for Their Potential as Vectors
Nathan Boyd	Horticultural Sciences	Gulf Coast REC	Preemergence Herbicides for Weed Control in Allamanda,Bird of Paradise, Firebush and Hibiscus
Adam Dale	Entomology and Nematology	Gainesville Campus	Novel Cultural Strategies for Managing Insect Pests of St. Agustinegrass
Paul Fisher	Environmental Horticulture	Gainesville Campus	Remediating Agrichemicals from Irrigation Water Using an Activated Carbon Filter
Rosanna Freyre	Environmental Horticulture	Gainesville Campus	Breeding Sterile Dwarf Mexican Petunia (Ruellia Simplex) at the University of Florida
Catharine Mannion	Entomology and Nematology	Tropical REC	Managing Ficus Whitefly Without Pesticides
S. Chris Marble	Environmental Horticulture	Gainesville Campus	Impact of Herbicide Application Carrier Volume on Weed Control in the Absence of Rainfall or Irrigation for Activiation
Xavier Martini	Entomology and Nematology	North Florida REC	Investigating Potential Alternative Vectors and Reservoirs of Rose Rosette Virus in the Florida Panhandle
Bryan Unruh	Environmental Horticulture	West Florida REC	A Mobile Web Application for Geolocating Fertilizer Ordinance Jurisdictions

2017-2018

PI NAME	HOME UNIT	LOCATION	TITLE
Charles Guy	Environmental Horticulture	Gainesville Campus	Assessing Human Health Benefits of Gardening
Raymond Odeh	Environmental Horticulture		
Allan Bacon	Soil and Water Science	Gainesville Campus	Long-term Recovery of Compacted Residential Soils
Eben Broadbent	Forest Resources and Conservation		
Adam Dale	Entomology and Nematology	Gainesville Campus	Investigating the Causal Agent of Bud Galls on Florida Ornamental Plants
Gul Shad Ali	Plant Pathology	Mid-Florida REC	
Erin Harlow	Duval County Extension	IFAS Extension	
Rhuanito Ferrarezi	Horticultural Sciences	Indian River REC	Accelerated Production of Citrus Nursery Trees Using Automated Ebbandflow Subirrigation
Basil Iannone	Forest Resources and Conservation	Gainesville Campus	Planting Stormwater Ponds: Determining the Benefits and Best Management Practices for Ornamental Plants in an Underutilized Portion of Residential Landscapes
Michelle Atkinson	Manatee County Extension	IFAS Extension	
Mary Lusk	Soil and Water Science	Gulf Coast REC	
Tom Yeager	Environmental Horticulture	Gainesville Campus	Redefining Irrigation Permit Allocations for Nurseries
Brian Bahder	Entomology and Nematology	Ft. Lauderdale REC	Developing dPCR for Detecting Phytoplasmas in Palms
Heqiang "Alfred" Huo	Environmental Horticulture	Mid-Florida REC	Development of Genetically Engineered Banker Plants for Biological Control of Whiteflies in Greenhouses
Lance Osborne	Entomology and Nematology		
H. Dail Laughinghouse	Agronomy	Ft. Lauderdale REC	Developing Effective ManagementOptions for *Nostoc* spp. in Florida Nurseries
Chris Marble	Environmental Horticulture	Mid-Florida REC	
David Berthold	(No Unit Affiliation)	Ft. Lauderdale REC	
Mathews Paret	Plant Pathology	North Florida REC	Recent Widespread Damage of Commercial and Landscape Roses In Florida To Crown Gall Disease: Characterizing the Bacterial Strains and Establishing Management Strategies
Gary Knox	Environmental Horticulture		

2018-2019

PI NAME	HOME UNIT	LOCATION	TITLE
Andrew Koeser	Environmental Horticulture	Gulf Coast REC	Determining Root Space Requirements for Florida Street Trees
Deb Hilbert	Environmental Horticulture		
Heidi Radunovich	Family, Youth and Community Sciences	Gainesville Campus	Identifying the Impacts of Opioids on Florida Nursery, Growers and Landscapers
Christa Court	Food and Resource Economics		
Heqiang "Alfred" Huo	Environmental Horticulture	Mid-Florida REC	Development of Salinity Tolerant Petunia Through CRISPR/Cas9 GeneEditing
Linhchi Nguyen	Environmental Horticulture		
Tom Yeager	Environmental Horticulture	Gainesville Campus	Use of Reclaimed Water in Production Nurseries
Shawn Steed	Hillsborough County Extension	IFAS Extension	
Brian Bahder	Entomology and Nematology	Ft. Lauderdale REC	Evaluating vector potential of Haplaxius crudus and Idioderma virescens
Thomas Chouvenc	Entomology and Nematology	Ft. Lauderdale REC	Measuring the Impact of a New Invasive Ant Species (Plagiolepis alluaudi) on Plant Feeding Insects in South Florida Nurseries
Brian Bahder	Entomology and Nematology	Ft. Lauderdale REC	
Andrea Lucky	Entomology and Nematology	Gainesville Campus	
Chris Marble	Environmental Horticulture	Mid-Florida REC	Improving Nursery Weed Control by Choosing Herbicides Based on Application Timing Flexibility and Formulation
Chris Marble	Environmental Horticulture	Mid-Florida REC	Developing Postemergence Weed Control Strategies for Nonturf Groundcovers in Florida
Sandra Wilson	Environmental Horticulture	Gainesville Campus	Introduction of New Native Plants to Florida's Green Industry
Carlee Steppe	Environmental Horticulture	Gainesville Campus	