FNGLA Endowment 2024-2025 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 $6,500 each to supplement and extend existing research projects. The principal balance of the endowment is more than $1.9 million, and **10 projects** involving **19 faculty members** were funded for 2024 - 2025.

The following priorities were determined for the selection of the 2024 - 2025 projects:

1. Improve Environmental and Resource Management
2. Improve Pest Management Practices and Strategies
3. Improve Production Systems Practices and Strategies
4. Genetics & Breeding to Enhance Quantities & Diversity of Plant Material
5. Developing and Implementing Emerging Technology
6. Enhance Floridian's Quality of Life

The selection process included reviews by the following FNGLA committee members:

- Ed Bravo
- Van Donnan
- Mike Marshall
- Linda Reindl
- David McDonald
- Heather Blake

A MESSAGE OF THANKS

To the Florida Nursery, Growers and Landscape Association:

Thank you for your support. The funding your organization raised allows UF/IFAS researchers to continue their great work towards research and discovery both on campus and at our off-campus research centers (see map on the final page of this document).

We also want to thank the selection committee for the time they dedicated to this program. Your thorough review ensures the projects that receive funding are the best of the best.

We look forward to this continued collaboration and hope you find this document helpful.

Sincerely,

Robert Gilbert
UF/IFAS Dean for Research
Director of the Florida Agricultural
Experiment Station (FAES)
Executive Director for Academic
Affairs

Improve Environmental and Resource Management

This priority area is defined as:

FNGLA encourages and supports research to maximize efficient water use and research designed to react to and identify exotic insects, diseases, and plants that can harm our industry and our environment. FNGLA supports research for control and prevention of such pest introductions.

FNGLA supported one project under this priority area, and that summary is on pages 5-8.

Envisioning a water-efficient green industry through stakeholder engagement

PI: **Yilin Zhuang, Agricultural and Biological Engineering | Mid-Florida REC; yilinz@ufl.edu**
CO-PI: **Ondine Wells, Marion County Extension**

ABSTRACT

This project engaged diverse stakeholders across Florida's green industry, including nursery growers, turf producers, builders, developers, landscape professionals, irrigation contractors, homeowner associations, and allied organizations, to identify barriers, opportunities, and priorities for advancing water-efficient landscaping. Data were collected through interviews, surveys, focus groups, and an interactive stakeholder open house to capture practical, experience-based insights across the supply chain, including plant selection, irrigation system design, soil health, market demand, regulatory requirements, and homeowner education. Key challenges identified included high upfront costs, limited availability of water-efficient plant materials, fragmented regulations across jurisdictions, gaps in homeowner knowledge, and limited training or licensure for irrigation professionals. Opportunities for progress included development of drought-tolerant cultivars, increased adoption of native plants, improved soil health practices, integration of trained maintenance professionals, adoption of digital water metering and water budgeting, and greater industry involvement in shaping policies and certification programs. Findings highlight the value of cross-sector collaboration and identify targeted education and research priorities to support industry-driven solutions that balance water conservation, economic growth, and landscape aesthetics in Florida.

OBJECTIVES

1. Identify Industry Barriers and Opportunities: Assess the barriers and opportunities stakeholders face in growing, installing, and maintaining water-efficient landscapes.
2. Foster Cross-Sector Collaboration: Build partnerships and facilitate knowledge exchange among industry professionals to advance adoptions of water-efficient practices.
3. Identify Educational and Research Priorities: Identify key areas where research and Extension education can support industry adoption of water-efficient landscapes while expanding the horticulture industry, satisfying consumer demand, and protecting water resources.

METHODS

This project used a multi-phase qualitative approach to capture perspectives from diverse sectors of Florida's green industry. Four primary engagement methods were used: key informant interviews, in-person surveys, virtual focus groups, and an in-person stakeholder open house.

- **Key Informant Interviews**: Twelve semi-structured interviews were conducted via Zoom (Nov. 2024 – Jan. 2025) with representatives from academia, government agencies, and Florida Nursery, Growers and Landscape Association (FNGLA). Interviews explored definitions of water-efficient landscapes, perceived barriers and opportunities, and additional stakeholders to involve.

Each interview (45 - 60 minutes) was recorded with consent, transcribed, and analyzed to identify themes.

- **In-Person Surveys**: At the FNGLA Jacksonville Landscape Show (Feb 2025), 12 nursery vendors completed brief surveys on plant selection, market demand, and production constraints for water-efficient plant materials. Responses were collected on paper and entered into a database for analysis.
- **Virtual Focus Groups**: Five 90-minute Zoom sessions (May 2025) included 2 to 7 participants per group (total n=20), representing growers, builders, developers, homeowner association (HOA) boards, landscape designers, irrigation contractors, utilities, and local government. A third-party moderator facilitated discussions on landscape materials, irrigation practices, market trends, homeowner education, regulatory influences, and collaboration opportunities. Sessions were recorded, transcribed, and analyzed using NVivo to identify themes and representative quotes.
- **In-Person Stakeholder Open House**: On July 10, 2025, an open house at UF/IFAS Mid-Florida Research and Education Center shared preliminary findings and collected feedback. The event included presentations, poster displays summarizing focus group and survey results, and small-group discussions on next steps. Written and verbal feedback was compiled for final analysis and served as an opportunity for networking and strengthening cross-sector connections.

RESULTS

Industry Barriers and Opportunities
Barriers
Cost and Time: Builders face high costs for smart controllers, temporary irrigation for plant establishment, and soil amendments. "*Temporary irrigation alone can cost close to $1,000 per home - unnecessary costs I have to pass on*." Certification programs require significant time and paperwork, creating a steep learning curve. Homebuyers' expectations for lush, traditional landscapes can add pressure to overspend.

Plant Availability and Adoption: Growers must respond to immediate market demand. Water-efficient plants are often overlooked if builders or homeowners do not request them limiting production and availability. "*Landscaping is treated as an afterthought by builders seeking the least expensive option.*" New cultivars may fail in the field, reducing confidence in adoption. "I*f those large landscaping companies aren't managing it [turf] right... it's so easy to blame the turf.*"

Irrigation Systems and Training: Maintaining complex irrigation systems, including rain sensors, microirrigation, is challenging without proper technical knowledge. Aging systems in older developments further reduce efficiency and increase maintenance needs. The lack of licensure for irrigation professionals leads to inconsistent system performance and water use inefficiency. "*We have a landscaper that sets the timers and... I don't really know what he's done. Sometimes the system is overwatering, sometimes under, and there's no way to verify that it's running efficiently without proper oversight or training.*"

Regulatory Complexity: Builders and water managers struggle with inconsistent regulations and requirements across jurisdictions, which complicates compliance and planning "*Too many different people driving the changes... it gets really complicated.*"

Homeowner Knowledge and Expectations: Many homeowners, particularly those new to Florida, are unfamiliar with proper irrigation scheduling and plant care, creating a disconnect between landscape aesthetics and water-efficient practices. "*People move to Florida and want a perfect lawn immediately - they don't understand plant establishment or timing.*" "*Even when we install efficient irrigation, many homeowners override schedules or water manually out of habit.*"

Cultivar Development: Continued breeding of slow-growing, drought-tolerant turf and ornamental varieties. "*If we had more reliable drought-tolerant options, adoption would be much easier.*"

Expansion of Native Plants: Increased demand for native and Florida-Friendly plants, supported by education and promotion. "*Homeowners respond really well when they understand the benefits of native plants - it just needs the right messaging.*"

Soil Health Focus: Recognition of soil health and mycorrhiza as critical to water efficiency. "*A healthy soil can do half the work for you when it comes to irrigation savings.*"

Professional Maintenance Models: Some nursery and landscape companies provide ongoing maintenance services to manage irrigation, plant health, and overall water efficiency because many homeowners lack the knowledge or time to maintain efficient landscapes themselves. "*We offer maintenance contracts because most homeowners just don't know how to manage it themselves.*"

Digital Metering and Water Budgeting: Real-time water-use data and budget-based management showing strong potential for conservation. "*Once they see actual numbers on water use, people really start paying attention.*"

Water Managers: Dedicated staff overseeing irrigation have achieved significant water savings. "*Having someone on site who can adjust and monitor irrigation makes a huge difference in efficiency.*"

Strengthening Collaboration: Industry interest in greater involvement during regulation and certification development, and in continued cross-sector conversations. "*If we could all talk early in the process, from growers to builders to water managers, we could avoid a lot of wasted effort.*"

Cross-Sector Collaboration

Participants emphasized that effective collaboration among growers, builders, developers, landscape architects, irrigation professionals, HOAs, utilities, regulatory agencies, and Extension is essential to advancing water-efficient landscaping. A participant noted: "*Collaborating is huge… this group is really representative… bringing in growers, manufacturers, along with… end consumers and regulatory agencies in a thoughtful way to where everyone can win… it's very hard to do, but worth it when it's done well.*"

Current Strengths

- Established partnerships between UF/IFAS, Water Management Districts, and industry groups.
- Successful local collaborations, such as HOAs working with utilities or Extension to improve irrigation efficiency.
- Joint research projects testing new cultivars, irrigation technologies, and soil management strategies.

Gaps in Collaboration

- Limited industry input in early stages of regulation and certification design.
- Few sustained venues for multi-sector dialogue beyond one-time events.
- Inconsistent homeowner education messaging across agencies and industry.

Recommendations

- Form ongoing working groups to guide policy, certification, and outreach.
- Engage industry representatives early in regulatory processes.
- Expand demonstration projects that integrate multiple sectors.
- Standardize homeowner education messages across partners.

Educational and Research Priorities

- **Research Needs**: Research should focus on developing and evaluating drought-tolerant turf and ornamental cultivars, assessing native and Florida-Friendly species, and producing practical, market-ready plant lists for builders. Strategies to improve soil health, including mycorrhiza inoculation, should be explored to support plant establishment in sandy soils. Studies should also evaluate the performance, maintenance, and water-saving potential of rain sensors, microirrigation, and smart controllers. Additionally, the feasibility and impact of community-level water budgets should be assessed, and real-time water-use data should be investigated as a tool to encourage behavioral change.
- **Educational Needs**: Homeowners need clear, consistent guidance on irrigation, plant care, and the benefits of water-efficient landscapes. Expanded certification and training programs should be available for maintenance companies, irrigation installers, and HOA managers, with potential licensure considered for irrigation professionals. Opportunities for cross-sector outreach, such as forums and shared resources, should be expanded to disseminate best practices across industries. Coordinated consumer awareness campaigns should promote water-efficient landscapes as attractive, desirable, and achievable. Stakeholders emphasized the need to link research and education. As one builder stated: "*Don't just hand us the research - show us how to use it in the field, and how to explain it to the homeowner so they understand why it matters.*"

CONCLUSIONS

This project engaged a broad cross-section of Florida's green industry, including builders, nursery and turf growers, landscape professionals, irrigation specialists, water managers, HOAs, and regulatory partners, to assess barriers, opportunities, and needs related to water-efficient landscapes. Through interviews, surveys, focus groups, and an open house, we gathered practical, experience-based insights from across the supply chain.

Findings revealed key barriers, including high upfront costs, limited availability of water-efficient plant materials, fragmented regulatory requirements, and gaps in homeowner and professional knowledge. Stakeholders also identified opportunities for progress, such as developing drought-tolerant cultivars, increasing adoption of native plants, improving soil health, expanding training and certification, and implementing technologies like digital metering and water budgeting.

Participants emphasized the importance of cross-sector collaboration, among industry sectors and between industry and regulatory agencies, in shaping effective programs, standards, and outreach. The education and research priorities identified through this project highlight areas where targeted outreach and applied research can encourage adoption of water-efficient practices and increase understanding among industry stakeholders and homeowners. The relationships and shared knowledge developed through this project provide a foundation for advancing water-efficient landscapes in Florida.

Improve Pest Management Practices and Strategies

This priority area is defined as:

FNGLA supports research to develop new biological and chemical pest management tools that are effective and environmentally safe.

FNGLA supported four projects under this priority area, and those summaries are on pages 10-27.

Development of a diagnostic test for quantification of oxytetracylcine in plam tissue

PI: **Brian Bahder, Entomology and Nematology | Ft. Lauderdale REC; bbahder@ufl.edu**

ABSTRACT

Lethal bronzing (LB) is a fatal phytoplasma infection of a variety of ornamental palms in Florida and is a significant threat to the green industries. Current management has emphasized rapid removal of infected palms and preventative inoculations of the antibiotic oxytetracycline (OTC). Current label rates/protocols are based on data generated from crude experiments in the 1970s evaluating bacterial growth on agar with tissue containing OTC that were taken from coconut palms.

With modern technology available and the fact that LB infects primarily cabbage palms and date palms, OTC protocols need to be revisited and improved. To accurately quantify OTC in palm tissue, a liquid chromatography/mass spectrometry (LC/Mass Spec) test will be developed and optimized.

METHODS

Objective 1: Develop LC/Mass Spec for OTC in palm leaf tissue.
Standard OTC powder was prepared fresh in water. Samples were kept at -20°C until processing. Palm leaf tissue was thawed and dried overnight at 50°C. Leaves were broken into smaller pieces and placed in homogenization tubes with steel beads and received 30 second bursts at 4350 rpm, x10. 100 mg leaf tissue was weighed. For standards, control leaf tissue was spiked with OTC so that is soaked into the dry tissue. 1 mL water was added to each tube and placed on a vortex mixer overnight at 4°C. The next morning, the water was transferred to new tubes. After transferring, the sample and standard spike tissue were rinsed with an additional 200 µL water and combined with the previously transferred 1 mL water. Liquid was centrifuged at 16000 g for 10 min, and supernatant was transferred to a new tube for drying via speedvac. Dried samples were reconstituted in 50 µL water for analysis. Throughout the entire procedure, care was taken to minimize contact with light since the compound is light sensitive.

RESULTS

From pure OTC, a calibration curve was generated (Figure 1) with concentrations ranging from 0 to 10 ng/mL (Table 1). Leaf tissue taken 1 week after treatment displayed positive detection and quantification of OTC, with values ranging from 2 to 5 ng/mL (Table 2), with an average of 4±0.55 ng/mL detected among the 5 replicates (Table 2).

CONCLUSIONS

These data demonstrate the successful calibration of a standard curve and validate the extraction protocol to both detect and quantify OTC in palm leaf tissue. With this assay developed and fully optimized, it will now be possible to accurately measure OTC in palm tissue to ultimately determine, how long it remains in target tissue (i.e. leaves) and what type of distribution in the canopy can be expected.

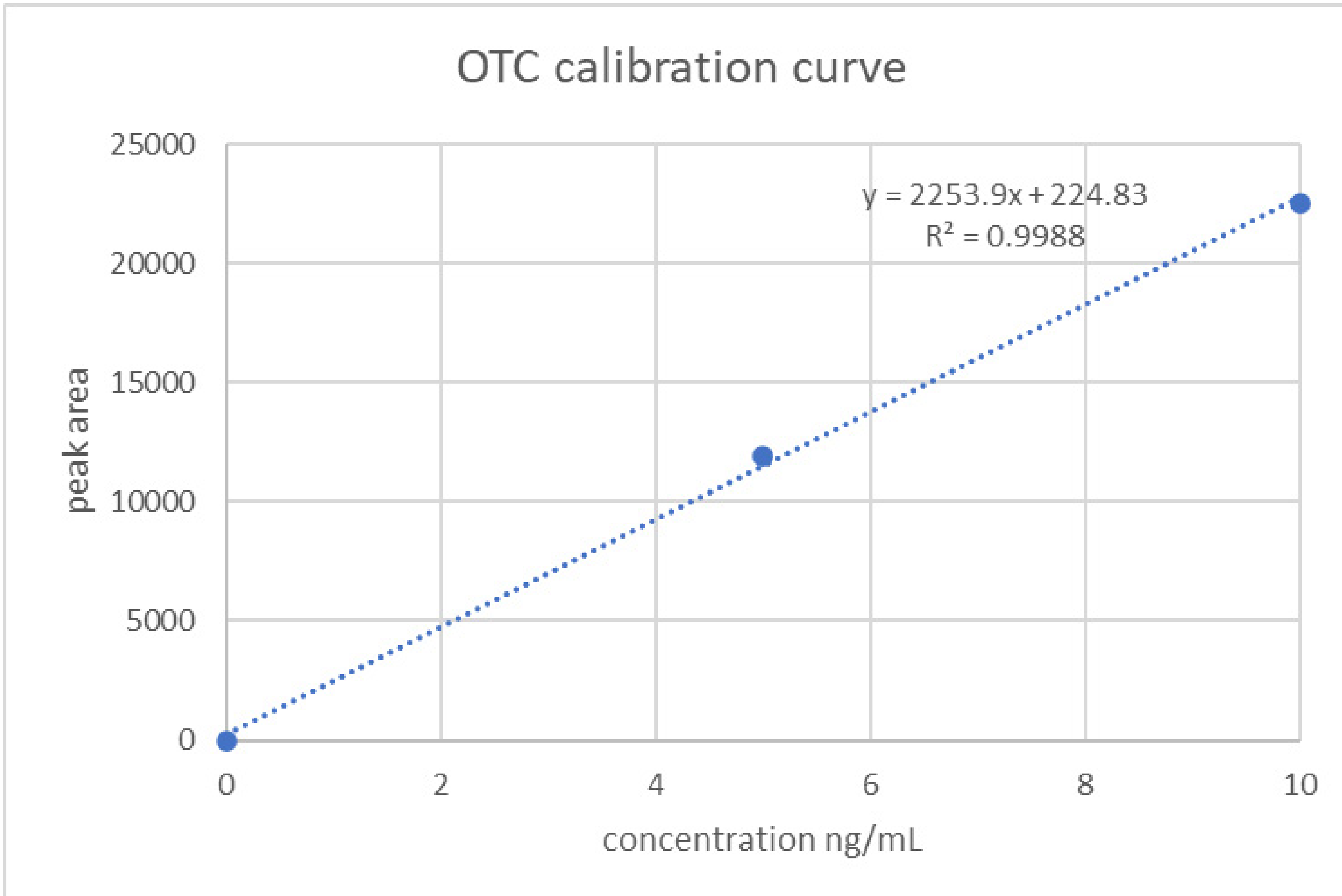

Figure 1. Standard curve for OTC calibration.

ng/mL	peak area	averaged
0	0	0
5	11944	11944
10	22539	22539
100	57921	57921
500	170556	179936
500	227412	
500	141841	
1000	574039	573807

Table 1. Extracted standard curve for OTC.

Replicate	Sample	Treatment	Peak area	ng/mL
1	leaf #2	treated control	9855	4
2	leaf #2	treated control	12132	5
3	leaf #2	treated control	9089	4
4	leaf #2	treated control	4611	2
5	leaf #2	treated control	10155	4

Table 2. Concentration of OTC measured in Cabbage palm fronds 1 week post injection.

Improving the prevention and management of phantasma scale on landscape palms

PI: **Adam Dale, Entomology and Nematology; agdale@ufl.edu**
CO-PI: **Henry Mayer, Miami-Dade County Extension; Michael Orfanedes, Broward County Extension**

ABSTRACT

The production, sale, and management of ornamental plants generates significant revenue for Florida's economy, while also furnishing the vegetation of the state's most rapidly expanding land use type. When healthy these plants provide numerous benefits. A recent invasive pest, the phantasma scale (*Fiorinia phantasma*), is yet another threat to ornamental plant health and the Green Industry. Despite our best efforts, this insect has spread to at least 12 Florida counties since its first detection in Coral Gables in 2018. With 2024-2025 FNGLA funding, we partnered with UF IFAS Extension in Broward and Miami-Dade Counties as well as municipal arborists in Palmetto Bay, Coral Springs, and Margate to set up a large, multi-year field study investigating the ecology and management of the phantasma scale. We have made significant progress towards accomplishing our objectives. We have established a network of 128 field sites composed of four different ornamental palm species established in urban and residential landscapes. Over the course of five, multi-day field trips and weeks of preparation and sample processing in the lab, we have fully inventoried and characterized local landscape characteristics at each site, identified and counted all scale insects on each plant sample, identified and quantified biological control rates, and initiated insecticide efficacy trials. Although we do not yet have results, we have accomplished an incredible amount of work thus far, which has set us well on our way to having meaningful applied research results. Our goal is to provide improved pest monitoring and management guidelines alongside evidence-based "right plant, right place" recommendations for plants susceptible to this, and similar, invasive insect species. This work represents meaningful progress towards safeguarding Florida and our neighbors from the impending spread of this and future invasive pests.

OBJECTIVES

1. Determine how local landscape characteristics and host origin influence *F. phantasma* density and distribution.
2. Identify natural enemies of *F. phantasma* and landscape factors that influence their biological control.
3. Identify insecticide solutions for foliar and systemic applications.

METHODS

The Study System

Scale insects (Hemiptera: Coccoidea) are an incredibly diverse group of plant-feeding insects that includes over 8,500 species. This group of insects are closely related to whiteflies and aphids, but differ in many important ways.

Among the scale insects, armored scales (family Diaspididae) are the most diverse family composed of over 2,700 species, and are recognized as among the world's most invasive and economically important pests. Within the armored scales, the genus *Fiorinia* is almost exclusively native to Southeast Asia but represents several key invasive plant pests in the United States, including tea scale (*F. theae*), elongate hemlock scale (*F. externa*), and most recently the phantasma scale (*F. phantasma*). *Fiorinia* scale insects are notoriously difficult to manage due to their protective double "armored" covering and unique pupillarial enclosure, meaning the adult female retains her second-instar shed exoskeleton as a protective covering.

Fiorinia phantasma was first detected in the U.S. in 2018 in Coral Gables, FL on a Canary Island date palm (*Phoenix canariensis*), and has since spread to at least 12 counties in South Florida. This insect is currently documented to infest and damage over 70 plant species from 54 genera within 25 families, although it shows a marked preference for palms. The known host range of this insect continues to expand, along with its geographic distribution within Florida and around the globe. Reports from green industry professionals also indicate repeated struggles to effectively control this pest once established on a host plant. To slow the invasion of this key pest and mitigate its economic and environmental impacts, we must increase our understanding of its ecology, distribution, and management.

The Miami Metropolitan Area (MMA) is the largest metropolitan region in Florida and the sixth largest in the United States. It encompasses Miami-Dade, Broward, and Palm Beach counties (U. S. Census Bureau 2025). This study is being conducted across two urban landscapes in the MMA: (1) City of Palmetto Bay (31.6 km^2) in Miami-Dade County and (2) the combination of Coral Springs and Margate (121 km^2) in Broward County (Figure 1). These municipalities were identified and selected based on actively managed and accessible tree inventories and the presence of all four focal palm species.

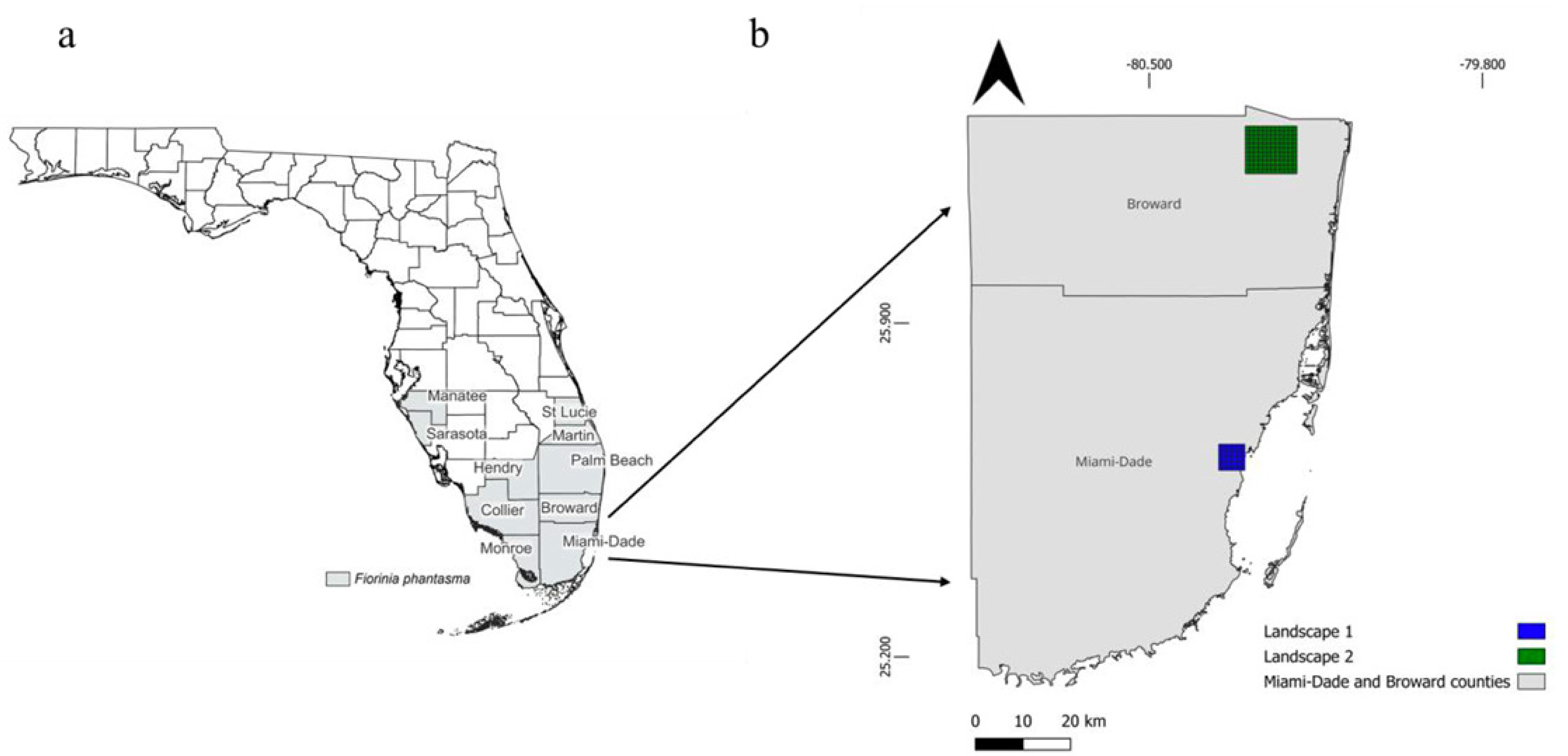

Figure 1. a) Known 2025 distribution of *Fiorinia phantasma* in Florida. b) Study sites in the MMA (Landscape 1 = City of Palmetto Bay, Landscape 2 = cities of Coral Springs and Margate) in Miami-Dade and Broward counties, Florida. Maps created by Minor Solano Gutierrez.

Study site selection and evaluation for Objectives 1 and 2
This study uses four palm species as model organisms to investigate the density and distribution of phantasma scale in South Florida landscapes We have two palms native to Florida (1) *Roystonea regia* (royal palm) and (2) *Thrinax radiata* (Florida thatch palm), and two palms native to Southeast Asia (3) *Cocos nucifera* (coconut palm) and (4) *Phoenix roebelenii* (pygmy date palm).

Thrinax radiata is an endangered species protected in the state but also highly propagated in the ornamental trade, valued for its drought and salt tolerance, high wind resistance, and adaptability to high-pH soils. *Roystonea regia* is commonly used in urban landscapes due to its majestic stature, wind resistance, and ecological compatibility. *Phoenix robellini* is one of the most widely planted ornamental palms in Florida due to its compact size, high wind resistance, and its value as a food source for wildlife. *Cocos nucifera* is globally recognized as an iconic symbol of the tropics and one of the most popular palms in the South Florida landscape. All four species all have broad regional and global relevance as ornamentals.

We selected palms located within public areas, either within 10 m of the road edge (right-of-way) or within city administrative properties. We obtained research permits from the City of Margate Parks and Recreation Department, the City of Palmetto Bay Parks and Recreation, and the City of Coral Springs Public Works Department. Using QGIS 3.42, we overlaid a georeferenced palm tree inventory provided by city officials onto an impervious surface raster from the 2023 National Land Cover Database (USGS, 2024). Impervious surface cover is commonly used as a proxy for urbanization and is known to influence temperature, water stress, and scale insect density (Dale & Frank 2017; Raupp et al. 2010). Using a modified approach from Dale and Frank (2017), we divided each city landscape into a 1 km^2 grid and further split it into four equally sized quadrants to ensure spatially balanced sampling. Within each grid cell, we created a 100 m buffer around the locations of palms of each species and calculated the average impervious surface. For each landscape, we selected sixteen individuals of each of the four palm species: eight from buffers with the highest impervious surface cover and eight from those with the lowest, with two palm trees per species sampled in each quadrant. This resulted in 64 palm trees per landscape and 128 trees in total. This design ensured that no more than one palm of the same species and impervious surface category was sampled within a single grid cell, maintaining spatial independence and capturing a gradient of urbanization across the study area (Figure 2).

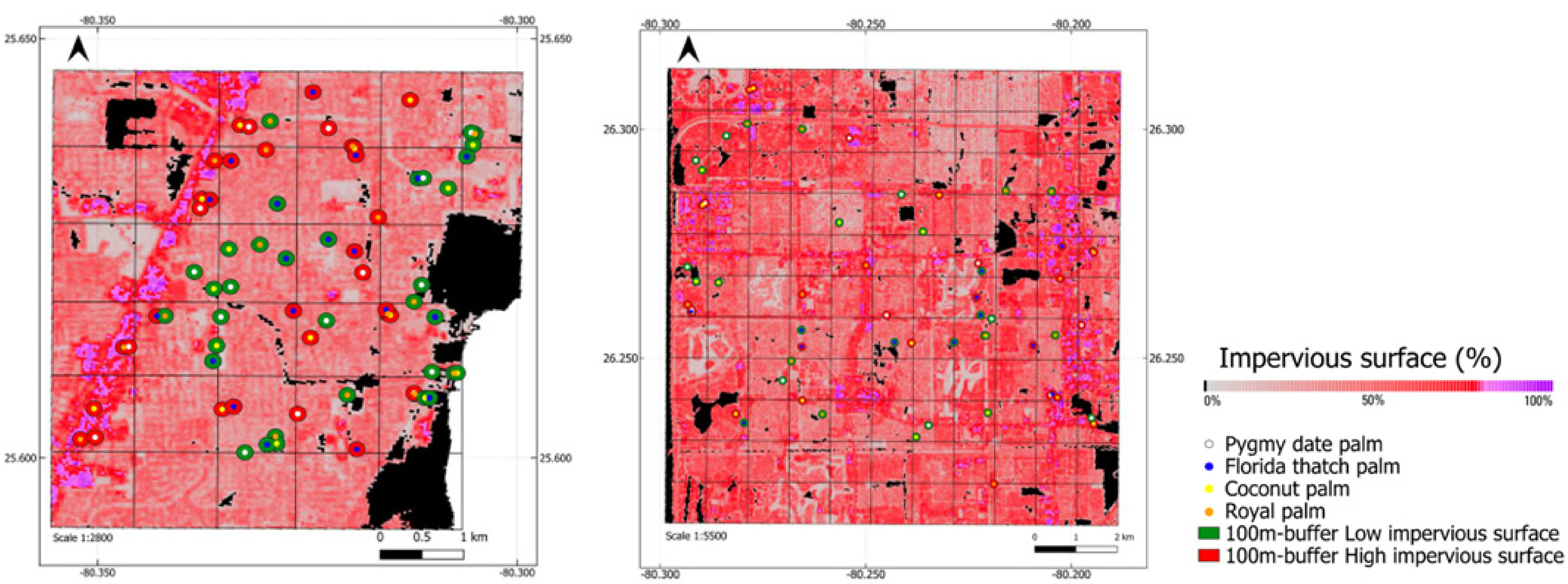

Figure 2. Study site maps showing palm sampling locations overlaid on impervious surface data. a) City of Palmetto Bay (Landscape 1), Miami-Dade County. b) Cities of Coral Springs and Margate (Landscape 2), Broward County. Impervious surface (%) based on the 2023 NLCD. Colored symbols represent different palm species, and buffers represent areas of low and high impervious surface cover. Maps created by Minor Solano Gutierrez.

To assess vegetational complexity (Figure 5a), we delineated a 10 x 10 meter area into 100 1m2 plots with the focal palm located in the center. In each plot, five vegetation categories were recorded as follows: ground cover (maximum height of 0.3 m, e.g., turf grass), herbaceous plants (maximum height of 1 m, e.g., garden annuals/perennials), shrubs (maximum height of 2 m), understory trees (maximum height of 5 m), and overstory trees (height exceeding 5 m).

We assigned one point for each vegetation type present per 1m2 grid, resulting in a score of 0–5 points per square and a vegetational complexity score between 0 and 500. To estimate the local impervious surface percentage around each palm on site (Figure 5b), we used the “Pace-to-Plant” technique as described in Dale et al. (2016). From the palm base, we walked 25 steps in four directions at a 45° angle from the longest nearest paved edge, counting all steps that landed on impervious surfaces. The total number of steps on impervious surface represent the percentage of area within a 25 meter radius that is impervious. Within this same 25 m radius, we will identify and count all *F. phantasma* host plants to estimate host availability at the local scale, providing a measure of potential resource availability for *F. phantasma*.

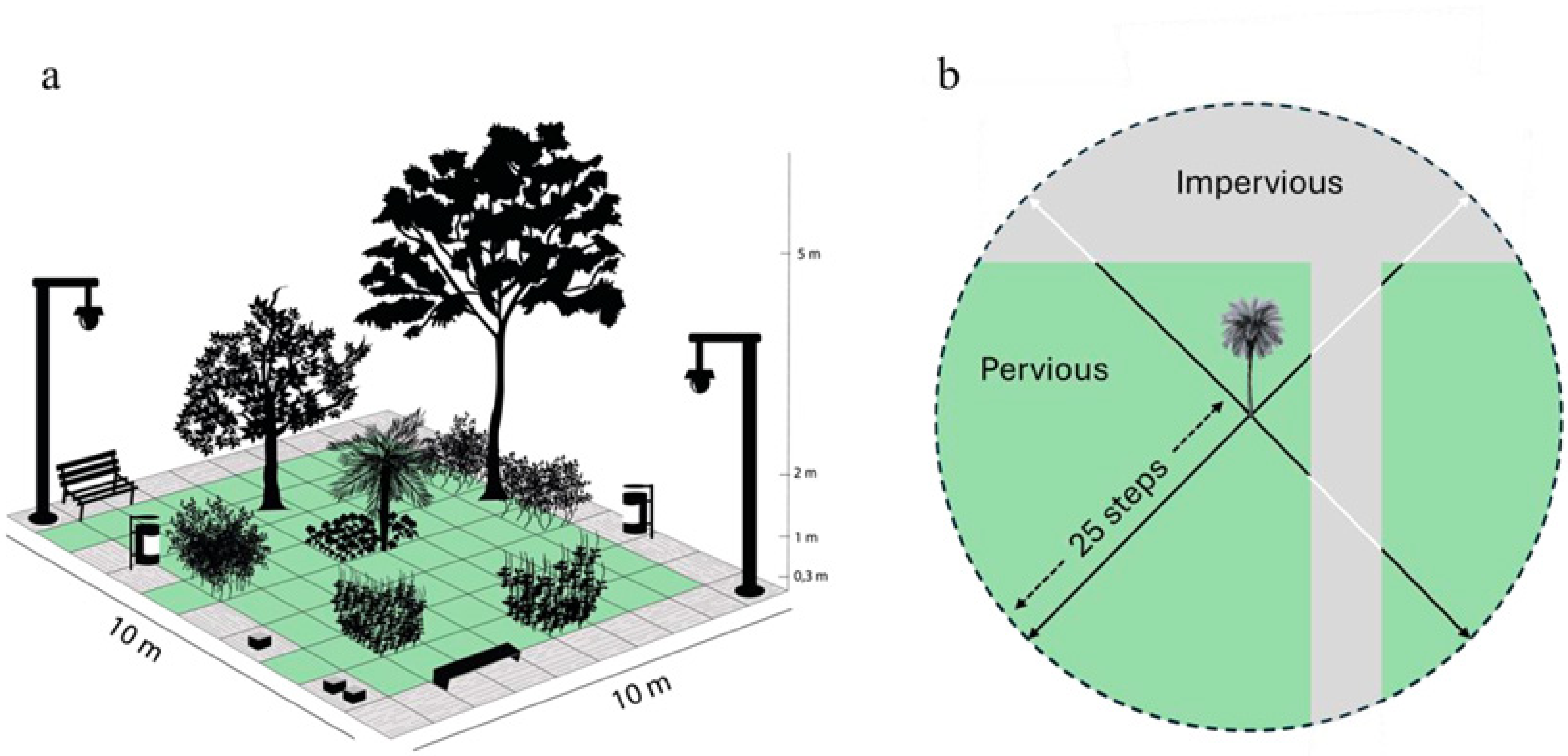

Figure 3. Illustrations depicting our methods for quantifying vegetational complexity and local impervious surface cover at each study site, with the focal palm in the center. Figure created by Minor Solano Gutierrez.

Objective 1 approach

This objective addresses the key question: How do urban habitat characteristics and host plant origin influence the density and distribution of *F. phantasma*? We hypothesize that *F. phantasma* density will be higher on non-native palms and in areas with greater impervious surface cover, abundant host availability, and increased suitable habitat connectivity.

To estimate the abundance of *F. phantasma* and other present scale insects, we collected the oldest frond from each palm, as the oldest frond usually harbors the highest density (Ouvrard et al. 2013). We used a stereomicroscope to identify and quantify all adult female scale insects on the sampled fronds. Adult female presence indicates successful scale insect reproduction and development on the host plant. Slide mounts were prepared to confirm species identifications using identification keys and resources from Watson (2002), García Morales et al. (2016), and Miller and Davidson (2005.

Objective 2 approach

This objective addresses the key questions: 1) What predators and parasitoids are attacking *F. phantasma* in South FL landscapes? and 2) How do urban habitat characteristics and host plant origin influence biological control rates? We hypothesize that there is minimal predation and parasitism occurring due to the nonnative origin of *F. phantasma* and the current high densities of the pest. We also hypothesize that biological control rates will be highest on palms planted in landscapes with high levels of vegetation complexity and diversity.

A yellow sticky card was installed on the petiole of the oldest frond of each study palm to capture flying natural enemies associated with the palm. Each sticky card remained in place for one month, at which point it was placed into a zip-top bag and stored in a freezer until inspection under a stereomicroscope. We are currently identifying all predators and parasitoids captured on each sticky card to the lowest taxonomic level possible. Sticky cards will also be leveraged to explore ancillary research questions related to the lethal bronzing disease (LBD) vector, *Haplaxias crudus*, as it can be captured using yellow sticky cards in palm canopies.

Scale insects showing signs of parasitism, such as visible parasitoid pupae, are being incubated in well-ventilated containers to allow for the emergence and collection of adult parasitoids for identification. In many cases, the scale insects themselves were absent, but the condition of their wax coverings provides evidence of predation or parasitism. A circular hole in the wax covering indicates successful emergence of a parasitoid wasp, while a ragged hole suggests predation by an insect with chewing mouthparts. We will calculate the percentage of parasitism and predation by dividing the number of scales showing exit holes or signs of chewing damage by the total number of scales present per plant.

Analyses for Objectives 1 and 2
We will use our measured landscape characteristics to determine if they effectively predict phantasma scale density and biological control rates on our 128 focal palms. We will also explore if scale density and biological control rates vary by palm host species.

Objective 3 approach
The primary method for managing armored scale insects on ornamental plants is insecticide treatment. *Fiorinia phantasma* presents and even more challenging pest to manage with insecticides due to its double encasing in waxy covering. For this reason, we are primarily reliant upon systemic and translaminar insecticides to provide control via insect ingestion of the insecticide. Additionally, many palms present a challenge due to their canopy height and our inability to safely or effectively make foliar insecticide applications to the canopy.

Here, we plan to evaluate the efficacy of systemic and translaminar insecticides targeting *F. phantasma* applied using multiple application methods. We are comparing the efficacy of foliar sprays, soil drenches, and basal bark sprays of systemic (acetamiprid, dinotefuran) and translaminar insecticides (foliar pyriproxyfen, spiromesifen) targeting phantasma scale on *P. robellini*. In 2026, we will continue these evaluations and broaden them to taller palm species, like foxtail palms (*Wodyetia bifurcata*).

RESULTS

Objective 1
We are currently processing all collected local landscape characteristics and scale insect density measurements from our 128 study sites. As indicated in Figure 4 below, we successfully captured a wide gradient of surrounding impervious surface cover around each focal palm species, ranging from 8% to 80% impervious cover within a 25 m radius. This is promising, as impervious cover has previously been a strong predictor of scale insect density and other local habitat characteristics. Thus far, phantasma scale insect density has ranged from zero to several thousand individuals per sampled leaf. We anticipate completing our statistical analyses by November 2025 and writing up our results for publication in the spring of 2026.

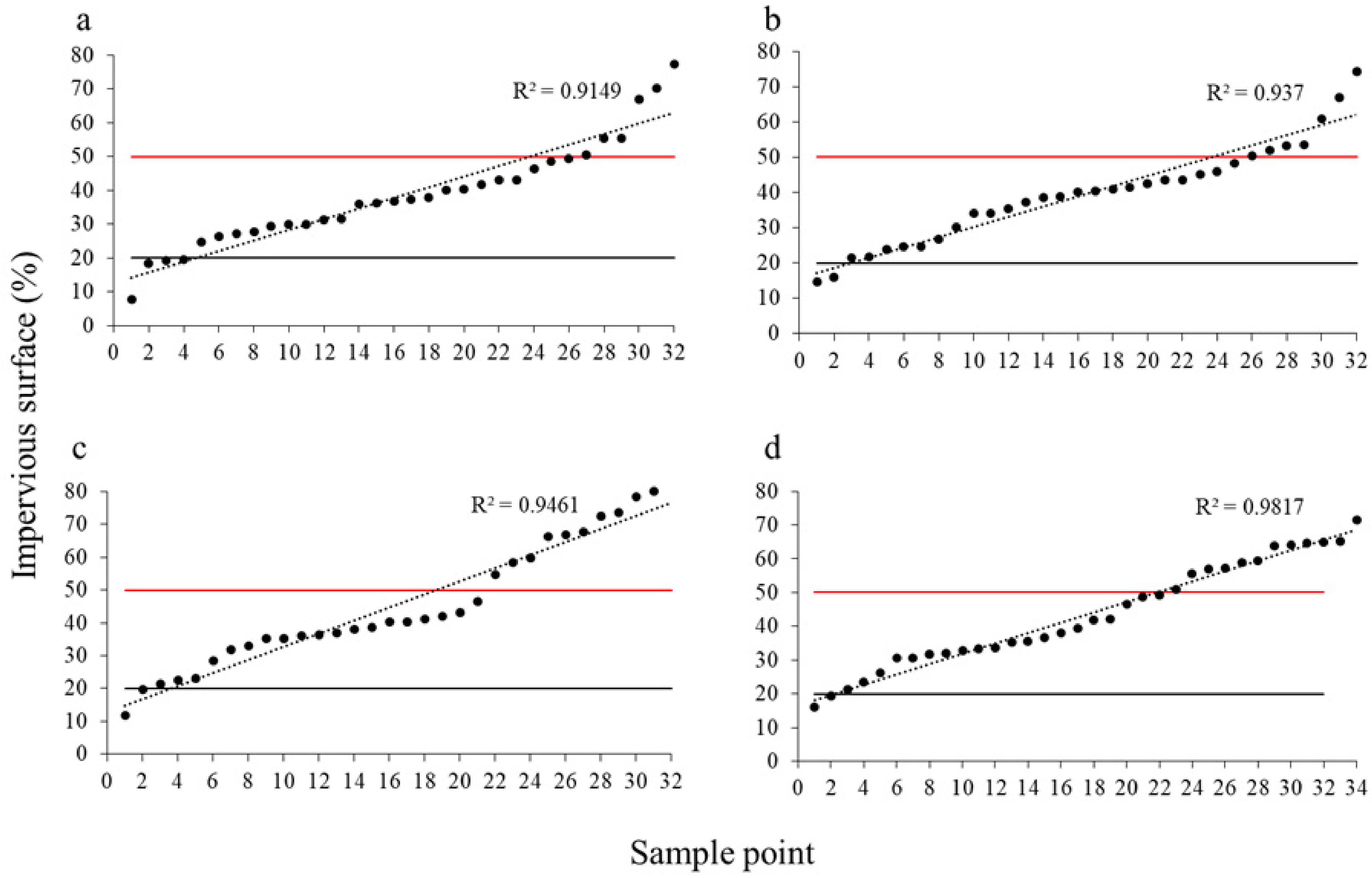

Figure 4. Each panel presents the percent impervious cover on the y-axis and study site on the x-axis. Each panel represents a different focal palm species, including *P. robellini*, *C. nucifera*, *R. regia*, and *T. radiata*. Each point represents an individual study site, totaling 32 per species and 128 total.

Objective 2

We are currently processing field samples, rearing collected parasitoid wasps, and identifying captured predators collected from our field survey samples. Thus far, we have found a very low rate of predation and parasitism on infested palms, suggesting that a lack of biological control is at least in part contributing to phantasma scale outbreaks. That said, we have observed predation and parasitism of phantasma scale, indicating that some predators and parasitoid wasps are attacking phantasma scale. Interestingly, when phantasma scale infestations are mixed with infestations of other scale insect species, biological control rates of those species are significantly higher than that of phantasma scale. Over the next several weeks, we will continue identifying predators and parasitoids captured on sticky cards. We will then explore the relationships between local landscape characteristics and host plant identity on rates of biological control. We anticipate completing our analyses and writing them up for publication in the spring of 2026.

Figure 5. Wax covering of *Fiorinia phantasma* with evidence of activity by natural enemies. (left) Wax covering with a ragged hole as evidence of predation by an insect with chewing mouthparts. (right) Wax covering with a circular hole as evidence of successful emergence by a parasitoid wasp. Photos by Minor Solano Gutierrez.

Objective 3
Thus far, we have made foliar and drench applications of dinotefuran to *P. robellini* and *W. bifurcata* infested with high density phantasma scale. As it takes many months to detect effects of insecticides on armored scale densities on palms, we will collect and evaluate insecticide efficacy in the spring of 2026.

CONCLUSIONS

The results of this work will shed light on how urbanization patterns and urban landscape design practices (plant species selection, plant diversity, vegetation structure, placement in the broader urban context) interact to shape the dynamics of invasive scale insect pests. Our results aim to identify the ecological benefits of specific landscape design and development practices, which can strengthen biotic resistance to the phantasma scale and future non-native pest invasions. Integrating biodiversity into urban greenspace planning not only improves resilience to pests but also supports broader ecological functions critical to healthy urban ecosystems.

This research will also provide actionable guidance for urban landscape design and pest management. Reducing host palm aggregation, increasing plant diversity, and preserving or enhancing vegetation structure may suppress *F. phantasma* populations and reduce reliance on chemical controls. Monitoring efforts should prioritize high-risk areas, which will be informed by our results, to enable early detection and targeted interventions. Finally, selecting palm species with demonstrated resistance or lower susceptibility can serve as a preventative measure, supporting sustainable ornamental plant management and protecting the economic and ecological value of urban palm landscapes.

A novel biological control agent for pest snails in Florida

PI: **Abolfazl Hajihassani, Entomology and Nematology | Ft. Lauderdale REC; ahajihassani@ufl.edu**

ABSTRACT

Snails (Mollusca: Gastropoda) are significant pests that cause substantial damage to landscapes, greenhouses, nurseries, and home gardens, resulting in considerable economic losses. The primary control method for snails involves using chemical molluscicides, which do not directly kill the snails but immobilize them, leading to death through dehydration. In Europe, the nematode *Phasmarhabditis hermaphrodita* is marketed for biological control of pest snails. In the United States, biological products for mollusk control are currently unavailable. Although three species of *Phasmarhabditis* nematodes have been discovered on the West Coast, their use is restricted to that region due to regulatory constraints, preventing their application on the East Coast.

During a survey in 2023, eight soil samples were collected from tropical fruit fields in South Florida and one sample from a peach in North Florida. Three entomopathogenic nematode species, *Oscheius carolinensis*, *O. myriophilus*, and *O. tipulae*, were isolated using Galleria mellonella as bait and molecularly identified. Four of the nine *Oscheius* isolates caused 100% mortality in *Bulimulus* snails after 10 days of exposure. These promising results warrant additional research to further evaluate the efficacy of *Oscheius* nematodes as a biological control strategy under field conditions with the goal of developing a novel biocontrol method for managing mollusks in Florida.

OBJECTIVES

1. Identify locally isolated *Oscheius* nematodes at the species level through molecular techniques.
2. Evaluate the pathogenicity of *Oscheius* isolates against *Bulimulus* snails under laboratory conditions.

METHODS

During a survey for entomopathogenic nematodes (EPNs) in 2023, nine soil samples were collected from fruit fields in Florida, including eight from tropical fruit fields in South Florida and one from a peach orchard in North Florida. The soil samples were incubated with *Galleria mellonella* larvae in plastic containers lightly misted with tap water. After 8-9 days of incubation, dead *G. mellonella* larvae were used to extract entomopathogenic nematodes (EPNs) using the standard White trap method. Recovered EPNs were molecularly identified via a process of DNA extraction, amplification, visualization, and gene sequencing. Briefly, the genomic DNA was extracted from the individual nematodes of each population using a modified quick alkaline lysis protocol, according to the method described in Janssen et al. (2016). PCR reactions were performed using different primer sets to amplify specific regions of the nematode genomes. For amplification of the large subunit 28S rDNA, we used the forward primer D2A (5'-ACA AGT ACC GTG AGG GAA AGT TG-3') and the reverse primer D3B (5'-TCG GAA GGA ACC AGC TAC TA-3'). The internal transcribed spacer (ITS) region was amplified using the forward primer Vrain2F (5'-CTT TGT ACA CAC CGC CCG TCG CT-3') and the reverse primer

Vrain2R (5'-TTT CAC TCG CCG TTA CTA AGG GAA TC-3'). The amplified PCR products were then visualized using gel electrophoresis to confirm the successful amplification of the target regions. The PCR products were sequenced and compared to existing sequences in the NCBI database using BLAST (Basic Local Alignment Search Tool). Species identification was determined based on high similarity between the obtained nucleotide sequences and previously submitted sequences of related species in GenBank. The resulting sequences were deposited in the NCBI database to obtain accession numbers.

We assessed the pathogenicity of *Oscheius* isolates against Bulimulus snails under laboratory conditions using multi-well plates. The snails were collected from an infested yard in Florida and maintained in an incubator for experimental use. Each well contained a moist Whitman filter paper, a small piece of grass for food, and one live snail of uniform size (Figure 1A). Thereafter, 100 infective juveniles of the identified *Oscheius* isolates were pipetted into each well. Each treatment had 10 replicates, and an untreated control (water) was included for comparison. Snail mortality was recorded on days 1, 2, 4, 6, 8, and 10 post-exposure.

RESULTS

Three nematode species, *Oscheius carolinensis*, *O. myriophilus*, and *O. tipulae* were identified by analyzing 28S rDNA and ITS rDNA sequences from recovered isolates. Representative sequences for each isolate were submitted to GenBank and assigned accession numbers (Table 1).

Table 1. Entomopathogenic nematode species identified from fruit tree orchards in Florida with related GenBank accession numbers.

Isolate Code	Identified nematode	Field location	Accession no. (28S rDNA)	Accession no. (ITS)
Nema1	*Oscheius carolinensis*	Homestead, FL	PP818657	PP826954
Nema2	*Oscheius carolinensis*	Homestead, FL	PP818658	PP826955
Nema3	*Oscheius carolinensis*	Homestead, FL	PP818659	PP826956
Nema4	*Oscheius carolinensis*	Homestead, FL	PP818660	PP826957
Nema5	*Oscheius myriophilus*	Homestead, FL	PP818652	PP826949
Nema6	*Oscheius tipulae*	Homestead, FL	PP818653	PP826950
Nema7	*Oscheius myriophilus*	Homestead, FL	PP818654	PP826951
Nema8	*Oscheius myriophilus*	Homestead, FL	PP818655	PP826952
Nema9	*Oscheius tipulae*	North FL	PP818656	PP826953

The bioassay data (Figure 1) demonstrated that 100 infective juveniles of *Oscheius* nematodes caused the mortality of *Bulimulus* snails after 10 days of exposure. Nematode mortality generally increased with longer exposure times across most treatments.

After 10 days, three isolates of *O. carolinensis* (Nema2, Nema3, Nema4), one isolate of *O. tipulae* (Nema6), and one isolate of *O. myriophilus* (Nema7) resulted in 100% snail mortality (Figure 2B). No mortality was observed in the control treatment (water) in all time periods.

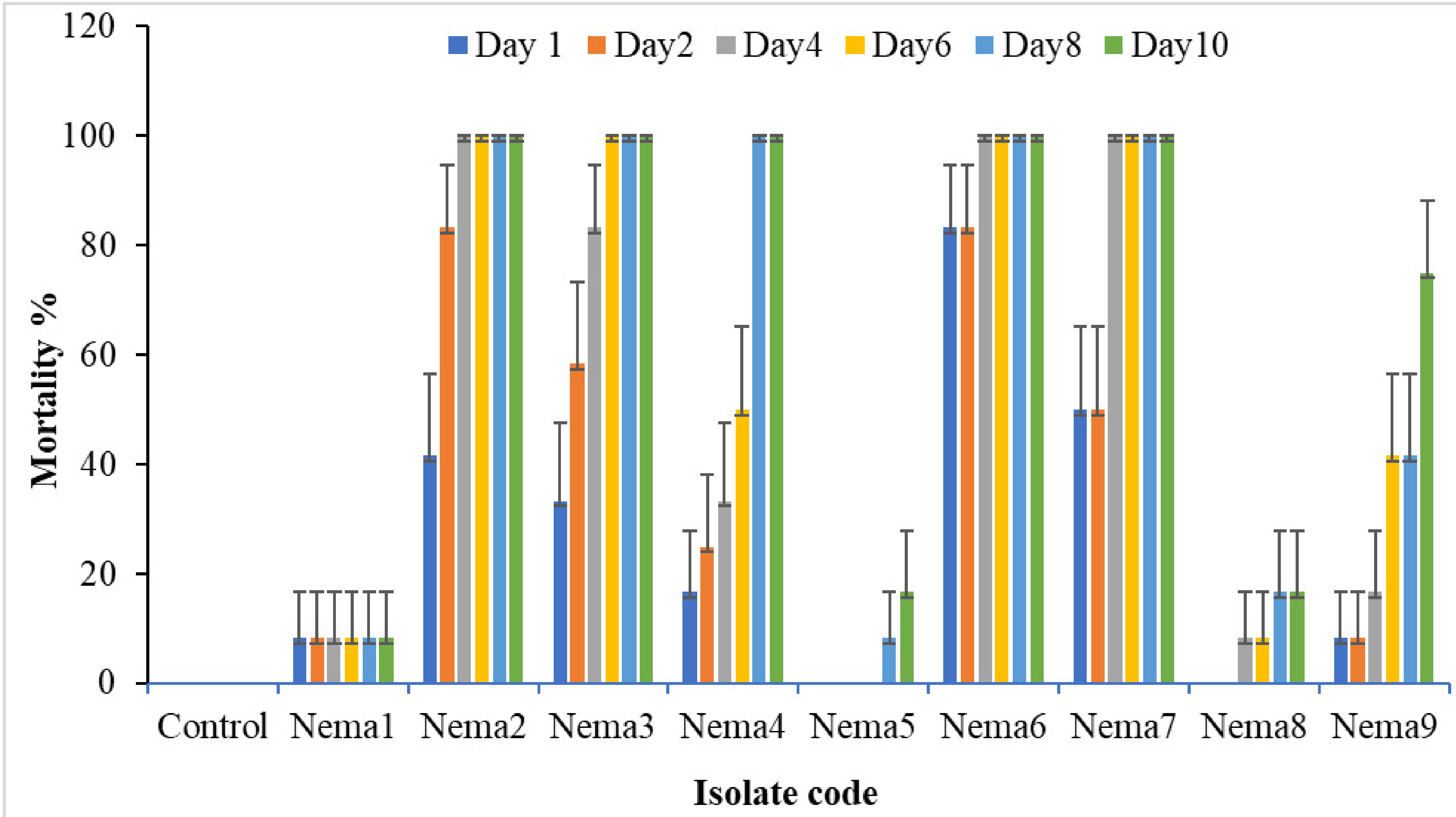

Figure 1. Mortality effects of *Oscheius* nematode isolates on *Bulimulus* snails under laboratory conditions over 1 to 10 days.

Figure 2. Comparison of a live snail (A) before infection with *Oscheius* nematode and a dead snail 10 days after exposure (B), showing the nematode's rapid and prolific reproduction within the snail's body, as indicated by the arrow.

CONCLUSIONS

This project represents one of the few surveys of the diversity of entomopathogenic nematodes within fruit tree orchards in Florida. We found nine isolates, including four isolates of *Oscheius carolinensis*, three isolates of *O. myriophilus*, and two isolates of *O. tipulae*. We identified at least four isolates that were effective in killing *Bulimulus* snails in *in vitro* assays Future studies should evaluate the control efficacy of these promising isolates in larger container setups and field conditions, with variable nematode population densities. If successful, they could provide environmentally safe alternatives to chemical pesticides for gastropod management, benefiting growers, nurseries, homeowners, and landscapers in Florida and beyond.

Optimizing preemergence doveweed [Murdannia nudiflora (L.) Brenan] control strategies in Florida turfgrass

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ABSTRACT

Doveweed [*Murdannia nudiflora* (L.) Brenan] has become a major concern in Florida due to its rapid spread and difficulty of postemergence control. Effective management requires preemergence (PRE) strategies, yet current options are often inadequate and Florida-specific recommendations are lacking. A field study was conducted from April to October 2025 at the West Florida Research and Education Center (WFREC) in Jay, FL, to evaluate multiple commercially available PRE herbicides, applied alone or in combination, compared with a nontreated control, for their ability to prevent doveweed establishment and ensure turfgrass safety in 'Tifway' hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy] with documented infestation history. Herbicides tested included various rates and combinations of dimethenamid-P (Tower), pendimethalin (Pendulum AquaCap), indaziflam (Specticle FLO), and S-metolachlor (Pennant Magnum). The most effective suppression was achieved with Tower at 21.0 oz acre-1 + Pendulum AquaCap at 1.6 oz 1000 ft-2 followed by two sequential Tower applications at 21.0 oz acre-1, which produced <700 AUPC units, >115 days ≤10% weed cover, and a maximum of 20% cover at 126 days (latest rating), compared to >6950 AUPC units, <17 days ≤10% weed cover, and a maximum of 90% cover in nontreated. Several other treatments provided comparable control to best performer, including all sequential Tower applications, most Specticle FLO programs applied once or initiated at ≥9 oz acre-1, and all sequential Pennant Magnum treatments. Pendulum AquaCap alone was ineffective but occasionally enhanced Tower efficacy, though inconsistently.

OBJECTIVES

- To evaluate the efficacy of multiple commercially available preemergence herbicides, applied alone and/or in combination, for their ability to prevent doveweed establishment in a turfgrass stand with documented infestation history.
- To assess turfgrass safety following preemergence herbicide applications.
- To establish a reference point for future research on preemergence doveweed control strategies.

MATERIALS AND METHODS

Study Locations and Conditions

Experiment was conducted from early April to late October 2025 at the West Florida Research and Education Center (WFREC) in Jay, FL (30.77°N, 87.14°W). The turf was 'Tifway' (also colloquially referred to as 'Tifway 419') hybrid bermudagrass [*Cynodon dactylon* (L.) Pers. × *C. transvaalensis* Burtt Davy] at WFREC. Standard cultural practices for golf course fairway/athletic field maintenance were utilized including mowing 3 times wk-1 at 0.5 inches and fertility of 5.0 lb N 1000 ft-2 yr-1.

This site was selected due to its documented history of severe doveweed infestation, although no doveweed was present at the time of study initiation.

Herbicide Treatments

Individual plots were 5 × 5 ft. Herbicides tested included combinations of dimethenamid-P (Tower, BASF Corporation, Research Triangle Park, NC), pendimethalin (Pendulum AquaCap, BASF Corporation, Research Triangle Park, NC), indaziflam (Specticle FLO, Environmental Science U.S., LLC, Cary, NC), S-metolachlor (Pennant Magnum, Syngenta Crop Protection, LLC., Greensboro, NC), and pre-mix of prodiamine + imazaquin + simazine (Coastal, Sipcam Agro USA, Inc., Durham, NC). Rates and reapplication intervals were selected based on label recommendations and are presented in Table 1. The number of treatments was selected to maximize the potential of the area available. No surfactants were included with herbicide treatments. All herbicide applications were made using a CO_2-powered backpack sprayer (R&D Sprayers, Bellspray, Inc., Opelousas, LA) equipped with four TeeJet® 8003VS flat-fan spray tips (TeeJet Technologies, Spraying Systems Co., Glendale Heights, IL) calibrated to deliver 1 gal 1000 ft-2 of spray solution. Immediately after application, herbicides were watered in with 0.2 inches of irrigation to ensure activation.

Table 1. Herbicide treatments and application dates used to evaluate doveweed control and turfgrass safety in 'Tifway ' hybrid bermudagrass golf course fairway/athletic field at the West Florida Research and Education Center (WFREC) in Jay, FL. 2025.

No.	Treatment	Active Ingredient	Rate		No. of apps	Timing
1	Nontreated Control	-	-		-	-
2	Tower	dimethenamid-P	32.00	oz/A	1	A
3	Tower	dimethenamid-P	21.00	oz/A	1	A
4	Tower	dimethenamid-P	32.00	oz/A	2	AB
5	Tower	dimethenamid-P	21.00	oz/A	3	ABC
6	Tower	dimethenamid-P	21.00	oz/A	3	A
	Pendulum AquaCap	pendimethalin	2.30	oz/M		
	Tower	dimethenamid-P	21.00	oz/A		BC
7	Tower	dimethenamid-P	21.00	oz/A	3	A
	Pendulum AquaCap	pendimethalin	1.60	oz/M		
	Tower	dimethenamid-P	21.00	oz/A		BC
8	Tower	dimethenamid-P	21.00	oz/A	3	A
	Pendulum AquaCap	pendimethalin	1.10	oz/M		
	Tower	dimethenamid-P	21.00	oz/A		BC
9	Pendulum AquaCap	pendimethalin	2.30	oz/M	4	A
	Tower	dimethenamid-P	21.00	oz/A		BCD
10	Pendulum AquaCap	pendimethalin	1.60	oz/M	4	A
	Tower	dimethenamid-P	21.00	oz/A		BCD
11	Pendulum AquaCap	pendimethalin	1.10	oz/M	4	A
	Tower	dimethenamid-P	21.00	oz/A		BCD
12	Specticle FLO	indaziflam	10.00	oz/A	1	A
13	Specticle FLO	indaziflam	9.00	oz/A	1	A
14	Specticle FLO	indaziflam	6.00	oz/A	1	A
15	Specticle FLO	indaziflam	3.00	oz/A	1	A
16	Specticle FLO	indaziflam	9.00	oz/A	2	AB

17	Specticle FLO	indaziflam	9.00	oz/A	2	A
			6.00	oz/A		B
18	Specticle FLO	indaziflam	9.00	oz/A	2	A
			3.00	oz/A		B
19	Specticle FLO	indaziflam	6.00	oz/A	2	AB
20	Specticle FLO	indaziflam	6.00	oz/A	2	A
			3.00	oz/A		B
21	Specticle FLO	indaziflam	6.00	oz/A	2	A
			4.00	oz/A		B
22	Specticle FLO	indaziflam	4.00	oz/A	2	AB
23	Specticle FLO	indaziflam	4.50	oz/A	3	ABC
24	Specticle FLO	indaziflam	3.00	oz/A	3	ABC
25	Pennant Magnum	S-metolachlor	41.60	oz/A	1	A
26	Pennant Magnum	S-metolachlor	25.60	oz/A	1	A
27	Pennant Magnum	S-metolachlor	20.80	oz/A	1	A
28	Pennant Magnum	S-metolachlor	41.6	oz/A	2	A
			25.60	oz/A		B
29	Pennant Magnum	S-metolachlor	25.60	oz/A	2	AB
30	Pennant Magnum	S-metolachlor	20.80	oz/A	2	AB
31	Pendulum AquaCap	pendimethalin	2.30	oz/M	1	A
32	Pendulum AquaCap	pendimethalin	1.60	oz/M	1	A
33	Pendulum AquaCap	pendimethalin	1.10	oz/M	1	A
34	Pendulum AquaCap	pendimethalin	2.30	oz/M	2	A
			1.10	oz/M		B
35	Pendulum AquaCap	pendimethalin	2.30	oz/M	2	A
			0.86	oz/M		B
36	Pendulum AquaCap	pendimethalin	1.60	oz/M	2	A
			1.10	oz/M		B
37	Pendulum AquaCap	pendimethalin	1.60	oz/M	2	A
			0.86	oz/M		B
38	Pendulum AquaCap	pendimethalin	1.10	oz/M	2	A
			1.10	oz/M		B
39	Pendulum AquaCap	pendimethalin	1.10	oz/M	2	A
			0.86	oz/M		B

Application timings: A – April 15, 2025; B – May 27, 2025; C – July 8, 2025; D – August 19, 2025. All treatments were applied at a 6-week interval.

Assessments and Data Collection

All evaluations were conducted at study initiation and biweekly thereafter, concluding 28 weeks after initial treatment (WAIT), which corresponded to 10 weeks after the final application for treatments that received four sequential applications. To assess hybrid bermudagrass safety responses, plots were visually evaluated for turfgrass injury [0-100% scale, 0% = no damage, 20% = maximum acceptable injury (i.e., acceptability threshold), 100% = dead turfgrass]. To assess herbicide efficacy, plots were visually evaluated for doveweed pressure expressed as weed cover (0-100%). To account for repeated observations over time and to clearly illustrate the duration of effective control in a practical way, the weed cover data were transformed into weed cover area under progress curve (AUPC), the duration (in days) where doveweed cover was ≤10% threshold, and the highest recorded infestation (maximum weed cover).

Such measurements are becoming more widely used in scientific literature offering turf managers essential information for making informed herbicide decisions. Weed cover AUPC represents cumulative weed pressure over time.

Larger AUPC values indicate that weeds established more quickly and/or maintained higher cover for a longer duration, whereas smaller values reflect slower establishment or lower overall cover. Days ≤10% weed cover threshold measure how long a treatment delayed weed establishment before exceeding an acceptable level.

More days below this threshold signify stronger or longer-lasting early-season suppression, whereas fewer days reflect rapid weed breakthrough. Maximum weed cover represents the peak infestation level reached during the study, reflecting the ultimate ability of a treatment to maintain a weed-free sward. Higher values indicate that weeds ultimately dominated the stand, whereas lower values demonstrate greater long-term suppression.

Statistical Design and Analysis
Study utilized a complete randomized block design with four replications. Data collected was analyzed using analysis of variance in R (R Core Team, 2023) and, where appropriate, means were compared using the Tukey HSD test at the 0.05 probability level.

RESULTS

Hybrid Bermudagrass Response
Although the study is still ongoing and observations are planned through October 2025, no phytotoxicity to turfgrass has been observed from any herbicide treatment to date; thus, no significant impact of treatments was detected.

Doveweed Emergence Suppression
Herbicide effects were highly significant for all measured parameters ($P < 0.0000$ for all) with respect to doveweed control efficacy. Nontreated plots confirmed the high doveweed pressure within the research area, as doveweed developed without interruption, showing rapid growth and resulting in the highest AUPC across the study (Figure 1). Cover began to increase within two weeks of trial initiation (Figure 2). Ultimately, doveweed cover in the nontreated control reached 90%, outcompeting the hybrid bermudagrass stand (Figure 3).

The most effective doveweed suppression was achieved with Tower at 21.0 oz acre-1 + Pendulum AquaCap at 1.6 oz 1000 ft-2 followed by two sequential Tower applications at 21.0 oz acre-1 (Trt 7), the only treatment not exceeding 700 AUPC units. The only other program with AUPC values below 1000 was Specticle FLO at 9 oz acre-1 applied twice (Trt 16) (Figure 1). Although AUPC captured the combined pace and magnitude of weed pressure increase over time, it was less descriptive of efficacy than the separate metrics of days ≤10% weed cover (Figure 2) and maximum weed cover (Figure 3), which more accurately reflected suppression longevity and ultimate treatment performance. The two top-performing programs maintained doveweed cover below 10% for more than 3.5 months, numerically outperforming all others (Figure 2). Several additional treatments provided statistically comparable control longevity, including all sequential Tower applications (Trts 4–8), with or without Pendulum AquaCap, which maintained suppression for 70–100 days below the 10% threshold. Comparable performance was also observed with Specticle FLO applied once at ≥9 oz acre-1 or in sequences initiated at 9 oz acre-1 (Trts 12, 13, 18), and all sequential Pennant Magnum treatments (Trts 28–30). Pendulum AquaCap occasionally enhanced Tower efficacy but without consistency. Specticle FLO also showed variability, as some sequential programs initiated at 9 oz acre-1 (e.g., Trt 17) performed worse than others using the same initial rate (Figure 2). By the most recent rating, doveweed cover did not exceed 20% only in the best-performing Tower + Pendulum AquaCap program (Trt 7), and remained below 30% in Tower + Pendulum AquaCap at 1.1 oz 1000 ft-2 followed by Tower (Trt 8) and in Specticle FLO applied twice at 9 oz acre-1 (Trt 16) (Figure 3). In contrast, no Pendulum AquaCap-alone effectively controlled doveweed (Figures 1–3).

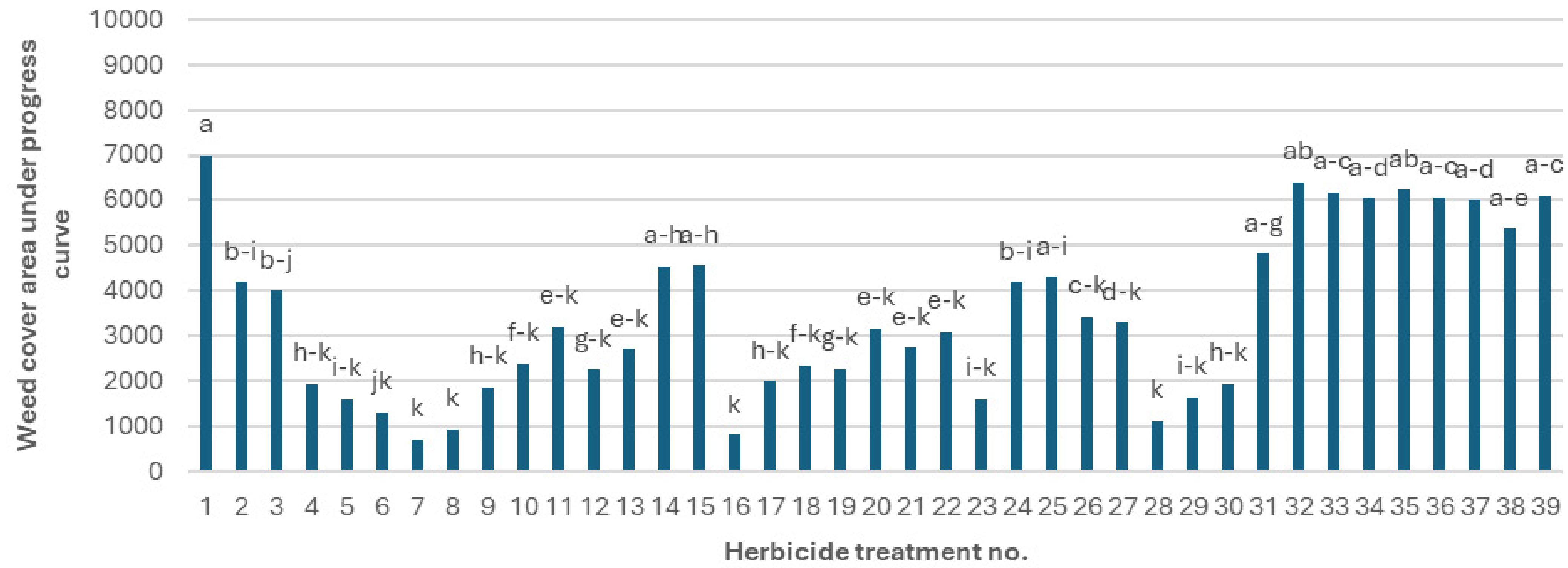

Figure 1. Preemergence herbicide effects on weed cover area under progress curve in 'Tifway' bermudagrass fairway/athletic field at West Florida Research and Education Center (WFREC), Jay, FL. 2025. Means marked with the same letter are not statistically different at P ≤ 0.05. Rates and application timings are detailed in Table 1.

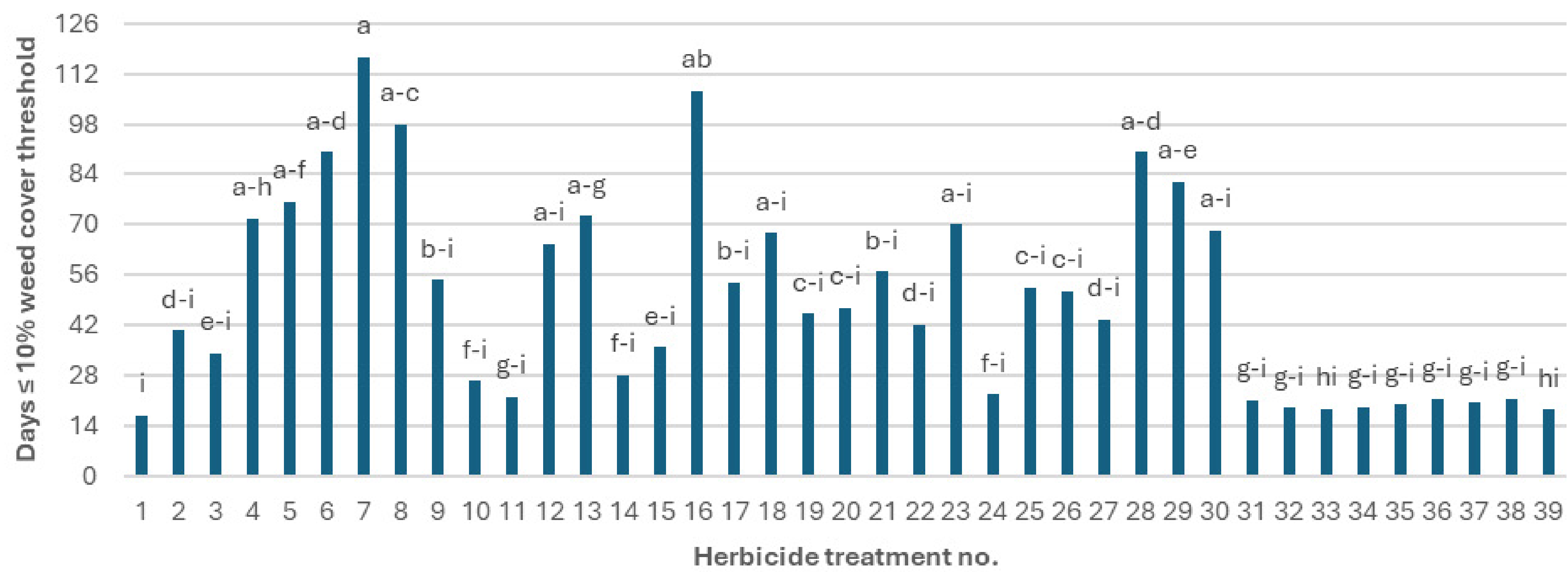

Figure 2. Preemergence herbicide effects on days ≤ 10% weed cover threshold in 'Tifway' bermudagrass fairway/athletic field at West Florida Research and Education Center (WFREC), Jay, FL. 2025. Means marked with the same letter are not statistically different at P ≤ 0.05. Rates and application timings are detailed in Table 1.

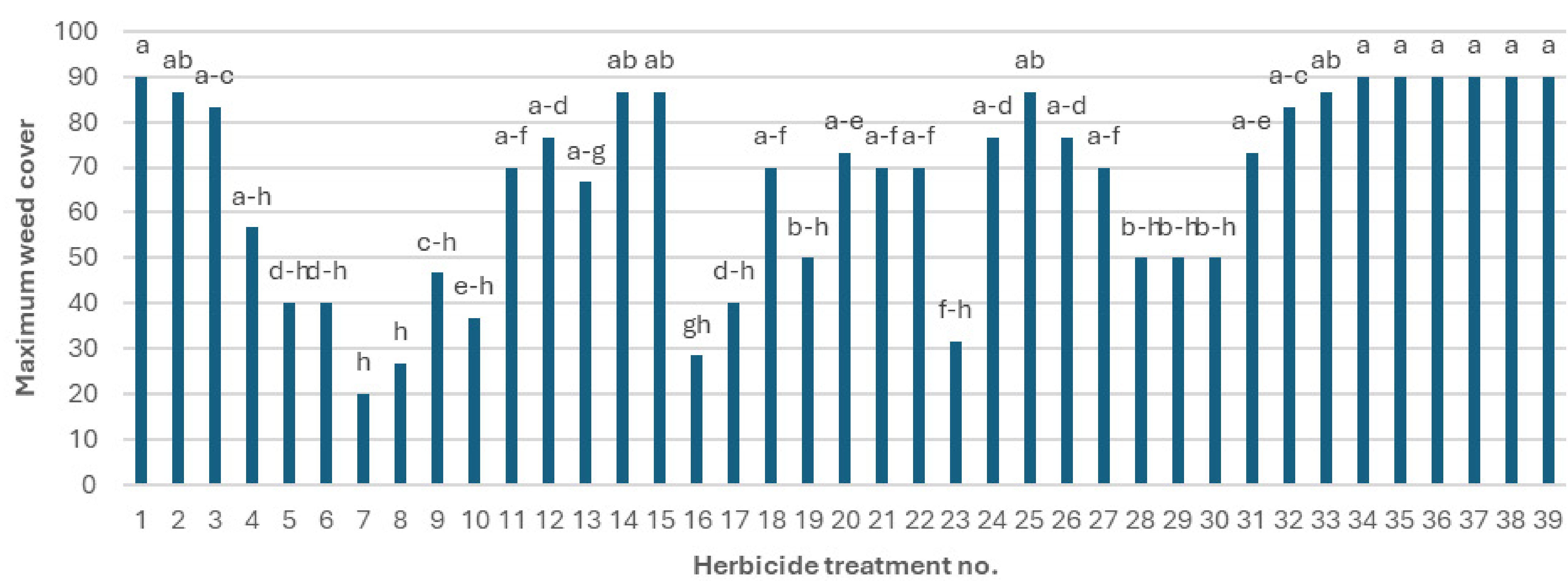

Figure 3. Preemergence herbicide effects on days ≤ 10% weed cover threshold in 'Tifway' bermudagrass fairway/athletic field at West Florida Research and Education Center (WFREC), Jay, FL. 2025. Means marked with the same letter are not statistically different at P ≤ 0.05. Rates and application timings are detailed in Table 1.

Figure 4. Doveweed cover in the nontreated control (left) and plot treated with Tower at 21.0 oz acre-1 + Pendulum AquaCap at 1.6 oz 1000 ft-2 followed by two sequential Tower applications at 21.0 oz acre-1 (Trt 7) at 14 weeks after the initial treatment on July 22, 2025. West Florida Research and Education Center, Jay, FL.

CONCLUSIONS

In summary, all tested treatments were safe to hybrid bermudagrass. Tower was identified as a strong, foundational preemergence option for doveweed management. Pendulum AquaCap alone was ineffective, though in some mixtures it improved efficacy inconsistently. If Pendulum AquaCap is to be included in a doveweed control program, it may be best positioned for earlier applications to help suppress earlier-germinating weeds, whereas Tower should be timed closer to expected doveweed germination to provide the primary suppression. Pennant Magnum alone showed strong promise and merits inclusion in integrated preemergence programs. Specticle FLO at high rates also provided good control in some cases, but performance varied across programs. Combinations or rotations of Tower, Pennant Magnum, and Specticle FLO should be further explored to optimize program consistency. Regardless of product selection, higher rates should be prioritized to maximize and sustain control. Another year of research will be necessary to validate these results, particularly with emphasis on refining initiation timing (possibly beginning in early April or even mid-March rather than mid-April). These findings highlight the potential of Tower, Specticle FLO, and Pennant Magnum within integrated strategies, while also demonstrating the limitations of Pendulum AquaCap, despite its labeling for doveweed control.

This research provides a baseline for practical recommendations and a foundation for improving doveweed management strategies by identifying approaches that suppress doveweed more effectively. Moving forward, critical questions include whether earlier applications or shorter reapplication intervals would enhance control consistency, how different tank mixes or rotations of preemergence products may improve performance, and what role additional active ingredients such as atrazine, simazine, isoxaben, flumioxazin, prodiamine, or pethoxamid might play. Continued refinement of application timing and program design will be essential for developing sustainable and environmentally responsible approaches to doveweed management.

Improve Production Systems Practices and Strategies

This priority area is defined as:

FNGLA supports research to develop advanced systems of product handling and transportation that will improve safety and efficiency.

FNGLA supported one project under this priority area,
and that summary is on pages 29-32.

Demand assessment for tree species utilized in Florida Landscapes

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CO-PI: **Ryan Klein, Environmental Horticulture; John Roberts, Palm Beach County Extension**

ABSTRACT

Disparities often arise between consumer preferences and market availability. In most industries, market corrections occur quickly. In contrast, urban tree markets—with their inherent complexity and multi-year growing cycles—are much harder to adjust. For this project, we used two complementary approaches to guide planting decisions. First, we conducted a comprehensive assessment of locally approved and required species lists, comparing them against the current listings in the state's primary wholesale plant finder. Second, we administered a consumer survey focused on general tree characteristics and their relative importance in attracting—or deterring—Floridians from purchasing specific species. Our preliminary findings show that several hundred tree and palm species were specified by local governments as desirable planting materials. We also found that trees labeled as "Florida Friendly," native, or hurricane resistant exerted significant positive influences on purchasing interest among Florida residents.

OBJECTIVES

Identify potential demand for urban tree species based on local government recommended or approved species lists and a Florida consumer survey. Contrast these findings with a snapshot of current availability as posted on the state's primary plant finder database.

METHODS

Study 1. Assessment of Local Government Tree Lists
We conducted a systematic review of local code to identify approved and recommended urban tree species, planting requirements, and regulatory constraints that influence species selection and distribution. This review encompassed all 67 counties in Florida as well as the state's 300 most populous cities.

Our initial approach involved a Google search using the query "Does [City/County] have a tree list?"—targeting results from official government websites or code databases. If this did not yield relevant results near the top of the search, we directly examined the local government's code via its contracted third-party hosting platforms. These were primarily Municode (CivicPlus, Tallahassee, Florida) and American Legal Publishing (American Legal Publishing Corporation, Cincinnati, Ohio), though other sources were consulted as needed.

To search these code databases efficiently, we used a sequence of terms progressing from specific to broad: *Quercus*, oak, *Acer*, maple, *Ilex*, holly, tree list, and tree. When tree lists were located, we either copied them manually or imported them into a large language model (LLM) application—Copilot (Microsoft, Redmond, Washington). The LLM was used to correct spelling and taxonomy, supplement missing scientific names where only common names were provided, and filter out shrubs and shrub-like palms when these were combined with canopy, understory, or specimen tree and palm species. The cleaned and standardized lists were then exported to our main species database.

Once the species lists were collected, we analyzed them using a large language model to identify unique species and compare the required and approved lists against the IFAS Assessment of Non-Native Plants in Florida's Natural Areas. This curated list of unique species then guided our search of Florida's primary plant availability database—PlantAnt (PlantAnt, Fort Lauderdale, Florida)—to assess current market availability.

Study 2. Assessment of Florida Consumer Preferences.
To assess consumer interest in different tree species, we used conjoint analysis to examine eight attributes that could potentially influence planting decisions. These attributes and their associated levels were as follows: mature tree height (small, medium, large), flower production (yes/no), hurricane resistance (yes/no), native status (yes/no), Florida-Friendly designation (yes/no), container size at planting (5-gallon, 15-gallon, 30-gallon), and cost (low, medium, high).

A total of 35 randomized tree profiles were generated using the caFactorialDesign() function in R (Bak and Bartlomowicz, 2012), employing a fractional, non-orthogonal design to balance attribute coverage with respondent burden. Each profile included descriptive text outlining the eight attributes and their assigned levels. To enhance respondent engagement and comprehension, we also provided visual materials for each profile: an AI-generated depiction of mature tree size in front of a single-story home, an image of tree flowers when applicable, the Florida-Friendly logo when relevant, and a nursery tree image shown beside a person icon to illustrate planting size at the time of purchase. These combined elements allowed respondents to evaluate each tree profile with both textual and visual context. Respondents were asked to rate their interest in purchasing the tree on a 1 to 10 scale.

An online panel company, Centiment (Denver, Colorado), was contracted to administer the survey. The sample was designed to be representative of Florida's demographics with respect to age, race, and gender. The study received an exemption from the University of Florida's Institutional Review Board. Prior to the full launch, we conducted a soft launch with 48 respondents to evaluate question clarity and make necessary adjustments. During this phase, we identified an inconsistency in the wording of the hurricane resistance attribute and excluded these initial responses from the final dataset. Ultimately, a total of 955 individuals were surveyed, yielding a ±3% margin of error at a 95% confidence level.

Analysis was conducted using the conjoint() function in R (Bak and Bartlomowicz, 2012), which generates a matrix of partial utilities for each attribute level across respondents, along with vectors representing attribute-level utilities and the relative importance of each attribute. These importance scores were visualized using bar plots. To enhance presentation and interpretation, relative importance values and partial worth utilities were subsequently plotted using a large language model—Copilot (Microsoft, Redmond, Washington).

RESULTS

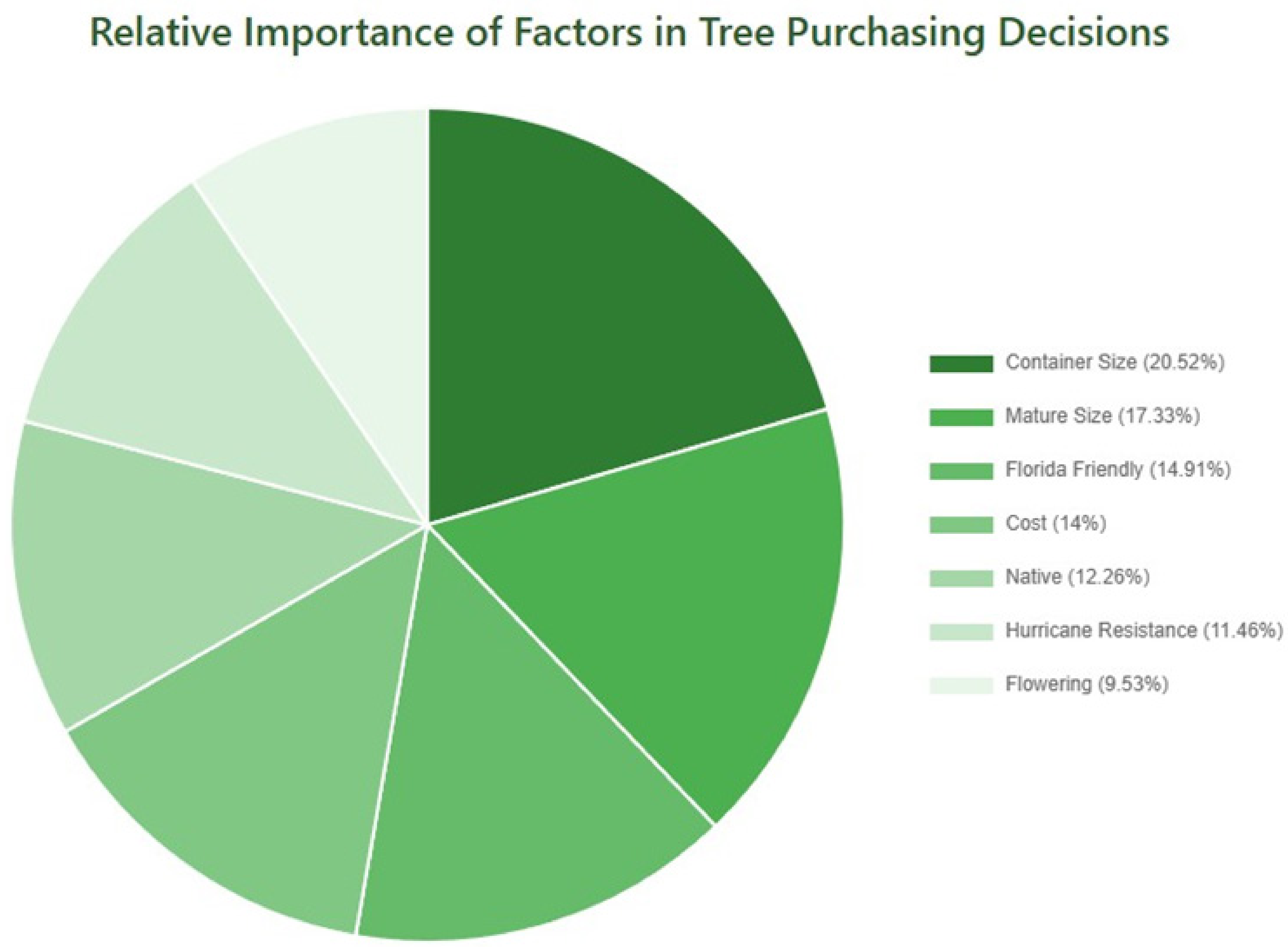
Study 1. Assessment of Local Government Tree Lists
Note: Final quality control of this dataset is still underway; therefore, the following results are preliminary. Of the 67 counties assessed, 36 had suggested or approved tree-planting lists. Among the 300 cities reviewed, 217 maintained similar lists. Some were highly comprehensive—containing up to 147 species—while others included only a handful of species.

In total, we have processed 9,145 species entries, comparing taxonomy against global databases, removing problematic taxa flagged by the IFAS assessment, and deduplicating minor spelling or abbreviation variations (for example, subspecies vs. variety). We're developing Python code to automate this workflow, but it remains a work in progress.

Once quality control is complete, we will compare our clean list to species availability on PlantAnt, flagging those not currently in production or offered by three or fewer nurseries. We will also identify trends among the most commonly produced species. The full findings will be published as an EDIS document.

Study 2. Assessment of Florida Consumer Preferences.

All attributes selected for this study were statistically significant predictors of consumer interest at the $p = 0.05$ level. Container size emerged as the strongest driver of consumer choice (Figure 1), followed by mature tree size, Florida-Friendly designation, cost, native status, and hurricane resistance. The presence or absence of attractive flowers was the least influential attribute tested.



Factor	Percentage
Container Size	20.52%
Mature Size	17.33%
Florida Friendly	14.91%
Cost	14%
Native	12.26%
Hurricane Resistance	11.46%
Flowering	9.53%

Figure 1. Relative importance of the eight attributes tested in our consumer choice survey.

Figure 2 illustrates how individual attribute levels influenced consumer interest in a hypothetical tree profile. Flowering, hurricane resistance, native status, and Florida-Friendly designation were all associated with increased interest, particularly among respondents who placed high value on native and Florida-Friendly trees. In contrast, both high and median price points—based on an assessment of tree prices from PlantAnt—reduced consumer interest compared to the below-median "low" price. Given that our sample reflected a general Florida consumer audience, large 30-gallon trees were a notable deterrent to interest, likely due to their higher cost and substantial planting size.

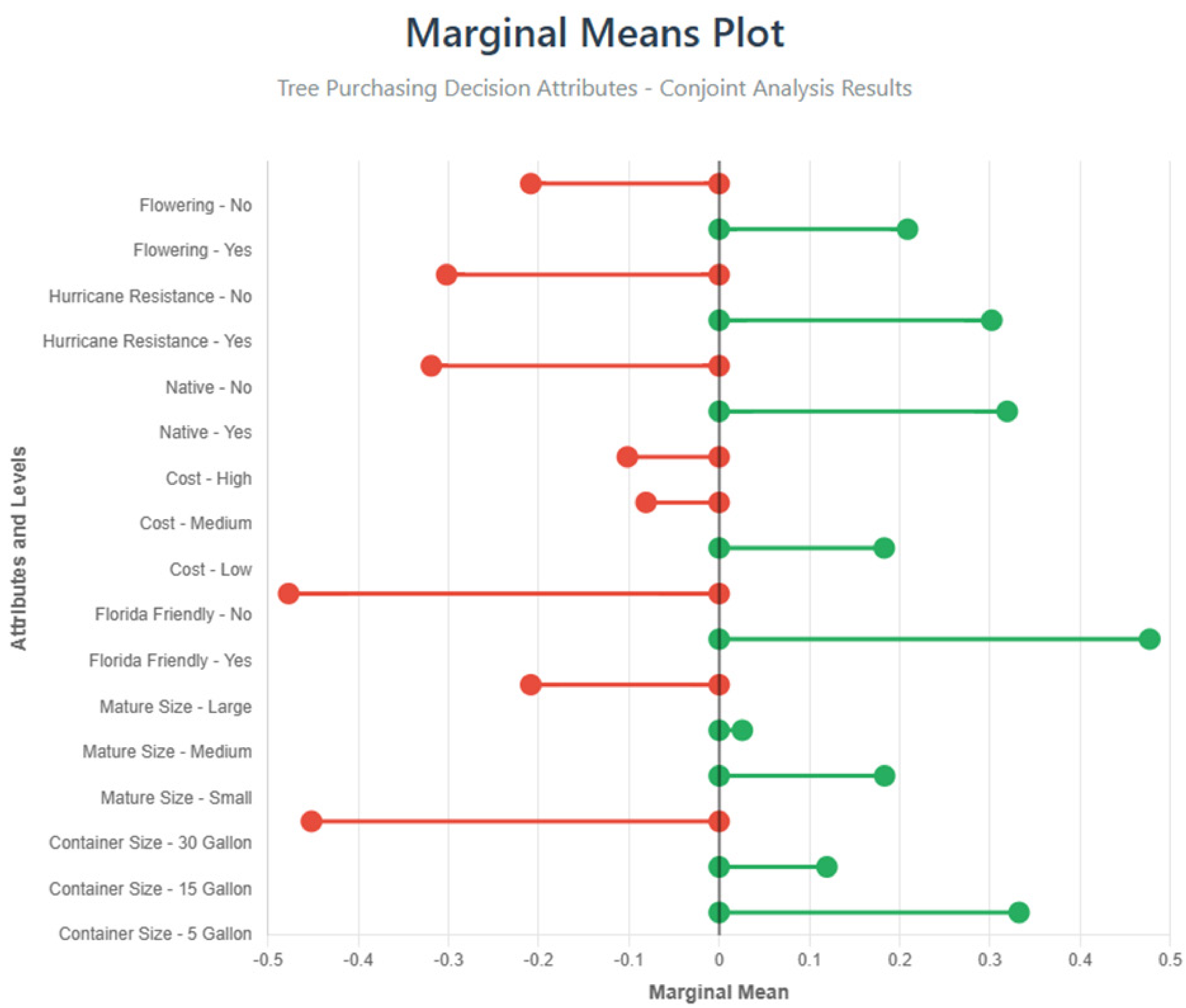


Figure 2. Marginal means plot from the conjoint analysis showing the relative influence of attribute levels on consumer preference. Values greater than 0 (shown in green) indicate a positive contribution to consumer interest, while values less than 0 (shown in red) reflect a negative contribution. Each bar represents the average utility score for a given attribute level across all respondents.

CONCLUSIONS

This study provides a preliminary overview of urban tree demand and consumer preferences in Florida, based on local government species recommendations and a statewide survey. Across 67 counties and 300 cities, hundreds of unique species and cultivars were identified as desirable for planting. Conjoint analysis revealed that container size, mature tree height, and Florida-Friendly designation were among the strongest drivers of consumer interest. These findings, combined with ongoing comparisons to nursery availability data, offer a foundation for future guidance on species selection, production planning, and urban forestry outreach.

Genetics and Breeding to Enhance Quantities and Diversity of Plant Material

This priority area is defined as:

FNGLA supports research to improve the quality of plant material to improve ecological and social benefits.

FNGLA supported two projects under this priority area, and those summaries are on pages 34-43.

Screening of novel Begonia genotypes for non-invasiveness

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ABSTRACT

Wax begonia (*Begonia semperflorens*) remains widely planted in Florida but carries concerns regarding invasive potential due to its partial origin from *B. cucullata*. This project evaluated reproductive pathways that underpin recruitment risk, including seedling establishment from fruit drop, pollen germination, seed embryo fill and viability, inter- and intra-specific crossing, and genome size variation. Wild-type *B. cucullata* var. *cucullata* and var. *arenosciola* produced spontaneous seedlings that survived multiple seasons and hurricanes, confirming their capacity for recruitment and spread. In contrast, UF breeding lines and intraspecific hybrids showed no seedling establishment under the same conditions. Pollen germination assays revealed high fertility in wild *B. cucullata*, but sharply reduced pollen germination in UF hybrids, while an interspecific cross (UF183-15 × *B. rubriflora*) generated progeny with empty anthers, indicating male sterility. Seed assays across wild types, UF selections, and hybrids showed generally low embryo fill (18–24%), low pre-germination viability (2–11%), and low final germination (3–18%). Flow cytometry separated materials into distinct cytotype clusters: UF breeding lines (~1.26–1.33 pg 2C), commercial checks (0.67–0.72 pg), and a wild species control (1.56 pg), with interspecific hybrids showing intermediate values (~1.02 pg). These genomic divergences suggest partial reproductive isolation. Collectively, the results demonstrate that while wild *B. cucullata* exhibits invasiveness, UF breeding lines combine desirable horticultural traits with low fertility and reduced recruitment risk, supporting their use as non-invasive alternatives.

OBJECTIVES

The objective of this project is to assess the seed production, viability, and ploidy level of commercial varieties of wax begonia and other non-named selections and hybrids compared to the resident invasive parent species.

METHODS

Plant Materials: The begonia used in this project included: wild species Begonia cucullata var. cucullata, *Begonia cucullata* var. *arenosciola*, *B. rubrifolia*, *B. dichroa*, and our heat tolerant lines: UF-183-11, UF-183-15, UF-5B, intraspecies hybrids (24.13.01, 24.13.04, 24.13.07, 24.13.09, 24.13.12, 24.13.13, 24.13.14, 24.13.28) from a cross between Cocktail Gin and our heat tolerant UF5B. Interspecies hybrids from *Begonia rubriflora* and UF183-15, commercial varieties: Cocktail Vodka, Double Up White, Ikon Blush white.
Methods: The evaluation was mainly performed in the greenhouse of Mid-Florida Research & Education Center. We investigated seed fill, fruit drops, and seedling establishments under the beds. **Seed Viability (TZ)**: Subsamples stained with 2,3,5-triphenyl tetrazolium chloride; % viable pre-germination scored. **Seed Germination**: 4 × 100 seeds/lot on moist germination paper/boxes; environmental conditions per proposal; counts 3×/week for 3–4 weeks; % at 2 wk and final % at 4 wk reported.

Seedling establishment from fruit drop: Seedlings m ^{2} recorded within 0.25–0.5 m^2 quadrats; counts normalized by canopy area and fruit load. **Pollen germination** was tested in a germination medium containing 10% sucrose, 0.01% H_3BO_3, 0.01% $CaCl_2$, 0.02% $MgSO_4 \cdot 7H_2O$, 0.01% KH_2PO_4; incubation for 12 hours; % germination and tube growth recorded (≥200 grains/sample).
Genome size estimation: An Accuri C6 (BD Biosciences, San Jose, CA) at the University of Florida Interdisciplinary Center for Biotechnology Research, Gainesville, FL, was used to estimate nuclear DNA content. Samples were prepared following the protocol defined in the CyStain™ PI Absolute P reagent kit (Sysmex Partec, Görlitz, Germany) with either Glycine max Merr. 'Polanka' (2.50 pg/2C) or Pisum sativum L. 'Ctirad' (9.09 pg/2C) used as an internal standard. Approximately 0.50 cm2 of freshly expanded leaf tissue from both sample and standard were co-chopped in a plastic Petri dish containing 500 µl of CyStain extraction buffer using a fresh razor blade. For samples containing a particularly high quantity of cytosolic compounds, 4-5 leaf meristems were used in place of leaf tissue. After an incubation period of approximately 30 seconds, the lysate was passed through a 50-µm mesh filter to remove debris, after which 2 ml of CyStain staining solution containing propidium iodide was added. The solution was then vortexed and immediately fed into the cytometer. Up to three replicates were performed for each genotype to ensure measurement validity. The .fcs files generated by the cytometer were then exported to FlowJo v10.10.0 for analysis. Estimated nuclear DNA content was calculated according to the equation provided by Doležel et al. (2007):

$$\text{Sample 2C value} = \text{Reference 2C Value} \times \frac{\text{sample mean fluorescence}}{\text{standard mean fluorescence}}$$

Statistical Analysis. An analysis of variance was performed using RStudio (R version 4.4.1) to determine significant differences ($P \leq 0.05$) among samples, and means were separated using Tukey's Honestly Significant Difference (HSD) test.

RESULTS

Seedling recruitment from fruit drop:
Begonia seeds are extremely small and easily dispersed by wind. We observed seedlings of *Begonia cucullata* var. *cucullata* establishing on the roof of the MREC building near the greenhouse (Figure 1A–B). These plants have survived for two years, enduring harsh summers, dry winters, and three major hurricanes (Idalia, Category 4, August 2023; Helene, Category 4, September 2024; Milton, Category 5, October 2024). Within a 0.5 m^2 plot beneath a bench of fruiting plants, seven spontaneous individuals of *B. cucullata* var. *cucullata* were documented: two mature and reproductive, four juveniles, and one seedling in early establishment (Figure 2). For *B. cucullata* var. *arenoscio*, two mature individuals were also found beneath the fruiting plants (Figure 3 A-B). Both *Begonia* var. *arenosciola* and var. *cucullata* produced spontaneous seedlings under benches, and one individual of *Begonia cucullata* var. cucullata persisted on a roof across seasons, providing evidence of self-sown survival in unmanaged microhabitats. This life-stage distribution demonstrates continuous recruitment from seed, with survival into reproductive stages, underscoring the capacity of wild *B. cucullata* to establish and spread beyond cultivated areas (Figures 1-3).

Figure 1. *Begonia cucullata* var. *cucullata* (OPGC 5014) surviving on the roof of the MREC building. (A) Established plant photographed in Fall 2023. (B) The same individual persisting and flowering in Spring 2025.

Figure 2. *Begonia cucullata* var. *cucullata* (OPGC 5014) producing self-sown seedlings beneath a greenhouse bench. Red arrows indicate different individuals.

Figure 3. *Begonia cucullata* var. *arenosciola* producing self-sown seedlings beneath a greenhouse bench. (A) The yellow arrow marks mature fruiting plants on the bench that likely served as the seed source for two plants under the bench. (B) close-up image of two plants under the bench. Red arrows indicate two large individuals.

In contrast, UF selections showed no recruitment under the same conditions. Neither UF183-11 nor the hybrid 24.13.01 (UF5B × Cocktail Gin) produced seedlings beneath benches during the observation period, suggesting substantially lower recruitment risk in UF breeding lines (Figure 4A–B).

Pollen development defects from the interspecies crossing: *In vitro* pollen germination assays revealed striking differences between wild-type and UF hybrid progenies. *Begonia cucullata* var. *cucullata* (OPGC 5014) exhibited abundant pollen germination with numerous grains producing elongated pollen tubes (Figure 5A). By contrast, progenies from UF5B × Cocktail Gin crosses showed markedly reduced germination, with only a small fraction of grains forming short or aborted tubes (Figure 5B–C). These results indicate a significant reduction in male fertility in UF hybrids compared to the wild type. Additional evidence of impaired fertility was observed in the interspecific cross UF183-15 (♀) × *B. rubriflora* (♂). Progeny displayed vigorous plant growth and novel pink flower coloration (Figure 6A–B), expanding the ornamental potential of these hybrids. Interestingly, stamen development was abnormal: stamens were present (Figure 6C) but produced empty anthers lacking viable pollen (Figure 6D). This combination of normal vegetative and floral morphology with defective pollen development strongly supports a sterility phenotype. Such male sterility represents an advantageous trait for invasiveness mitigation while simultaneously contributing novel horticultural traits.

Figure 4. Limited recruitment of UF begonia selections under greenhouse conditions. (A) Hybrid 24.13.01 (UF5B × Cocktail Gin) showing no spontaneous seedlings beneath a greenhouse bench. (B) UF183-11 also showing no spontaneous seedlings under the same conditions.

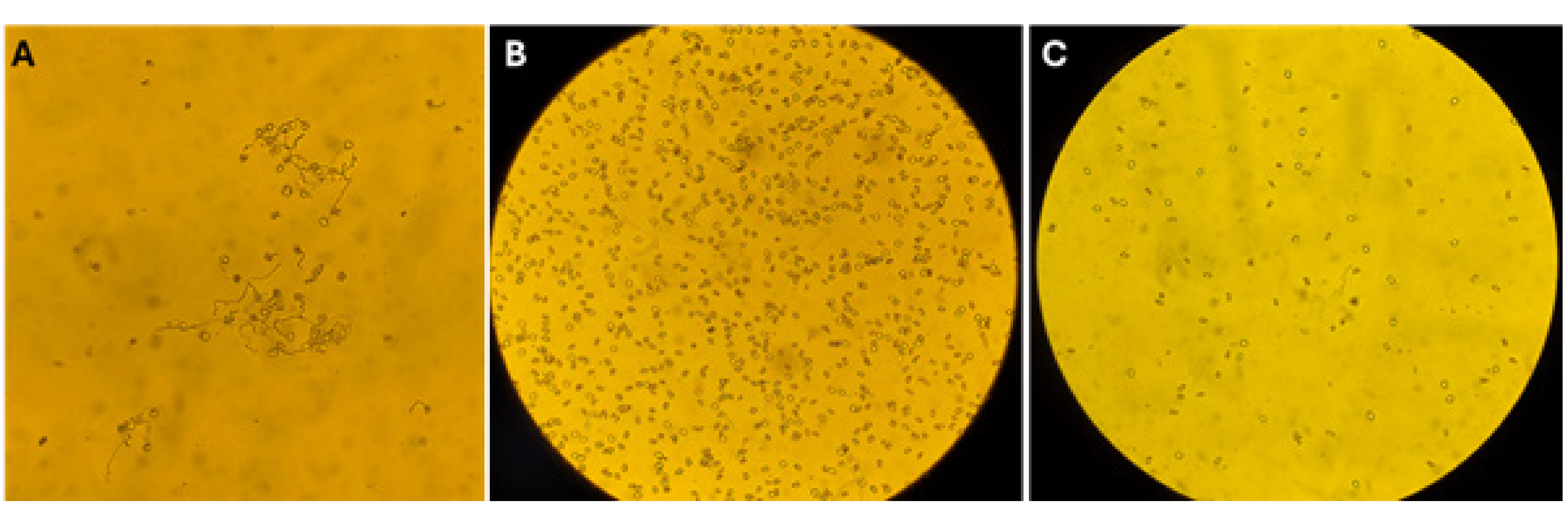

Figure 5. Pollen germination assay. (A) *Begonia cucullata* var. *cucullata* (OPGC 5014) showing high pollen germination. (B–C) Progenies from the UF5B × Cocktail Gin cross displaying markedly reduced pollen germination.

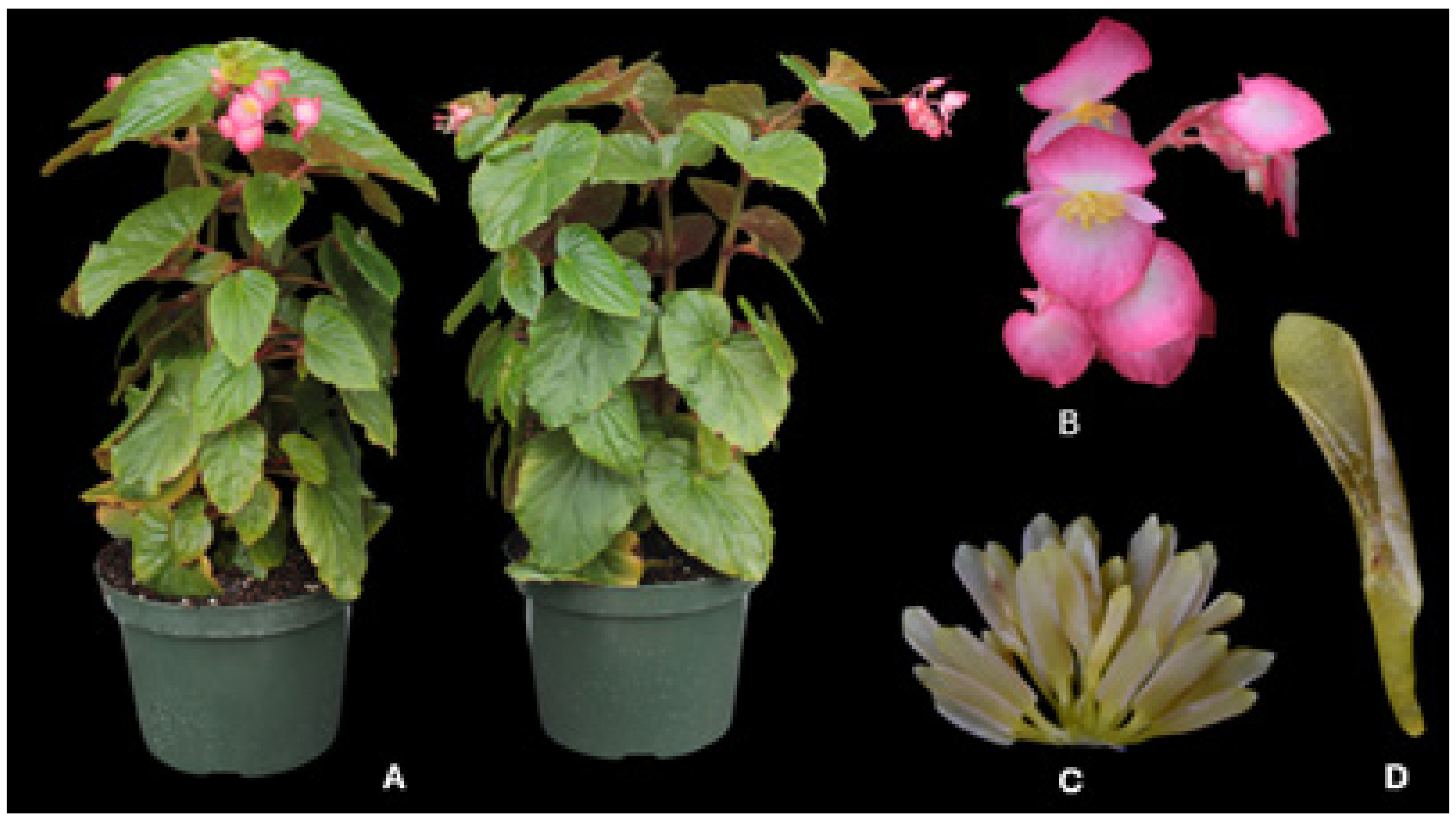

Figure 6. Progeny from the interspecific cross *Begonia* 'UF183-15' (♀) × *B. rubriflora* (♂). (A) Whole plant showing hybrid morphology. (B) Inflorescence with novel flower coloration. (C) Stamens. (D) Empty anther indicating loss of viable pollen and reduced male fertility.

Seed germination: Seeds were collected from the wild-type invasive *Begonia cucullata* var. *cucullata* and compared with open-pollinated UF183-11 and manually crossed 24.12.14 hybrids to assess seed fill, pre-germination viability, and germination percentage. Across all seed lots, a large proportion of seeds lacked fully developed embryos (Figure 7A). Microscopic inspection showed embryo fill ranging from only 18–24%. TZ staining indicated that 2–11% of seeds were viable prior to germination testing. Germination progressed rapidly within the first two weeks and plateaued by week four, with final rates reaching just 3–18% (Figure 7B). These consistently low values highlight limited seed viability and poor germination capacity across wild type and hybrid backgrounds. Future work will quantify seed production per plant to provide a more complete estimate of reproductive potential.

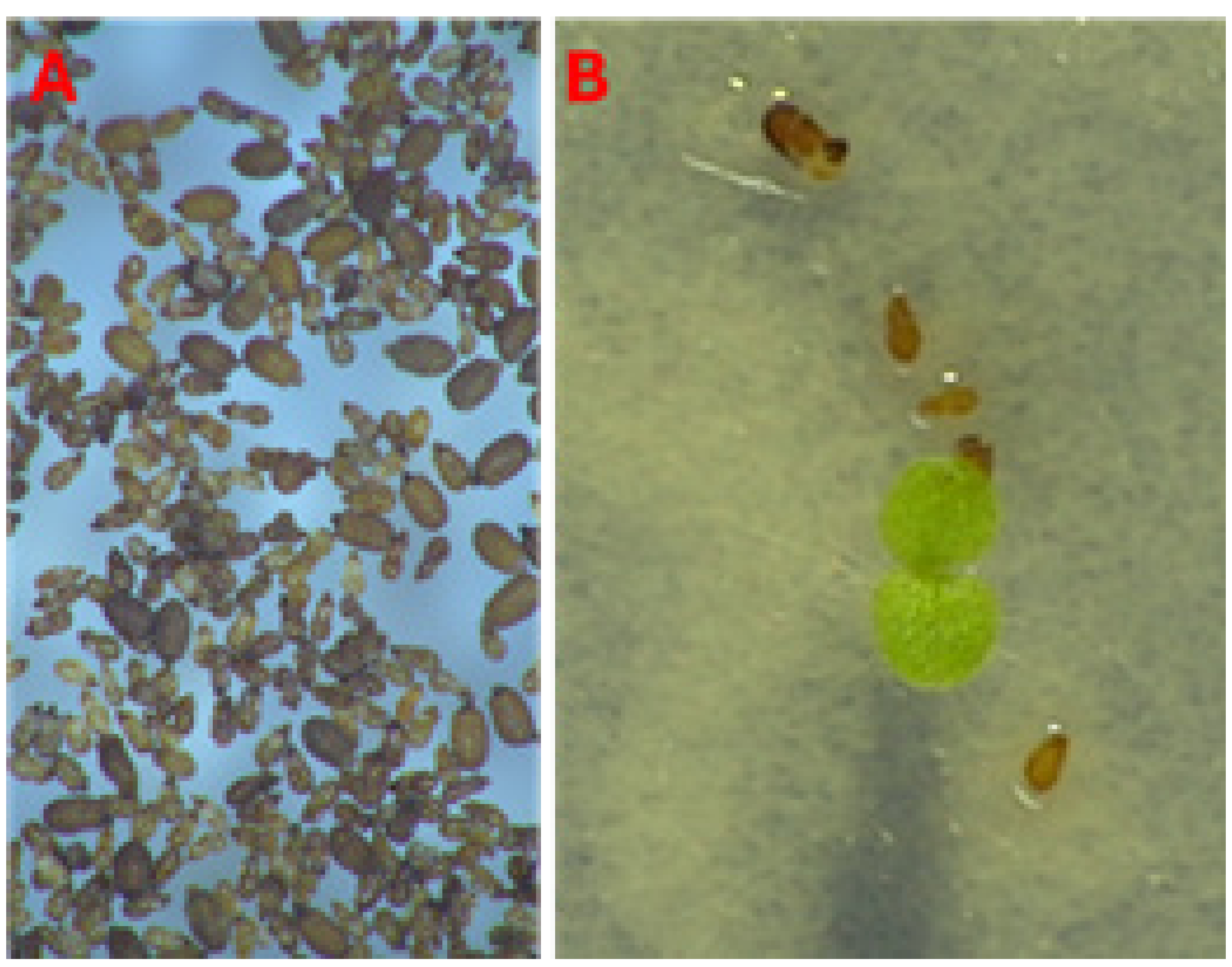

Figure 7. Seed viability and germination of *Begonia cucullata* var. *cucullata*. (A) Representative seed lot showing that only a small proportion of seeds are plump and filled, while the majority appear empty or shriveled. (B) Germination assay showing a rare viable seed producing a green seedling, while most seeds remain ungerminated.

Genome size estimation: Flow cytometry resolved clear cytotype tiers across our materials. The UF/24.13 cohort—including 24.13.01/.04/.07/.09/.12/.13/.14 together with UF parents (UF5B, UF-183-11/-15)—clustered tightly at ~1.26–1.33 pg 2C (Tukey b–bc), indicating close genomic affinity and predictable within-group cross behavior. By contrast, commercial checks such as Double Up White (0.67 ± 0.05 pg) and Ikon (0.72 ± 0.03 pg) formed a significantly smaller-genome cluster (Tukey f), while *B. dichroa* occupied the largest-genome tier at 1.56 ± 0.05 pg (Tukey a), together demonstrating pronounced genome-size divergence relative to the UF/24.13 cytotype. Further, the inter-group hybrid Ikon × UF5B centered near the mid-parent expectation (~1.02 ± 0.08 pg; Tukey e), and intermediate references such as *B. rubrifolia* (~1.15 ± 0.04 pg; Tukey cd) and Cocktail Vodka (~1.02 ± 0.04 pg; Tukey e) likewise fell between clusters, patterns consistent with partial reproductive barriers across groups. Assay quality supports these separations, with representative mean sample CVs ~5–7% and mean standard CVs ~4–5% across lines (e.g., 24.13.01–24.13.07). Together, these genome-size data define three cytotype strata (UF/24.13 ≈ 1.3 pg; commercial checks ≈0.7–1.0 pg; *B. dichroa* ≈1.56 pg) that predict limited inter-group fertility, supporting our strategy to pair high-performance UF selections with intrinsic reproductive containment to reduce invasiveness risk.

Table 1 Genome size estimation of different begonias			
Sample	2C DNA (pg)	Mean Sample CV	Mean Standard CV
24.13.01	1.31 ± 0.07 b[1]	5.98	4.87
24.13.04	1.29 ± 0.01 b	7.04	4.94
24.13.07	1.26 ± 0.01 bc	5.98	4.94
24.13.09	1.33 ± 0.06 b	5.8	5.04
24.13.12	1.28 ± 0.08 b	5.32	4.67
24.13.13	1.33 ± 0.03 b	6.3	4.67
24.13.14	1.33 ± 0.04 b	5.51	5
24.31.28	1.23 ± 0.01 bcd	5.92	4.51
Cocktail Vodka	1.02 ± 0.04 e	5.68	4.58
B. dichroa	1.56 ± 0.05 a	5.41	4.39
Double Up White	0.67 ± 0.05 f	5.5	4.4
Ikon	0.72 ± 0.03 f	6.01	5.42
Ikon x UF5B	1.02 ± 0.08 e	6.01	4.22
B. rubrifolia	1.15 ± 0.04 cd	5.81	5.43
UF-183-11	1.28 ± 0.04 b	6.28	4.92
UF-183-15	1.26 ± 0.02 bc	6.21	5.42
UF5B	1.31 ± 0.00 b	5.2	5.01

[1]Means followed by the same letter are not significantly different by Tukey's HSD test ($P \leq 0.05$).

CONCLUSION AND IMPACT

Wild *Begonia cucullata* demonstrated clear invasiveness, with seedlings establishing and persisting in unmanaged habitats, reflecting strong vigor and stress tolerance. This resilience can be valuable in breeding, provided fertility is carefully managed. In contrast, UF breeding lines and intraspecific hybrids showed no spontaneous recruitment and reduced pollen fertility, indicating minimal invasive risk. Interspecific hybrids, while sterile due to empty anthers, introduced novel ornamental traits such as unique flower coloration and plant architecture. Poor seed development and germination further reduce invasive potential without limiting propagation by cuttings. Genome size analysis defined distinct cytotypes and will guide parental selection to combine vigor with reproductive containment. Collectively, these findings support the safe use of UF selections and interspecific hybrids for developing innovative, non-invasive begonia cultivars.

Breeding industry-suitable tropical Hibiscus cultivars in Florida

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CO-PI: **Alexandra Revynthi, Entomology and Nematology | Tropical REC**

ABSTRACT

Tropical hibiscus (*Hibiscus rosa-sinensis* L.) is an economically important ornamental crop widely cultivated in Florida. However, its production is challenged by bacterial leaf spot, hibiscus bud weevil, and a shortage of new varieties that meet industry needs. This project evaluated both the genotypic (genome size) and phenotypic (plant morphology, bacterial leaf spot resistance, and hibiscus bud weevil tolerance) diversity of the tropical hibiscus germplasm collection for new cultivar development. Genetic diversity analysis of 96 tropical hibiscus accessions revealed a complex genomic background, with genome sizes ranging from 3.06 Gbp to 12.75 Gbp. The collection showed broad morphological variation (color and shape) in flower and foliage. Pathogen isolation and identification confirmed *Pseudomonas syringae* as the primary causal agent of bacterial leaf spot for tropical hibiscus production in Florida. Preliminary disease and pest evaluations revealed considerable variation within the collection, with 'Snow Queen' being a promising breeding parent for its combined disease resistance and pest resilience. This study highlights substantial genetic and phenotypic diversity within tropical hibiscus germplasm and provides valuable insights for breeding new disease and pest resilient cultivars for Florida ornamental industry.

OBJECTIVES

Tropical hibiscus (*H. rosa-sinensis* L.) is one of the most important ornamental crops in Florida, with its production heavily concentrated in Miami-Dade County. Tropical hibiscus is a complex hybrid group derived from multiple Hibiscus species native to tropical regions worldwide and is popular for its vivid flower colors, prolific blooming and showy foliage. Despite its importance, tropical hibiscus production faces major challenges, including bacterial leaf spot, hibiscus bud weevil, and limited cultivars that meet industry needs and adapt to local environmental conditions. Current breeding programs have largely emphasized flower-related traits for market appeal, often overlooking adaptability traits such as pest and disease resistance.

To address these gaps, a tropical hibiscus germplasm collection was established at UF/IFAS TREC to support the development of locally adapted cultivars. The project focuses on combining elite ornamental qualities with resilience to pests, diseases, and environmental stresses, to establish the foundation for a comprehensive hibiscus breeding program. By harnessing the genetic and phenotypic diversity of this germplasm collection under local environmental conditions, this project aims to deliver new hibiscus cultivars that combine high ornamental value with greater resilience, ultimately supporting the sustainability and competitiveness of Florida nursery industry.

The objectives of this project were: 1) to characterize the genomic variation of the collection for breeding parent selection. Genomic information such as genome size can guide the selection of suitable breeding parents for hybridization.

2) to evaluate phenotypic variation of the germplasm collection for flower and foliage evaluation, bacterial leaf spot resistance, and hibiscus bud weevil (HBW) tolerance. Accessions with desirable characteristics will be identified and used in targeted breeding to develop improved cultivars.

METHODS

The tropical hibiscus germplasm collection maintained at UF/IFAS TREC was used in this study. DNA content and genome size were measured using a flow cytometer (Attune Autosampler; Attune Acoustic Focusing Cytometer, Invitrogen, Singapore). Rice (*Oryza sativa* L. ssp. *japonica* cv. Nipponbare) was used as the internal reference standard. An average of 5,000 were analyzed for each accession. The 2C genome size was calculated as:

$$\text{Sample 2C (pg)} = \frac{\text{Sample peak mean}}{\text{Standard peak mean}} \times \text{Reference 2C DNA content (pg)}$$

Mean genome sizes and standard deviations (SDs) were calculated using Microsoft Excel (Redmond, WA, USA). Flower and foliage traits (color and shape) were recorded as categorical data following the descriptors provided in the *Tropical Hibiscus Handbook* (American Hibiscus Society).

Lesions (0.5 × 0.5 cm) were excised from leaves with BLS-like symptoms were collected, surface-sterilized (70% ethanol for 45 s, 10% bleach for 5 min, rinsed three times), and plated on nutrient agar under sterile conditions. Plates were incubated at 25–28 °C for 3–4 days, and colonies were selected based on morphology. Pathogenicity was verified on healthy hibiscus plants, and molecular identification was performed using 16S rRNA sequencing. For resistance screening, old foliage was removed to allow new leaf growth. Plants were sprayed with a bacterial suspension (1×10^9 CFU/mL) or nutrient broth (control), enclosed in polyethylene bags for 48 h, and then maintained under regular irrigation. Disease severity was scored 30 days post-inoculation on five leaves per plant using a 1–5 scale (1 = 1–20% area, 2 = 21–40%, 3 = 41–60%, 4 = 61–80%, 5 = >81%). Data were analyzed by ANOVA in R ($p < 0.05$), and accessions were classified as highly tolerant (1), tolerant (2), susceptible (3), or highly susceptible (4–5).

Adult HBW (male and female) were provided by the Ornamental Entomology Lab at UF/IFAS TREC. Fifteen fresh hibiscus flower buds were collected daily and provided to paired male–female adults housed in modified plastic Petri dishes (100 × 15 mm). Each dish contained a 21 mm mesh-covered ventilation hole and a 2 mm cotton-plugged hole for humidity control. Adults were allowed to feed, mate, and oviposit for one week, and the buds were replaced daily for four consecutive days. Buds were inspected daily for feeding holes and eggs, then incubated under controlled conditions (27 ± 1 °C, 12:12 h L:D, 60% RH) for 12–15 days to record larval development, adult emergence, and sex ratio. Data were analyzed using RStudio (v. 4.4.1).

RESULTS

DNA content among tropical hibiscus accessions showed a 4.1-fold difference ranging from 3.06 ± 0.03 pg to 12.75 ± 0.10 pg (Figure 1a–c). Most accessions displayed low standard deviations, indicating consistent measurements. The majority possessed medium genome sizes (6–10 Gbp), while eight accessions had small genomes (3.06–4.11 Gbp) and three accessions had large genomes (11.05–12.75 Gbp) (Figure 1d). These results have been published by the leading graduate student (Chen et al., 2025, *HortSci*.).

Extensive variation was observed in both flowers and foliage (Figure 2). Six flower structures were identified, with most accessions showing mixed coloration. Red and pink were the predominant flower colors, followed by yellow and peach. Leaf traits, including variation in color, margin, flatness, smoothness, and overall structure, were diverse among the tropical hibiscus collection.

Pathogen isolation and molecular identification confirmed *Pseudomonas syringae* as the primary causal agent for bacterial leaf spot. Cultivars exhibited clear differences in symptom severity and morphology (Figure 3). 'Snow Queen' was highly tolerant to bacterial leaf spot, while 'Double Peach' was highly susceptible with lesion areas reaching 76%. In some cases, infection phenotypes differed between leaf surfaces. 'Double Peach' developed numerous small yellow lesions on the abaxial (lower) surface, whereas the adaxial (upper) surface showed milder symptoms (Figure 4). In contrast, 'President Red' displayed similar symptoms on both surfaces. These findings suggest that bacterial leaf spot resistance is complex and may be governed by multiple genetic mechanisms.

Seventeen accessions were evaluated for hibiscus bud weevil tolerance. Significant cultivar differences were detected in feeding damage, oviposition, larval survival, and female emergence, while male emergence did not differ significantly (Figure 5). hibiscus bud weevil adults exhibited clear feeding preferences; for instance, both sexes fed heavily on 'Lion's Tail Yellow', but females did not preferentially oviposit in its buds. Five cultivars consistently supported high levels of feeding, oviposition, and larval development, indicating susceptibility, while two cultivars exhibited low levels across all stages, reflecting strong pest tolerance (Figure 6).

CONCLUSIONS

This project demonstrated substantial genetic and phenotypic diversity within the tropical hibiscus germplasm collection, providing a strong foundation for breeding improved cultivars. Genome size characterization enabled the identification of suitable breeding parents, while morphological variation highlighted opportunities for developing new cultivars with desirable flower and foliage traits. Differential responses to bacterial leaf spot and hibiscus bud weevil revealed valuable sources to confer resistance through breeding, supporting the development of pest- and disease-resilient varieties. These advances will help reduce chemical input, lower production costs, and minimize environmental impacts. Ultimately, the identification of resistant accessions represents a critical step toward sustainable tropical hibiscus production that will benefit the Florida ornamental industry, growers, landscapers, and consumers with healthier, more resilient plants.

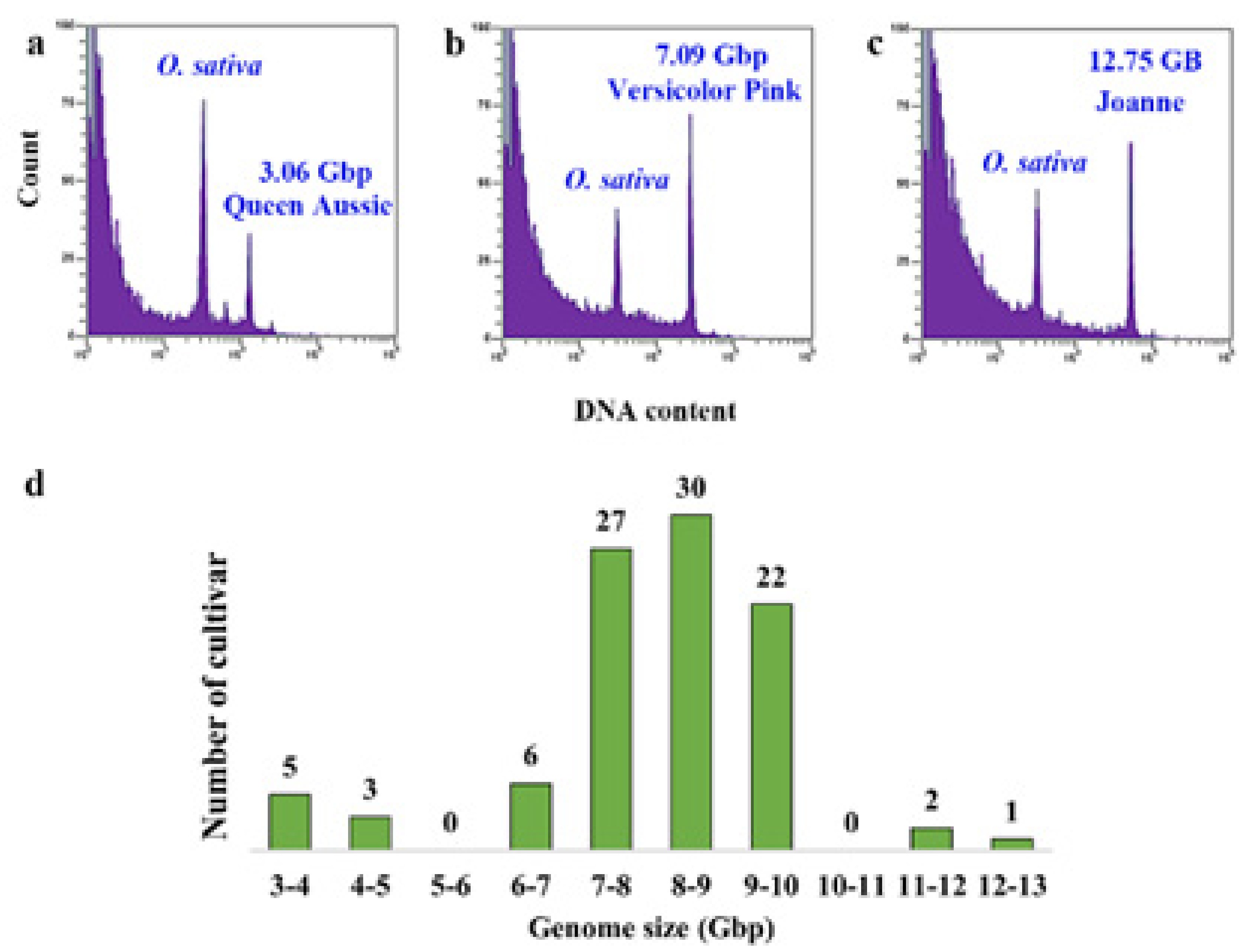

Figure 1. Genome size variation of tropical hibiscus. a-c, genome size of known cultivars "Queen Aussie", "Versicolor" and "Joanne"; d, genome size distribution.

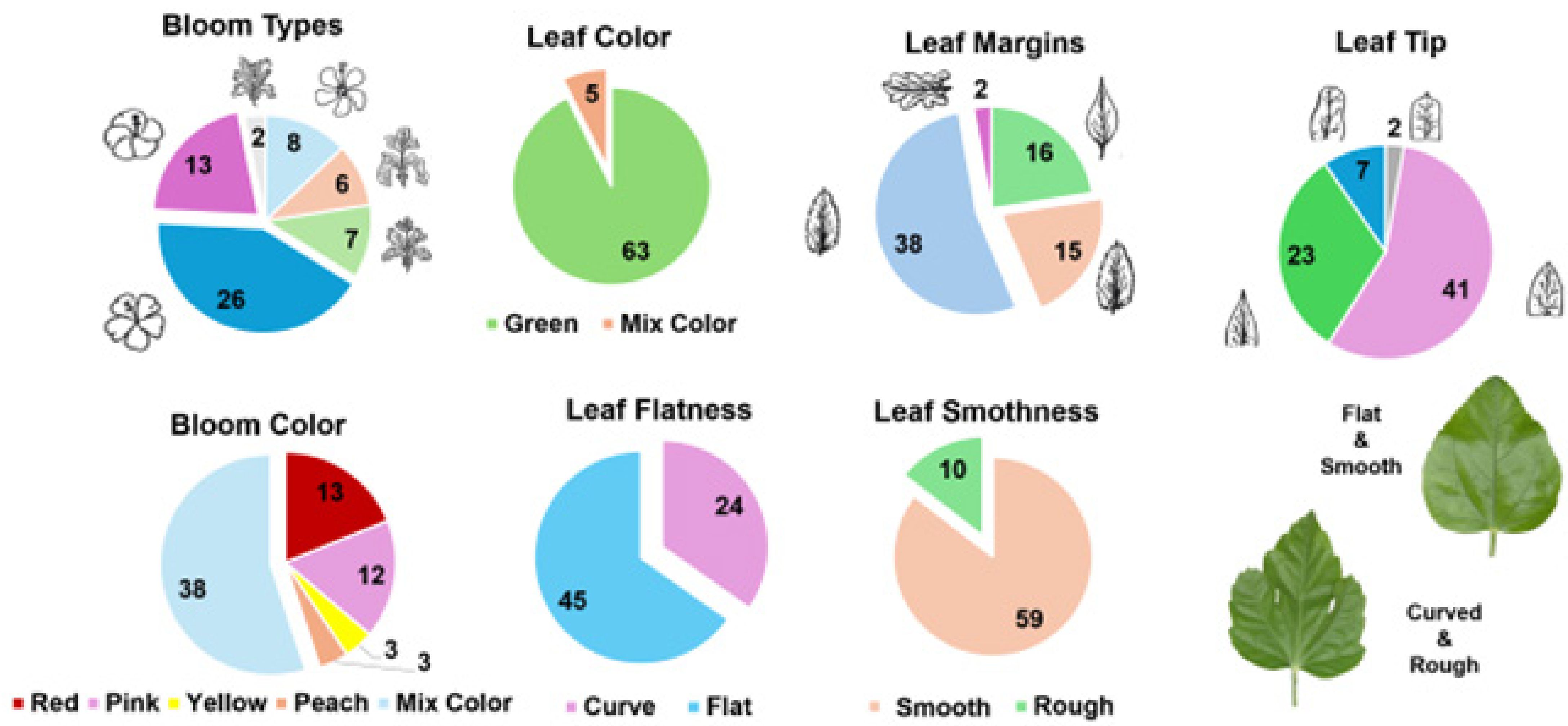

Figure 2. Morphological distribution of tropical hibiscus collection.

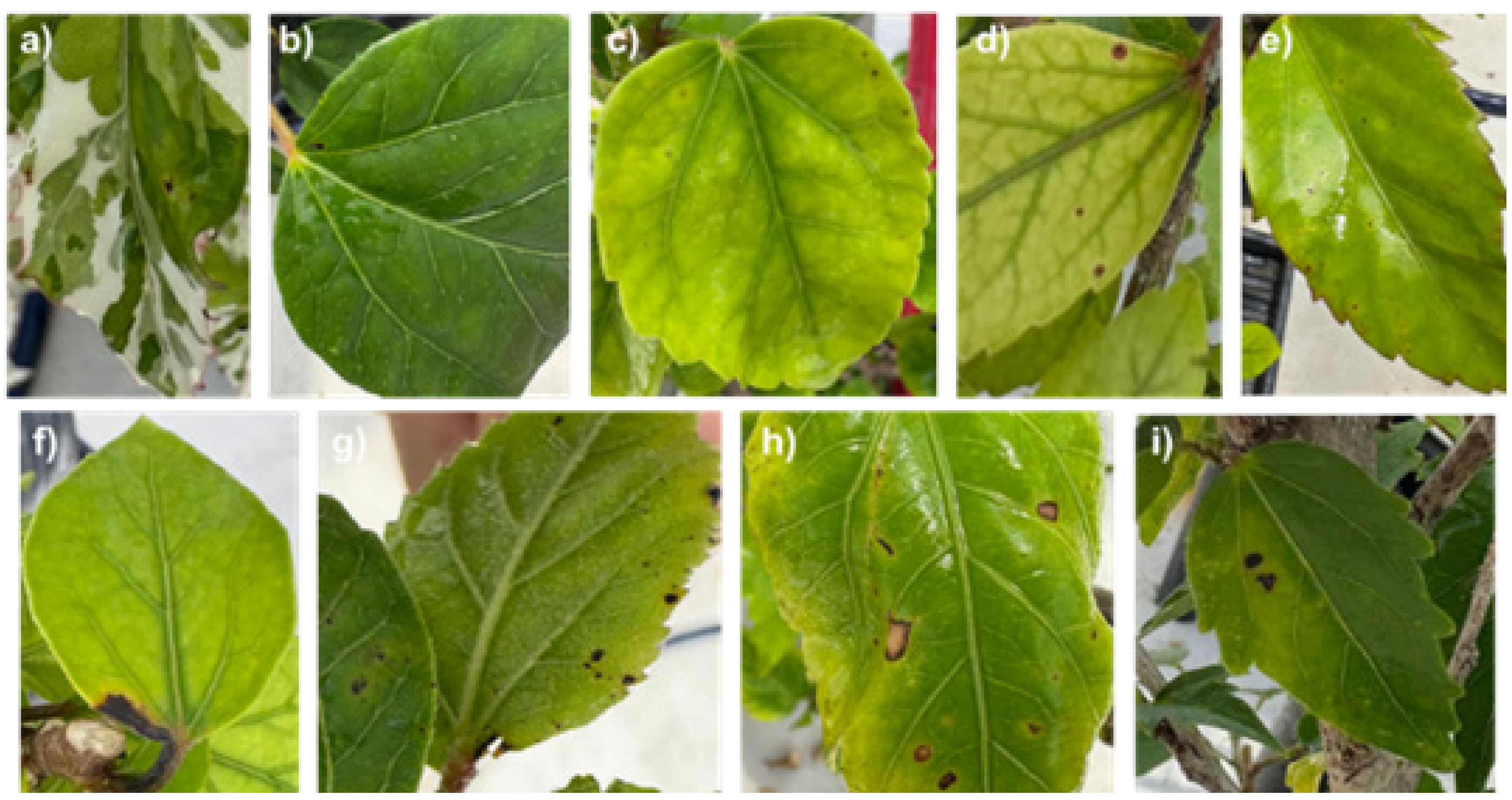

Figure 3. Morphological variation of bacterial leaf spot (*P. syringae*) symptoms across tropical hibiscus cultivars. a) Snow Queen, b) Yellow Tequila, c) Joann, d) Fiji Island, e) Brilliant, f) Sunscape, g) Seminole Pink, h) President Red, i) Double Peach.

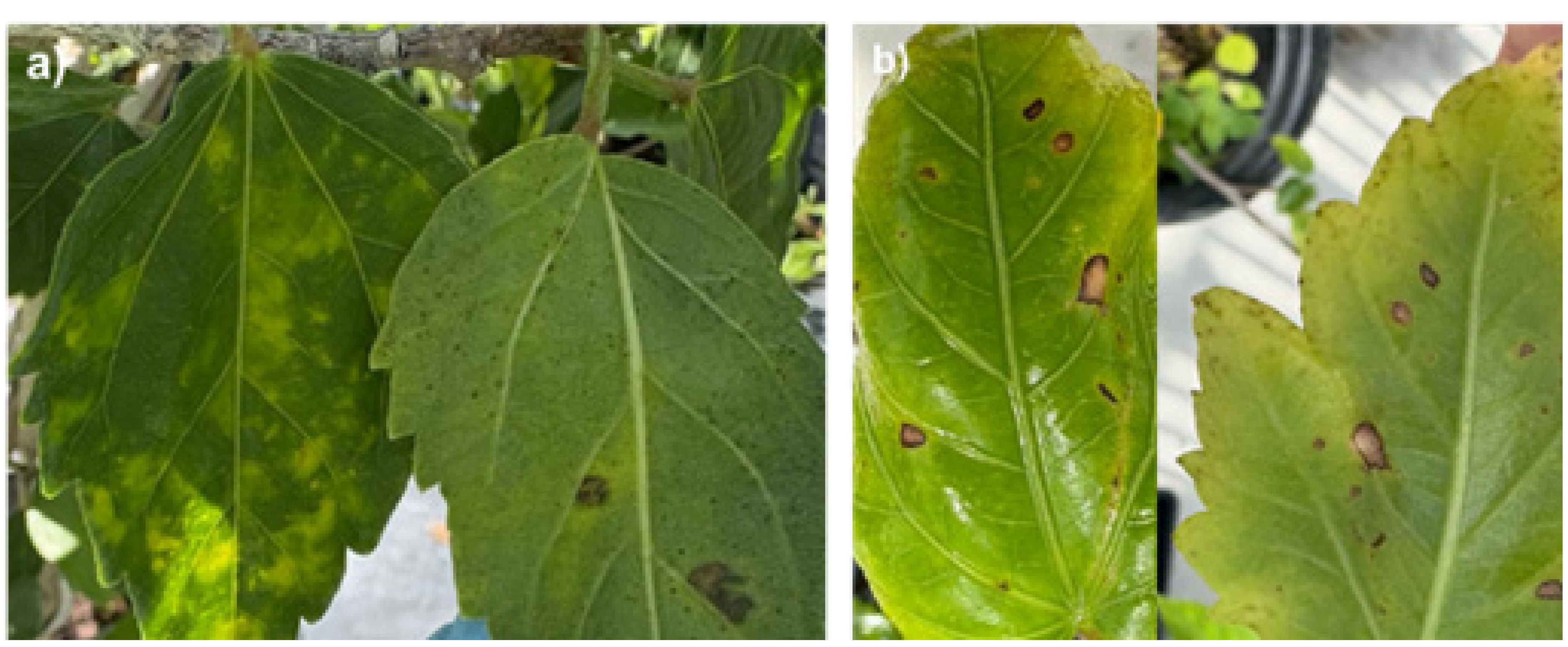

Figure 4. Differential infection of bacterial leaf spot on the leaves of tropical hibiscus accessions. a) Double Peach; b) President Red.

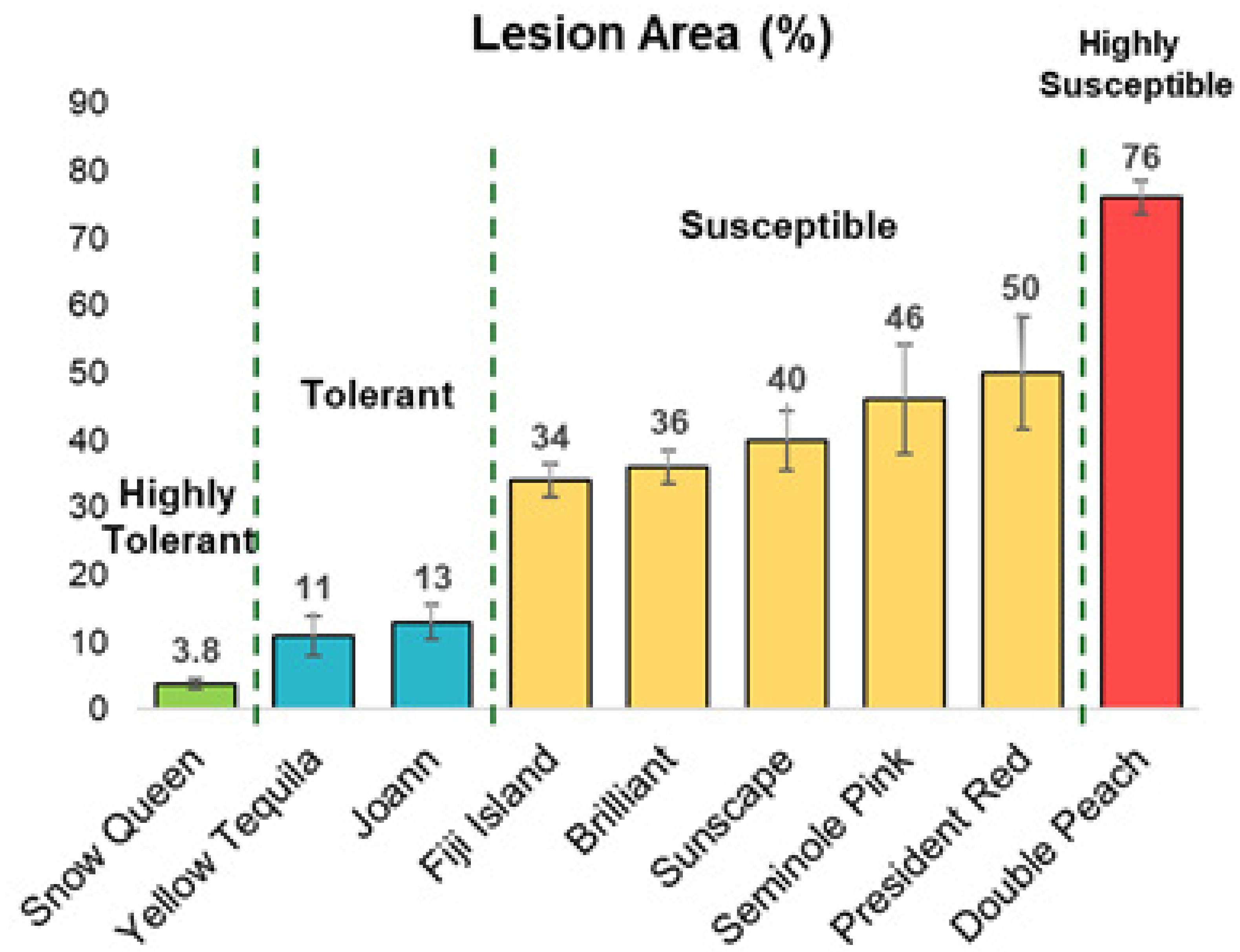

Figure 5. Differential host responses to bacterial leaf spot (*P. syringae*) in tropical hibiscus accessions.

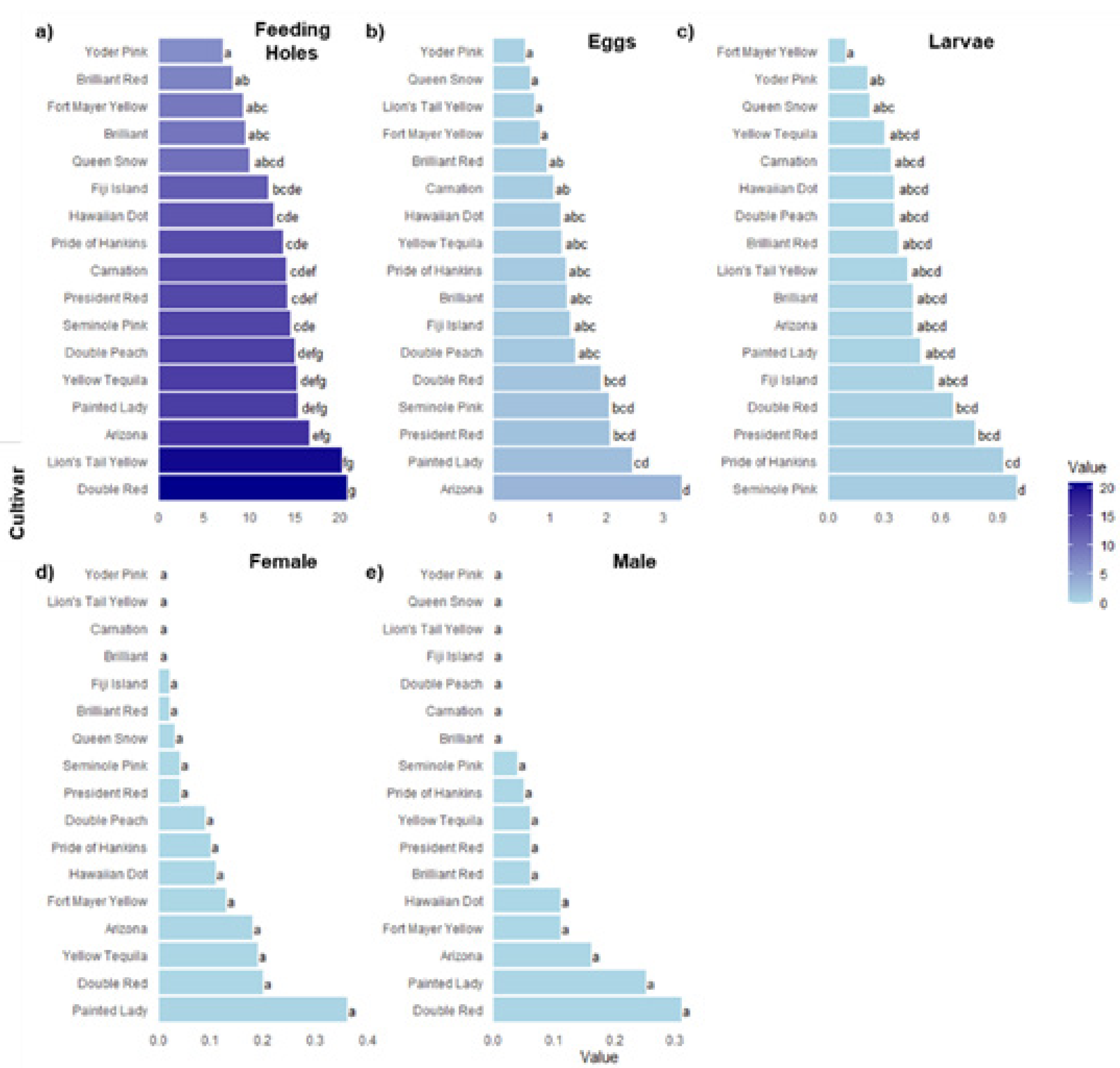

Figure 6. Hibiscus bud weevil evaluation in tropical hibiscus. a) Mean number of the feeding holes; b) Mean number of the egg deposition; c) Mean number of the larval survival; d) Mean number of the hatching female; d) Mean number of the hatching male. Statistically different cultivars are separated with lowercase letters (N = 115 for each cultivar, GLMM, $p < 0.05$).

Developing and Implementing Emerging Technology

This priority area is defined as:

FNGLA supports research on applications of emerging technology related to digital agriculture, artificial intelligence, and robotics and automation.

FNGLA supported one project under this priority area,
and that summary is on pages 45-49.

Developing Artificial Intelligence-supported Approach fro (Peri) Urban Food Production Planning, Engagement, and Development

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ABSTRACT

Urban food production (UFP) offers a promising pathway to advance urban sustainability and resilience, and enhance resource efficiency, yet its development in Florida lags behind other U.S. regions. This project aimed to evaluate the status, social enabling factors, and planning strategies for UFP in Florida, with a focus on South Florida as a testbed. Using artificial intelligence (AI) and big data, we quantified public interest in UFP through a 10-year analysis of news media coverage, surveyed residents to assess behavioral and policy support, and developed an AI-supported framework to identify and evaluate potential UFP sites for future planning and development. Our results showed that Florida exhibits relatively lower levels of public interest in UFP compared to the other populous regions in the U.S. (e.g., west coast, Midwest, and northeast), although interest has risen, especially since COVID-19. Analysis of survey results revealed that demographic factors, social norms, and awareness strongly shape supportive behaviors, while policy support is positively influenced by direct UFP experience. Finally, AI-supported approach can be powerful in UFP research, which has been limited with fragmented datasets, in particular with its effectiveness in integrating multi-model datasets (e.g., satellite imagery, land-use data, social media data, zoning) to assess UFP suitability. Overall, findings from this project provide actionable insights for advancing UFP planning and policy in Florida.

OBJECTIVES AND METHODS

Globally, more than half of the population lives in urban areas that predominately rely on external supplies of food, energy, and water resources. It is projected that 2.5 billion more people will live on the planet by the mid-21st century, with disproportionate growth in urban populations (i.e., 68% by 2050) (Forman and Wu 2016, Seto et al. 2017). Urbanization and soaring resource demands in cities are further exacerbated by factors related to changing climate, shifting land uses, and aging urban infrastructures (Muller 2007). It is thus crucial to explore sustainability pathways in urban areas that enhance resource efficiency, reduce environmental tradeoffs, and improve urban resilience through integrated support of FEW infrastructures (Elmqvist et al. 2019). Urban food production (UFP) – broadly defined as the process of growing and processing food products in urban and peri-urban areas – has been demonstrated great potentials as transformative change to advance urban resilience and sustainability (Lovell 2010, Azunre et al. 2019, Newell et al. 2022). UA is also increasingly recognized as vital nature-based solutions to address key social-environmental challenges in urban systems and provide ecosystem services (e.g., quality food supply, heat mitigation, carbon storage, nutrient flow regulation, air quality regulation, habitat support) (Artmann and Sartison 2018, Kingsley et al. 2021).

UA has indeed resuscitated growing interests and support from public and private entities and policymakers at different scales (e.g., from building, to community, city, and metropolitan region), especially during the COVID-19 pandemic (Valencia et al. 2022b, 2022c). While UA has implications on social, economic, and environmental sustainability, its impacts are largely constrained to small-scale implementations. Significant barriers persist that could preclude the expansion of UA development and its networks, such as lacked public support, land scarcity (Martellozzo et al. 2014), insufficient technological and infrastructural support (Chang et al. 2020a, 2020b, Valencia et al. 2022c), limited food distribution network (Mohareb et al. 2017), governance structures (Valencia et al. 2022a), as well as environmental and regulatory concerns (Bryld 2003). Florida, in particular, lagged in this field and sector compared to other states in the U.S. Hence, to realize urban food production impacts, it is key to understand the current status and context of (peri) urban food production, and identify approaches that could support its planning and development to realize their full potentials.

Although this research topic is interesting, it is extremely challenging to perform due to highly scarce and fragmented datasets that are 'buried' or curated in different sectors. Fortunately, the advent of artificial intelligence (AI) allows us to start tapping into the large-scale and multi-modal datasets in different formats and platforms to tackle this research question. With initial support from the Florida Nursery, Growers, and Landscape Association (FNGLA), we have performed preliminary research that leverages AI and big data to: (1) quantify public interests for the development of UFP in Florida, as compared to the other states in the U.S. (i.e., status quo assessment); (2) examine factors that could influence public support for the engagement and development in UFP (i.e., social enabling factors for UFP); and (3) produce an AI-supported approach and framework for supporting UFP planning and development (e.g., site selection and evaluations) (i.e., biophysical enabling factors for UFP). We have focused on our work primarily in south Florida (i.e., Greater Miami region as a testbed), because (a) it is most urbanized in Florida; (b) enormous community interests in and support for UFP emerged, based on PI Qiu's extension program; (c) it faces growing demands for food, environmental horticultural and landscaping services; and (d) PI Qiu has amassed baseline datasets related to UFP for this study region.

Specifically, to address the first objective on the current public interests in UFP in Florida, we have searched Google using a Boolean query term "urban AND (agriculture* OR farm* OR garden* OR food production*)", selected "News", and set a custom date range from January 2014 to October 2024. We manually downloaded the results and used a browser automation tool named "Selenium", supported by Python, to scrape the pages for the URL, publisher, title, and a short description of each article (~150 characters). Further, we instituted a number of checks to account for external confounds, such as biases due to temporary cookies, the order of queries, and the timing of search requests, following the standard protocol for optimizing search results (Fischer et al. 2020, Tateosian et al. 2023). Each query was instituted in a new browser window opened in incognito mode. Moreover, the order of the queries was randomized to prevent time-related biases from affecting the results. Lastly, three full sets of results were collected for the search term over the 10-year data collection period to account for any maxima in news attention. Full news articles were then retrieved using the Newspaper3k package in Python. For articles not accessed with Newspaper3k due to paid subscription policies or other reasons, we did not obtain the full-length articles. Instead, we used only Google's News snapshots, considering their titles and short descriptions for natural language processing. To address the second objective to unravel factors influence public support of UFP engagement and therefore its development, we have performed a comprehensive survey of residents in South Florida, which was developed to measure and assess the Value-Belief-Norm (VBN) framework (including values, beliefs, norms, and behavioral intentions, alongside key contextual covariates) and the extent to which they explain the public's behavior towards support UFP. Based on the survey results along with our collated social-environmental factors, we perform machine learning methods and model assessments to elicit dominant factors that influence the public's behavioral intentions.

To address the third objective, we have developed a series of AI-supported approach for UFP planning and development, which specifically integrated multi-scale space-borne remote sensing (i.e. Sentinel-2) for site sorting via ensemble learning, clustering and Multi-Criteria Decision Analysis for site ranking, and supervised and reinforcement learning for site confirmation. Our framework chose to use the multi-agent reinforcement learning (MARL), which has been initially developed and used to solve game theory problems with imperfect information (Nowé et al. 2012). MARL algorithms are typically developed based on the Markov game, which is the extension of Markov Decision Processes under the MAS (multi-agent system) environment.

RESULTS

This project is leading to three peer-reviewed publications that are at different stages of preparation, which were summarized in this section. Specifically, for the first objectives, we have found that overall Florida showed low-to-intermediate level of public interests in UFP as compared to other states (Fig. 1; Qiu et al. in prep). States in the west coast (e.g., Washington, California) and Midwest and Northeast (e.g., Wisconsin, Illinois, and New York) showed much greater level of public interests in UFP. Over time, there has been an increase in public interest in UFP in Florida, especially since the Covid-19. Major sources of news that documented UFP in Florida included: Tampa Bay Times and USF St. Petersburg, indicating the interests of UPF in this region. Overall, results from this bjective helped to set up the stage for understanding the general level of public interests and potential engagement towards UFP development.

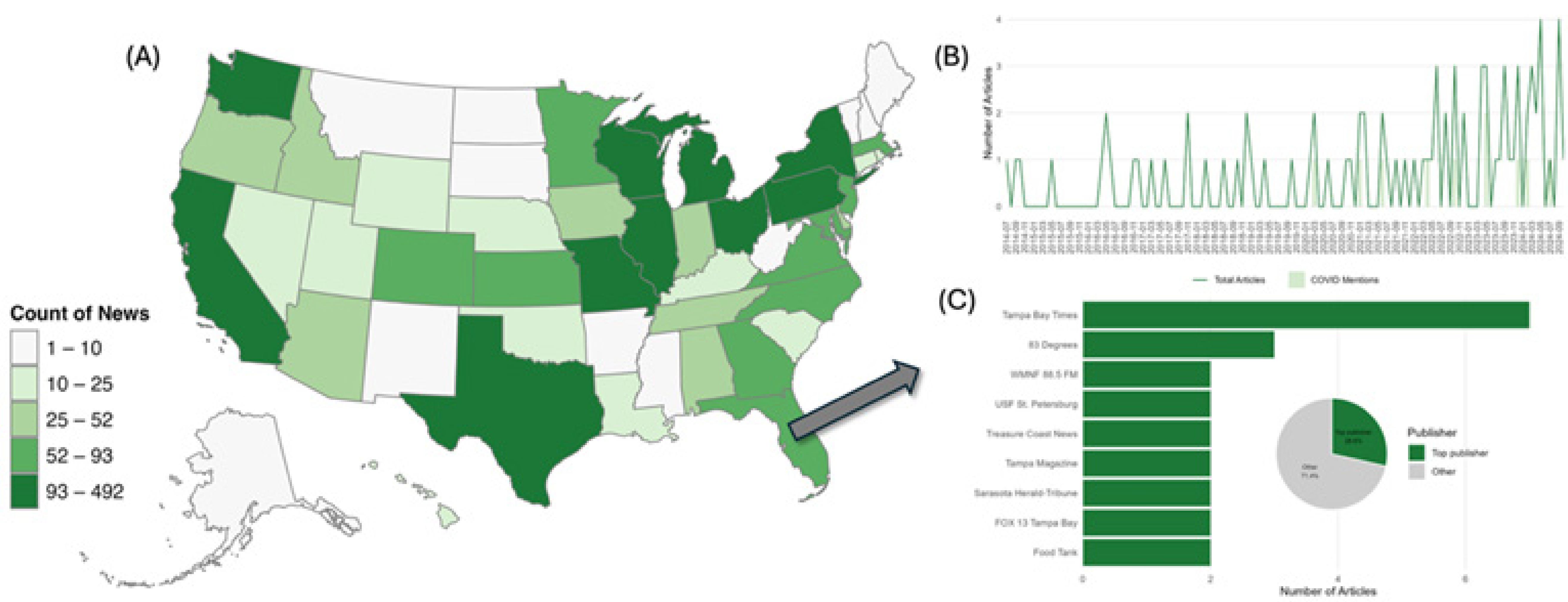


Fig. 1. (A) Spatial pattern of the overall public interests in (peri) urban food production (UFP) across the U.S. (original data source: Google News); **(B)** Temporal dynamics of public interests in UFP in Florida; and **(C)** Top news sources that documented UFP in Florida (Qiu et al., *In prep*).

For the second objective, we have found that, not surprising, demographic factors played a key role in explaining the supportive behaviors and policy support outcomes for UFP (Fig. 2; Zhao et al. in prep). The Kruskal-Wallis test results reveal that several demographic variables—particularly age, income, employment, and education—were consistently associated with significant differences across all behavioral measures. In addition, our results also showed that different private-sphere behaviors—donating, engaging, and purchasing—were each affected by a unique and distinct combination of psychological and contextual factors. For example, the intent to donate towards UFP was significantly affected by social norm, establishing it as a primarily socially motivated action where individuals appear to be influenced by the perceived actions and expectations of their community. The model for direct engagement was overwhelmingly explained by practical factors, whereas the decision to purchase UFP-related products was most strongly affected by a direct path from ascription of responsibility. In contrast, for behavior towards public policy support, our model revealed that both experience and awareness of UFP were significant positive factors. Overall, our results revealed the specific kind and relative importance of social enabling factors for UFP.

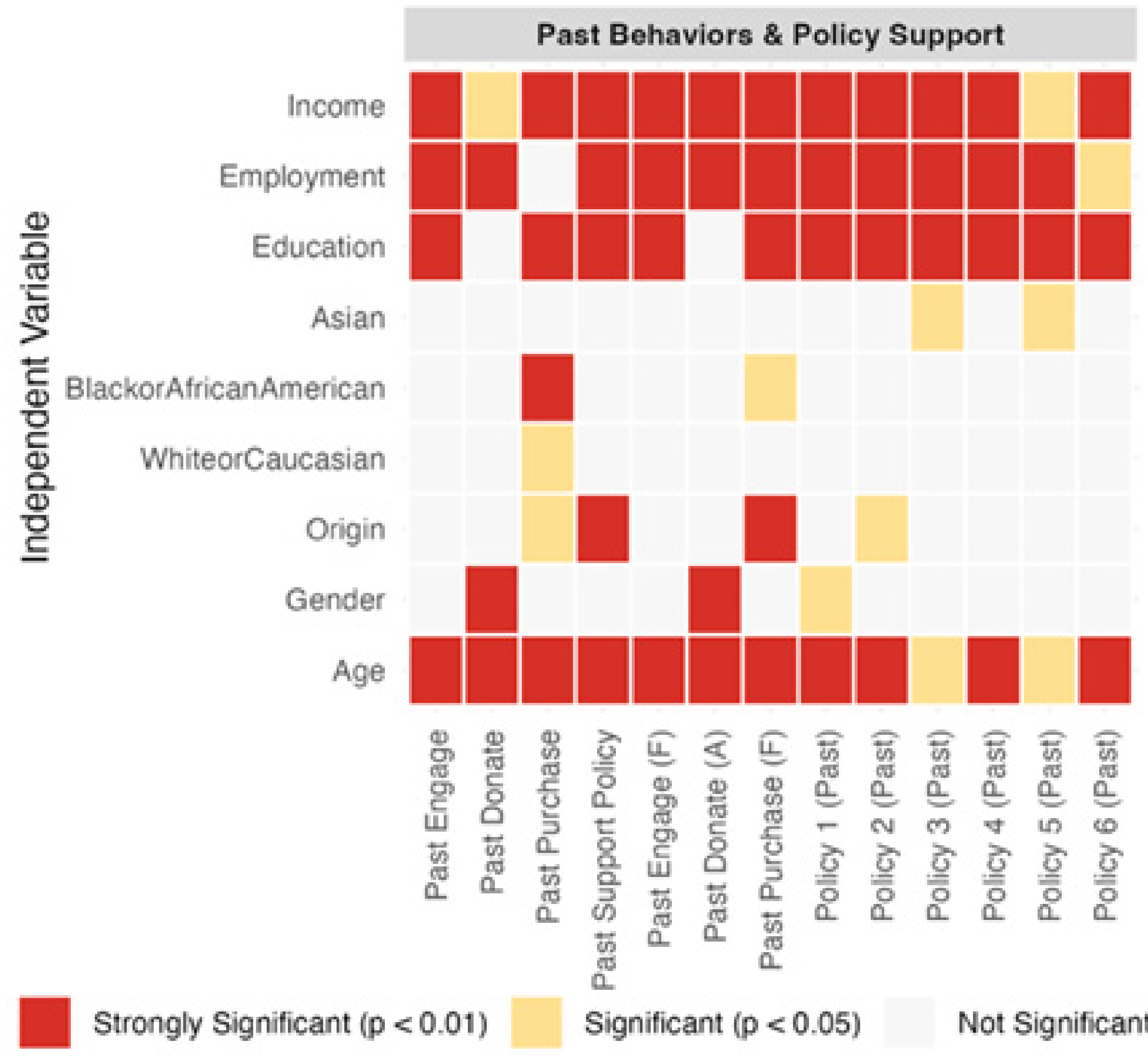
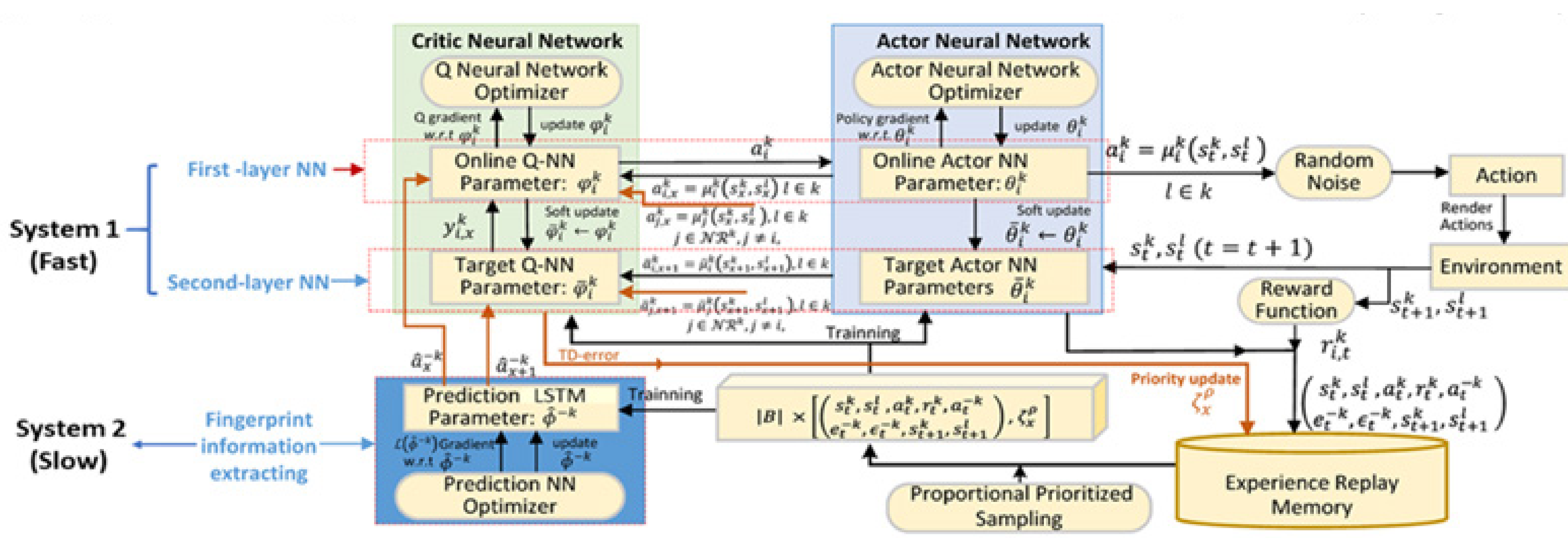


Fig. 2. Heatmap of demographic group differences in supportive behaviors and policy support for urban food production in south Florida. This heatmap summarizes the significance of group differences (based on Kruskal-Wallis tests) between demographic variables and various outcome measures related to support for urban agriculture (Zhao et al., In prep).

For the third objective, our designed AI analytical framework was capable to integrating and processing multi-source and high-resolution satellite imagery for scoping UFP potential sites, and overall Sentinel-2 with visible, near infrared and shortwave infrared sensors overperformed other datasets (e.g., SPOT) for identifying suitable vacant lots and sites. In addition, we utilized other data sources (e.g., land use, zoning, social media data, etc.) and performed clustering analysis based on the screened sites and site attributes to agglomerate potential UFP sites in a polycentric manner and in a multidimensional space to explore their trajectory of growth. We further designed AI techniques that can be used to evaluate the suitability and sustainability for UFP expansion (Fig. 3; Chang et al. in prep) that involves in a comparative study between existing and new UFP sites through the Fingerprint Networked Reinforcement Learning (FNRL) to explore interactions in the symbiosis relationships among different resource sectors and relevant stakeholders (i.e., multi-agents) and to synergize across-sectorial advantages. Overall, our results indicate that this analytical framework can be used as a powerful tool for planning and development of UFP sites. In particular, our initial testing showed that this AI-approach performed better for (peri) urban farms and community gardens than other UFP types. Our next step is to collect more field data of existing UFP sites in the study region for fine-tune the AI model and model result validation.

Fig. 3. Novel model architecture of a Long Short-Term Memory (LSTM)-based Fingerprint Networked Reinforcement Learning (FNRL) that shows multi-agent interaction based on multi-modal nonlinear and nonstationary data streams (Chang et al. in prep).



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Enhance Floridians' Quality of Life

This priority area is defined as:

FNGLA supports research that will improve or enhance the quality of life for Floridians.

FNGLA supported one project under this priority area, and that summary is on pages 51-56.

Providing plants that best stablize coastlines: Seeking smooth cordgrad (*Spartina alterniflora*) traits for Living Shorelines

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CO-PI: **Laura Reynolds, Soil Water and Ecosystem Services**

ABSTRACT

The ecological and social services offered through coastal systems, including shoreline stabilization, erosion control, water filtration, and recreation, are negatively impacted by environmental degradation. Coastal restoration can return these ecosystem functions, but trait differences in planted material can influence the degree to which functions are returned. For monospecific plant communities like smooth cordgrass (*Spartina alterniflora*, hereafter *Spartina*), trait differences are linked to genetic identity, elevating consideration of genetic fitness of coastal plantings. Populations with higher genetic variation tend to recover more effectively from disturbances, highlighting the importance of conserving genetic diversity in restoration projects. Living shorelines (LSLs) with *Spartina* as plant material serve as a shoreline stabilization technique that helps prevent coastal degradation and promote ecological, social, and economic benefits. Not all *Spartina* exhibit the same traits; some have larger clump area, increased belowground biomass, or higher shoot density, all of which may help LSLs contribute to ecosystem services. Success in coastal restoration using *Spartina* depends on the source and quality of plant material. Different genotypes can vary widely in traits like growth, biomass, and stability, even across small geographic distances. We measured traits important for ecosystem services from five native *Spartina* populations along both coasts of Florida, conducted a greenhouse study to distinguish advantageous traits for LSLs, and characterized population genetics using microsatellites to compare genotypes.

OBJECTIVES

We assessed genotypes from natural systems of *Spartina* to understand how sourcing from natural environments may provide the traits advantageous in LSLs exhibited by *Spartina* for the native plant industry. To meet this objective, we proposed four tasks: Task 1) Survey morphological traits of natural populations; Task 2) Genotype natural population; Task 3) Screen genotypes for advantageous traits in a common garden and Task 4) This final report and slideshow summary.

METHODS

Site Selection

Spartina communities were assessed along both coasts of Florida from five natural saltmarsh populations. All chosen study systems are considered natural marshes and contain *Spartina* mainly as a monoculture along with other saltmarsh species, like Juncus roemarianus and Rhizophera mangle. Two sites were *Spartina* populations along the Atlantic coast of Florida (Pumpkin Hill Creek Preserve State Park, PMK; and Tomoka State Park, TOM) and three sites were *Spartina* populations along the Gulf coast of Florida (Big Lagoon State Park, BLA; Cedar Key Cemetery Point Park, CKC; and Werner-Boyce Salt Springs State Park, WEB; Figure 1,Table 1). Experiments were conducted at the University of Florida's Environmental Horticulture Greenhouse Complex (GNV).

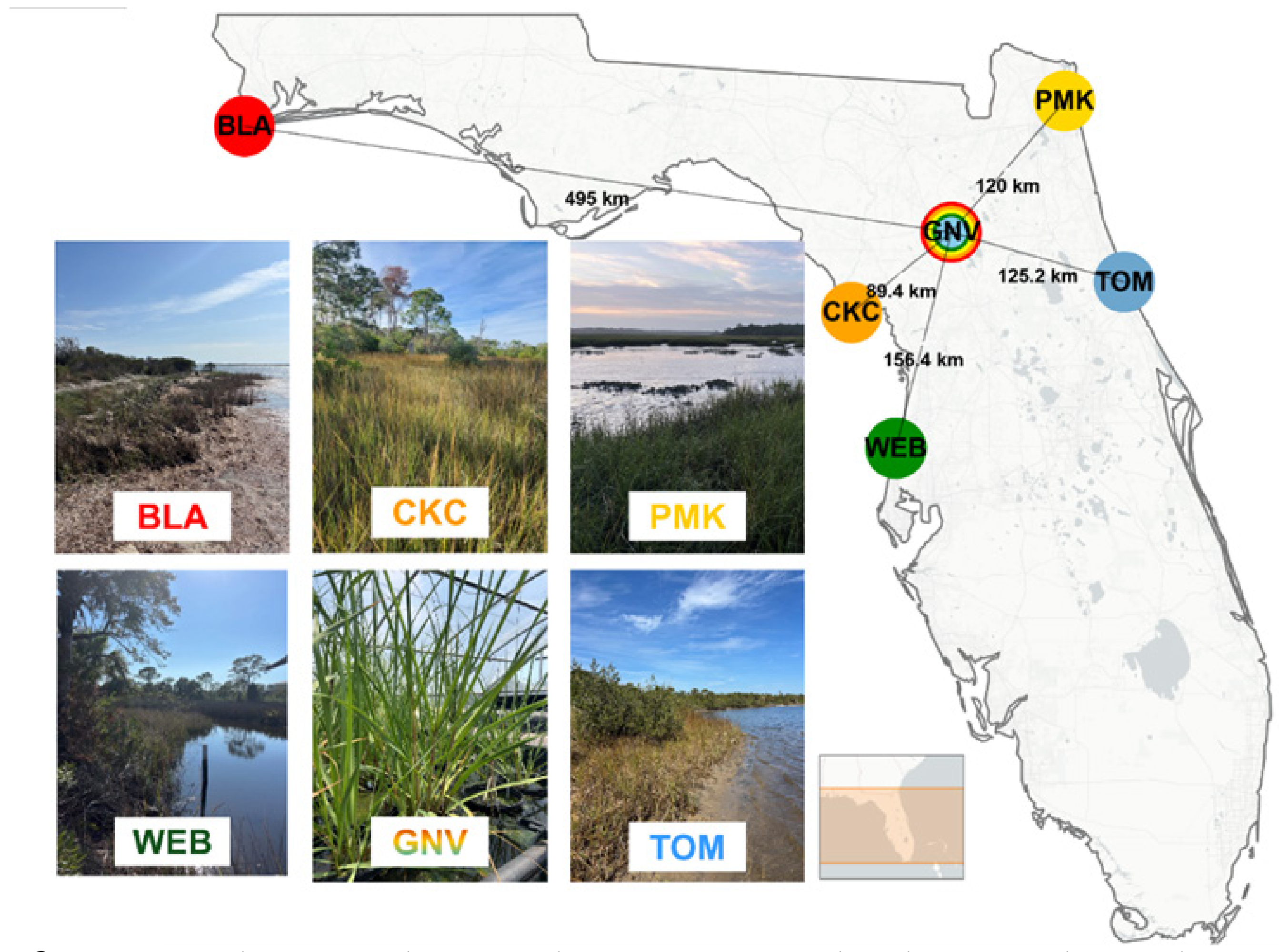


Figure 1. Map of natural marshes where morphological and genetic analysis took place

Experimental Design
At each site, we conducted a morphological survey, collected genetic samples, and collected *Spartina* shoots for a common garden study. Collection from all sites occurred in February 2025.

Task 1: Morphological Survey
At each site, we haphazardly surveyed 30 points, at least five meters away from each other, as standard in other *Spartina* projects. From each site, five measurements of each trait from 30 quadrat surveys were taken, including shoot height, leaf count, leaf length and leaf width and were recorded and averaged for data analysis. For stem density, there were six measurements haphazardly taken out of the 30 quadrats.

Task 2: Genetic Analysis
To characterize intraspecific and interspecific genetics of natural *Spartina* populations, we collected 30 individuals from each site, yielding 150 samples for genomic DNA extraction and PCR analysis. Samples were sent to Arizona Genetics Core lab for fragment analysis. We extracted DNA from each sample with the Qiagen DNeasy plant extraction kits. We then amplified DNA at eleven microsatellite loci (SPAR.02, SPAR.03, SPAR.05, SPAR.07, SPAR.08, SPAR.09 and SPAR.10 (Blum et al., 2004) SPAR.14, SPAR.16, SPAR.20 and SPAR.34 from (Sloop et al., 2005)) using standard PCR techniques (Zerebecki, 2018). PCR products were analyzed on a ABI3730 DNA Analyzer at the University of Arizona Genetics Core and scored using the software Geneious. Population differentiation was estimated as FST, calculated using the software GenAlEx (Peakall & Smouse, 2012).

Task 3: Screen Genotypes for Advantageous Traits
In addition to field measured traits, a common greenhouse study evaluated morphological traits from the five natural sites in order to screen for advantageous traits by observing the morphological traits and the speed of production. Ten individuals, all under 100 cm, were collected from each site to grow in a common garden. The five different sources for use in experiments were collected and planted in February 2025. We collected plants with trowel to shallow-dig plants from at least 5 meters apart and storing them in marsh waters in bins for transport to the greenhouse, where they were planted in 2-gallon pots within 72 hours. Media treatments were combined in a batch soil mixer using sand sourced from Argos USA Corp. (Atlanta, GA) and Pro-Mix BX general-use potting media manufactured by Premier Tech Horticulture (Rivière-du-Loup, Québec, Canada), to create two substrate treatments. The "Organic" substrate was composed of 75% sand and 25% media by volume. A controlled-release fertilizer, Osmocote 12-12-12 (ICL Specialty Fertilizers, Dublin, OH), was added at a rate of 3.4 g/L. Salinity was maintained at 20 ppt using Instant Ocean Sea Salt (Spectrum Brands, Blacksburg, VA), with a greenhouse bench refilled to a constant water level as needed. Initial aboveground and belowground biomass was calculated from additional plants taken directly from the marsh representative of transplanted cohort and under 100 cm. These plants were clipped, rinsed and stored in paper bags in which they were dried in the forced air oven at 65 Celsius until constant dry weight (48 hours) and then weighed.

RESULTS

Task 1: Morphological Survey

The observed trait differences across sites demonstrate how *Spartina* populations allocate resources differently depending on environmental origin, which reflects adaptive strategies. In the field, WEB and PMK exhibited greater shoot height, leaf width, and leaf length, indicating aboveground growth in their natural environment, potentially enhancing light capture and sediment trapping, which is important for shoreline stabilization. TOM, by contrast, showed lower biomass and fewer shoots, suggesting resource limitation or a strategy favoring belowground persistence or survival under stress. BLA and CKC showed moderate traits, which reflecting more balanced allocation between root and shoot systems. This variation highlights the role of trait expression, which is important for selecting *Spartina* ecotypes with traits that support desired ecosystem services like erosion control or wave attenuation.

Task 2: Genetic Analysis

Pairwise genetic differentiation (Fst) displays the proportion of genetic variance between population differences. BLA-WEB (.39), TOM-WEB (.386), and BLA-CKC (0.341) have the strongest differentiation. PMK-WEB (0.197) has the lowest differentiation, followed by PMK-CKC (0.239), TOM-PMK (0.240), and PMK-BLA (0.268). WEB appears to be the most genetically distinct from the other populations. PMK, CKC, and TOM are less differentiated from each other. In a restoration context, these sources have high genetic diversity and similarity, which may avoid the introduction of maladapted or overly unique genotypes.

Analysis Of Molecular Variance (AMOVA) shows that *Spartina* has genetic diversity at multiple levels, among populations (structure), among individuals (diversity within sites), and within individuals (heterozygosity). The AMOVA shows that 30% of total variation is due to differences among populations. 29% of variation was explained by individuals within the same population, which shows that there was individual-level diversity that may be caused by sexual reproduction or clonal diversity. 40% of variation is due to within-individual variation, meaning many individuals are heterozygous. A large proportion of genetic diversity exists at the individual level, inside each plant, rather than between individuals or population. This suggests that individuals carry diverse alleles, and individuals contribute to the total genetic diversity even before comparing them to others in the population.

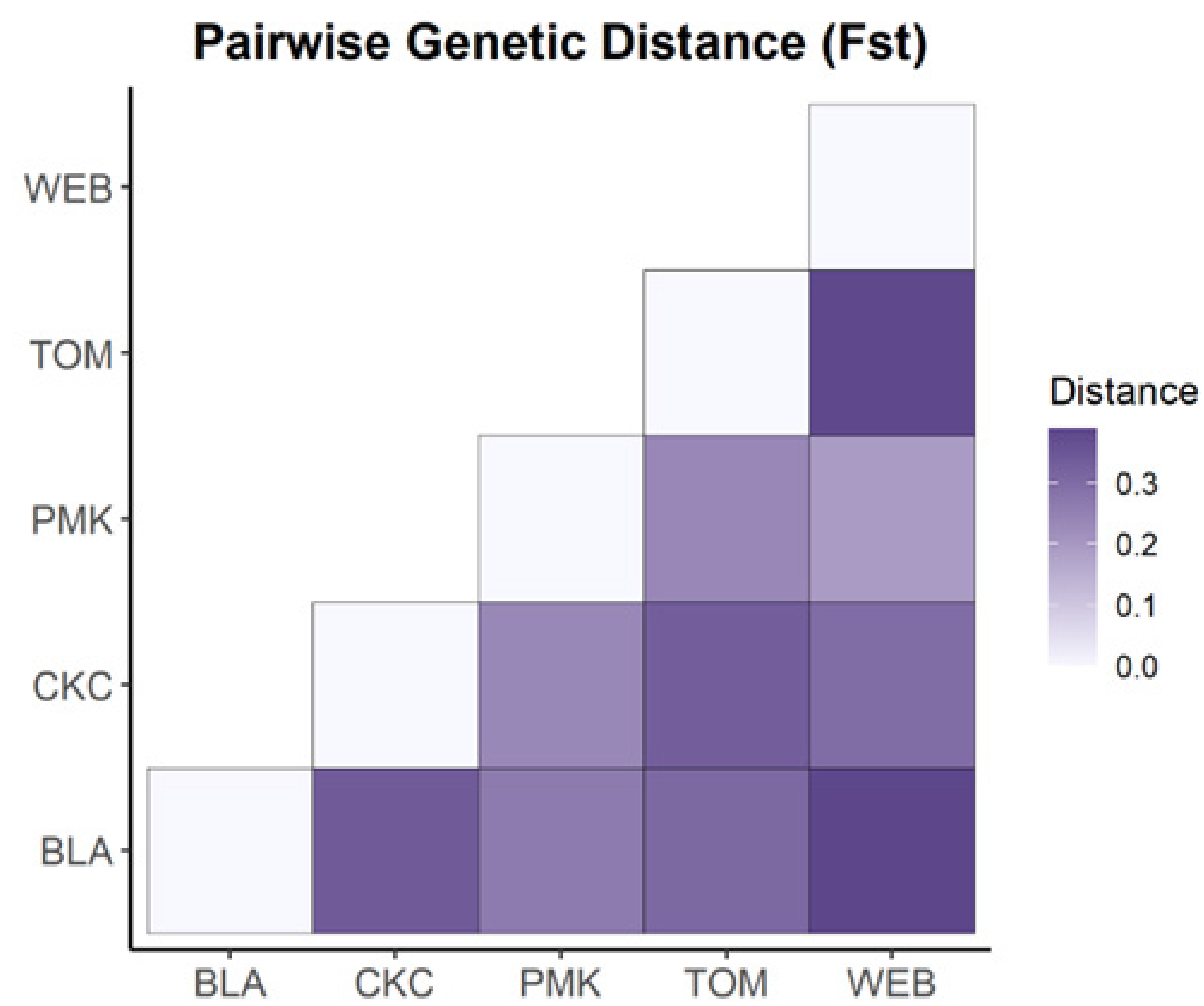


Figure 2. Pairwise genetic differentiation (Fst) among natural populations of Spartina based on multilocus genotypes.

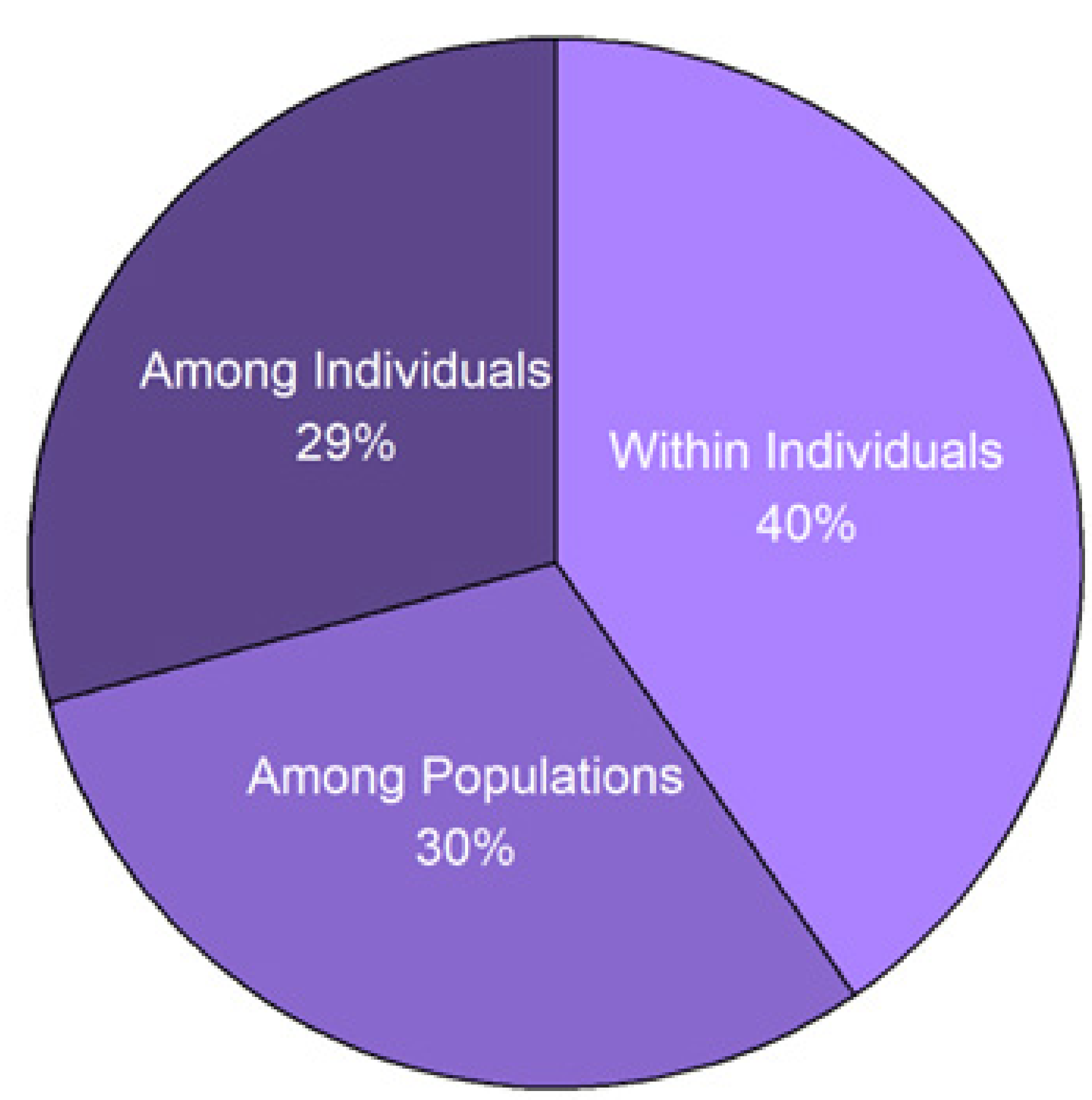


Figure 3.Analysis of molecular variance (AMOVA) showing the partitioning of genetic variation.

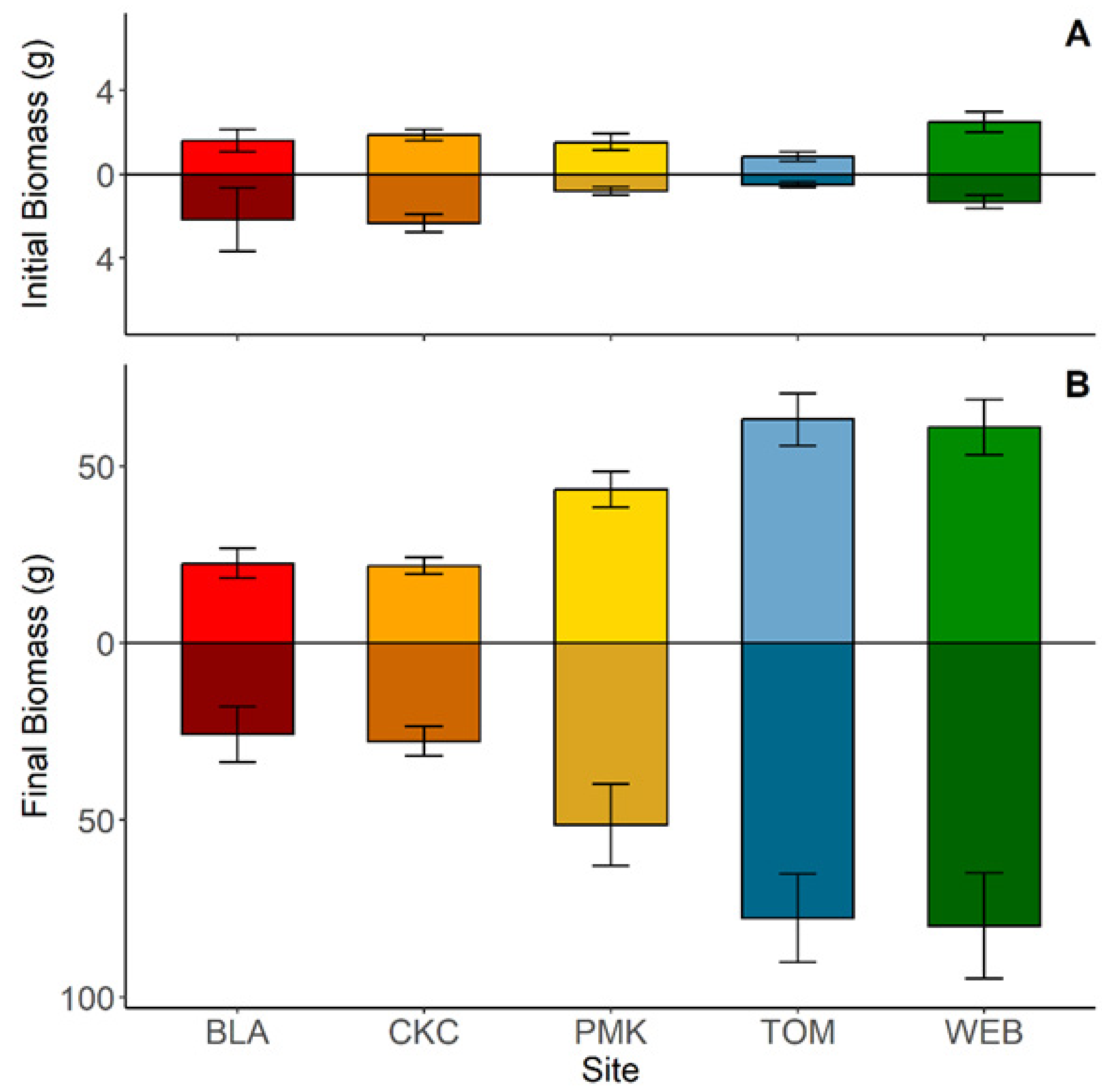


Figure 6. Mean initial (A) and final (B) aboveground and belowground biomass (g) of *Spartina* across five natural marshes (BLA, CKC, PMK, TOM, WEB).

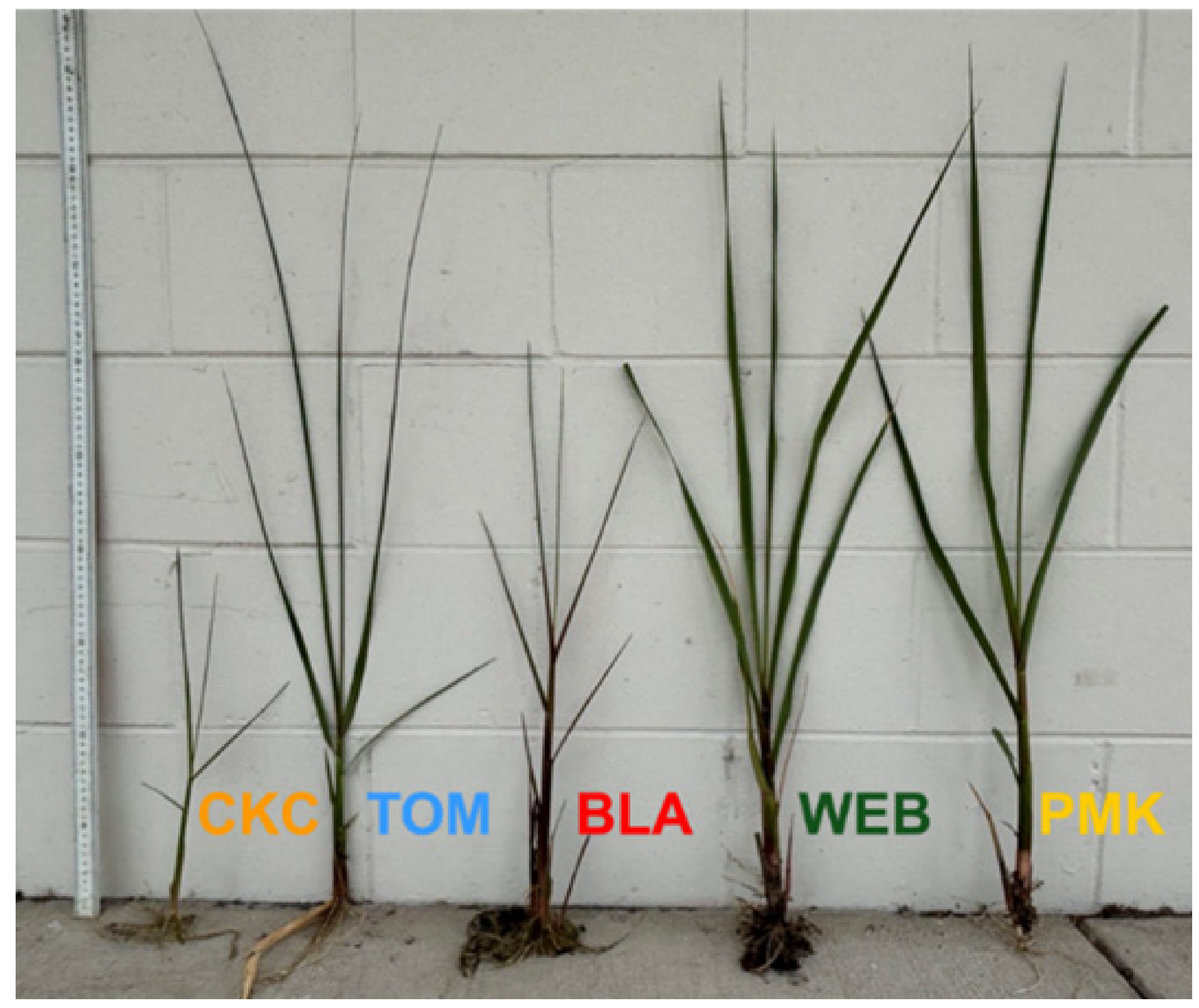
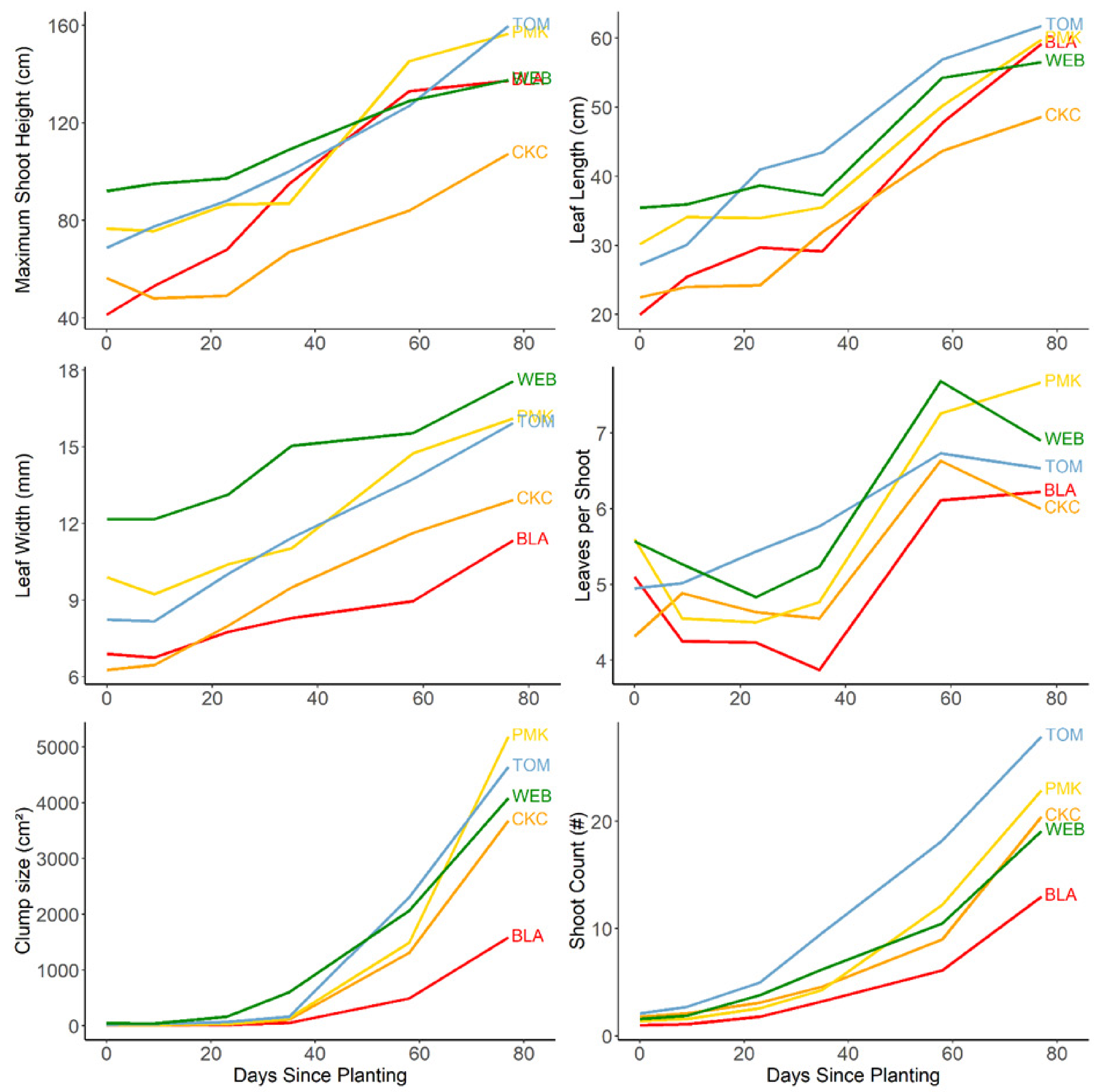


Figure 4. Representative shoot from each *Spartina* population: CKC, TOM, BLA, WEB, and PMK. Shoot size reflects aboveground variation at end of experiment. Belowground biomass is not representative of total root or rhizome mass.

Figure 5. Growth trajectories of *Spartina* morphological traits across five source populations over a 77-day common garden experiment in UF Greenhouse. Each panel shows site-level mean values for one trait measured at six time points: maximum shoot height, average leaf length, average leaf width, average number of leaves per shoot, average clump area, and average shoot count per pot. Lines represent populations from distinct collection sites (BLA, CKC, PMK, TOM, WEB), colored consistently across panels.



Task 3: Screen Genotypes for Advantageous Traits

Data was collected biweekly from February 2025 to March 2025, triweekly from March 2025 to May 2025, and at the conclusion of the experiment on May 6, 2025. Plant traits linked to LSL function were measured on all plants throughout the 77-day experiment, resulting in six sampling events. Traits included maximum shoot height, random shoot height, number of shoots, clump area, leaves per shoot, leaf width, and leaf length (Figure 5). Initial and Final Biomass serve as a plant trait metric for LSL function, providing two timepoints for biomass (Figure 6). Three of the fifty plants died at different stages of the experiment, one from PMK, one from CKC, and one from BLA, which excluded from trait measurements following their death.

TOM had the greatest average for five variables: maximum shoot height, random shoot height, leaf length, number of shoots, and final aboveground biomass. PMK had the greatest average in two variables: leaves per shoot and clump area. WEB had the greatest averages for two variables: leaf width and final belowground biomass. TOM, PMK, and WEB consistently performed well across trait metrics and consistently had the highest average among variables, indicating genetic and environmental potential for restoration projects. For example, plants from TOM had the greatest average final maximum height, followed by PMK, WEB, BLA, and CKC. CKC outperformed WEB for top three in number of shoots, with WEB ranking slightly lower. Also, BLA outperformed WEB for top three in leaf length, with BLA ranking higher than WEB.

CONCLUSIONS

Evaluating *Spartina* in both its natural environment and under controlled conditions in a common garden highlights the critical role of trait plasticity and genetic composition in determining suitability for LSL applications. While there were clear differences in initial traits among the different populations in the field, final trait expression and biomass production from the common garden experiment revealed clear variation in growth trends among the five natural *Spartina* populations. Under controlled conditions in the common garden, natural sites TOM, WEB, and PMK consistently demonstrated strong above- and belowground performance, which suggests that these populations are well-suited plant material for rapid establishment and ecosystem service delivery in LSLs. CKC and BLA exhibited more conservative growth responses which may reflect other advantages, like stress-tolerant strategies suitable for specific low-energy or resource-limited environments. Genetic analysis supported this variation, revealing moderate differentiation among populations and distinct genetic structures among some sites. The presence of substantial within-individual genetic variation (40%) and population-level structure (30%) highlights the importance of considering both trait expression and genetic background when selecting source material. These results emphasize the value of evaluating traits under controlled conditions to understand differences between populations and guide plant selection for coastal restoration projects. Results suggest that trait expression under controlled conditions, not just field-origin traits, must inform selection of sources with advantageous traits for planting in LSLs, and sourcing should also incorporate genotypic and phenotypic diversity. Incorporating trait monitoring in restoration success metrics may help identify which traits are most predictive of long-term establishment, resilience, and ecosystem service delivery across variable *Spartina* LSL and restoration sites. With this data, there is potential for more strategic sourcing of plant material, matching specific population traits to environmental contexts, and ultimately improving restoration outcomes.

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FLORIDA NURSERY, GROWERS AND LANDSCAPE ASSOCIATION
Leading Florida's Green Industry

Smooth Cordgrass (*Spartina alterniflora*)
Recommendations for Growers

1 Prioritize Propagation of Certain Sources

- PMK and WEB consistently perform well across key morphological traits.
- Use these sources for high-energy environments where vegetative spread and sediment stabilization are critical.

2 Consider Multiple Sources

- Trait plasticity varies between sites. Some sites perform better in the greenhouse than in the field.
- Planting multiple sources can increase resilience to unpredictable coastal stressors.

3 Leverage Trait-Specific Strengths

- PMK: Shoot production =High biomass & erosion control
- WEB: Consistent height/ width =Sediment trapping
- CKC: Smaller plant on average = Lower energy systems
- BLA: Responds well to greenhouse =Adaptive potential
- TOM: Tall shoots in greenhouse =Fit for mid-elevation marshes

4 Stock High-Tillering Genotypes in Nursies

- High number of shoots per plant is ideal for plug multiplication and nursery production.
- Recommended Source: TOM, PMK, & CKC

5 Support Seed/ Plug Production

- Develop nursery contracts and seed increase programs focused on high-performing genotypes
- Ensures a ready supply of genetically and ecologically fit plants.

6 Consider Time-to-Trait Performance

- PMK and WEB reached key trait thresholds quickly in the greenhouse.
- Choose sources for fast-track nursery production when time is limited before planting windows.

7 Incorporate Trait Monitoring in Restoration Success Metrics

- Monitoring traits provides early indicators of restoration trajectory.
- Stakeholders should include trait-based success metrics in post-planting assessments.

List of FNGLA Funded Projects Since 2005-06

2005-2006

PI/Co-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 Stability 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 nHouse 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/Co-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/Co-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/Co-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/Co-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/Co-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	Soil & Water Sciences	Gainesville Campus	Enhanced Decision Capabilities for Irrigation of Container Plants

2011-2012

PI/Co-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/Co-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/Co-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/Co-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/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Mace Bauer	Entomology & Nematology	Gainesville Campus	Improve Environment and Resource Management
Nathan Boyd	Environmental Horticulture	Gulf Coast REC	Weed Management Options for Tropical Ornamentals
Paul Fisher	Horticultural Sciences	Gainesville Campus	Delivering Adequate Oxygen for Rooting of Plant Cuttings
Paul Fisher	Agricultural & Biological Engineering	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	Agricultural & Biological Engineering	Ft. Lauderdale REC	Varying Leaching Fractions and Waste Water Blends to Grow Containerized Foliage Plants
Bart Schutzman	Environmental Horticulture	Gainesville Campus	Expansion and 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
Thomas Yeager	Environmental Horticulture	Gainesville Campus	Using Leaching Fraction to Achieve Appropriate Irrigation Application Amounts

2016-2017

PI/Co-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 & 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 & 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 & 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/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Charles Guy	Environmental Horticulture	Gainesville Campus	Assessing Human Health Benefits of Gardening
Raymond Odeh	Environmental Horticulture	Gainesville Campus	
Allan Bacon	Soil and Water Science	Gainesville Campus	Long-term Recovery of Compacted Residential Soils
Eben Broadbent	Forest Resources and Conservation	Gainesville Campus	
Adam Dale	Entomology & 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	Mid-Florida REC	
H. Dail Laughinghouse	Agronomy	Ft. Lauderdale REC	Developing Effective Management Options 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	North Florida REC	

2018-2019

PI/Co-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	Gulf Coast REC	
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	Gainesville Campus	
Heqiang "Alfred" Huo	Environmental Horticulture	Mid-Florida REC	Development of Salinity Tolerant Petunia Through CRISPR/Cas9 GeneEditing
Linhchi Nguyen	Environmental Horticulture	Mid-Florida REC	
Tom Yeager	Environmental Horticulture	Gainesville Campus	Use of Reclaimed Water in Production Nurseries
Shawn Steed	Hillsborough County Extension	IFAS Extension	
Brian Bahder	Entomology & Nematology	Ft. Lauderdale REC	Evaluating vector potential of Haplaxius crudus and Idioderma virescens
Thomas Chouvenc	Entomology & 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 & Nematology	Ft. Lauderdale REC	
Andrea Lucky	Entomology & Nematology	Ft. Lauderdale REC	
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	

2019-2020

PI/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Andrew K. Koeser	Environmental Horticulture	Gulf Coast REC	Tree Preservation Ordinances in the State of Florida – How does Policy Impact Canopy Coverage?
Deborah R. Hilbert	Environmental Horticulture	Gulf Coast REC	
Drew C. McLean	Environmental Horticulture	Gulf Coast REC	
Alexander J. Reisinger	Soil and Water Sciences	Gainesville Campus	Quantifying Nitrogen Leaching from Residential Soils in Florida
Eban Bean	Agricultural and Biological Engineering	Gainesville Campus	
Mark Clark	Soil and Water Sciences	Gainesville Campus	
Laura Warner	Agricultural Education and Communication	Gainesville Campus	Environmentally Friendly Landscaping: Addressing a Need for the Communications Research
Michael Dukes	Agricultural and Biological Engineering	Gainesville Campus	
Esen Momol	Center for Landscape Conservation & Ecology	Gainesville Campus	
Eban Bean	Agricultural and Biological Engineering	Gainesville Campus	Optimizing Soil Amendment Characteristics for Improving Environmental and Resource Sustainability
Michael Dukes	Agricultural and Biological Engineering	Gainesville Campus	
Wagner Vendrame	Environmental Horticulture	Tropical REC	Pilot Study on Management Strategies of Hibiscus Bud Weevil
Catharine Mannion	Entomology and Nematology	Tropical REC	
Romina Gazis	Plant Pathology	Tropical REC	
Adam G. Dale	Entomology and Nematology	Gainesville Campus	Determining the Effects of St. Augustinegrass Cultivar Diversity on Belowground Ecosystem Processes
Dorota Porazinska	Entomology and Nematology	Gainesville Campus	
Xavier Martini	Entomology and Nematology	North Florida REC	Survey of the Invasive Mite Phyllocoptes Fructiphilus Rose Rosette Virus (RRV) and of its Predatory Mites in Northern Florida
Austin N. Fifev	Entomology and Nematology	North Florida REC	
Catharine Mannion	Entomology and Nematology	Tropical REC	Hibiscus Bud Weevil – A New Threat to Hibiscus Production
William Schal	IFAS Extension	Tropical REC	
Alfred Huo	Envirionmental Horticulture	Mid-Florida REC	Effect of Carbon and SiO2 Nanoparticles on Rooting and Growth of Different Ornamental Plants
Roger Kjelgren	Environmental Horticulture	Mid-Florida REC	

2020-2021

PI/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Mysha Clarke	School of Forest, Fisheries, and Geomatics Sciences	Gainesville Campus	The role of gardening activities on resilience quality of life (especially during the COVID-19 pandemic)
Andrew Koeser	Environmental Horticulture	Gulf Coast REC	Determining Minimum Planting Widths for the Small-Stature Trees in Compact Developments
Deb Hilbert	Environmental Horticulture	Gulf Coast REC	
Drew McLean	Environmental Horticulture	Gulf Coast REC	
Marco Schiavon	Environmental Horticulture	Ft. Lauderdale REC	Construction of plots for long term evaluation of effects of effluent water on turfgrass
Bryan Unruh	Environmental Horticulture	West Florida REC	Establishment and Evaluation of Mixed Species Landscapes Comprising Perennial Grasses and Legumes
Ann Blount	Agronomy	Gainesville Campus	
Adam Dale	Entomology and Nematology	Gainesville Campus	
Thomas Yeager	Environmental Horticulture	Gainesville Campus	Reducing Nutrient Loss from Containers
Jeff Million	Environmental Horticulture	Gainesville Campus	
Brian Bahder	Entomology and Nematology	Ft. Lauderdale REC	Measuring degradation of insect and phytoplasma DNA on sticky traps
Adam Dale	Entomology and Nematology	Gainesville Campus	Developing methods for biodiversity-certified ornamental plant production
Jaret Daniels	Florida Museum of Natural History	Gainesville Campus	
Chris Marble	Environmental Horticulture	Mid-Florida REC	Finding, Evaluating, and Fine-tuning Herbicide Alternatives to Glyphosate for the Florida Landscape Industry
Anthony Witcher	Tennessee State University		
Gary Vallad	Plant Pathology	Gulf Coast REC	Viburnum Foliar Disease Management; Downy Mildew & Cercospora Leaf Spot
Shawn Steed	Extension Agent lll	Hillsborough City	
Fernando Alferez	Horticultural Sciences	Southwest Florida REC	Improving seed production and availability of major citrus rootstocks by determining seed viability during maturation and storage
Manjul Dutt	Horticultural Sciences	Citrus REC	

2021-2022

PI/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Basil Iannone	Forest, Fisheries & Geomatics Sciences	Gainesville Main Campus	How does plant diversity, vegetation structure, and management contribute to ecosystem services in residential landscaping?
Jesse Jones	Forest, Fisheries & Geomatics Sciences	Gainesville Main Campus	
Brian Bahder	Entomology and Nematology	Ft. Lauderdale REC	Assessment of insecticides for control of Haplaxius crudus, the vector of lethal bronzing
De-Fen Mou	Entomology and Nematology	Ft. Lauderdale REC	
Braham Dhillon	Plant Pathology	Ft. Lauderdale REC	Detecting overlap of pathogen presence and trunk rot in palms
Adam Dale	Entomology and Nematology	Gainesville Main Campus	Integrating Pest and Pollinator Management Strategies for Ornamental Plant Production
Jaret Daniels	Florida Museum of Natural History	Gainesville Main Campus	
Bernadette Mach	Entomology and Nematology	Gainesville Main Campus	
Ramdas Kanissery	Horticultural Sciences	Southwest Florida REC	"Place it and forget it" - Super absorbent medium for long-term weed suppression and plant-safe herbicide placement in nursery production
Stephen "Chris" Marble	Environmental Horticulture	Mid-Florida REC	Finding, Evaluating, and Fine-tuning Herbicide Alternatives to Glyphosate for the Florida Landscape Industry: PART II
Gary Vallad	Plant Pathology	Gulf Coast REC	Viburnum Foliar Disease Management: Disease mitigation during plant propagation
Shawn Steed	Environmental Horticulture	UF/IFAS Extension	
Wael Elwakil	Hillsborough County Extension	UF/IFAS Extension	
Wagner Vendrame	Environmental Horticulture	Gainesville Main Campus	Improved Foliage Production Using Micropropagation - The Monstera Model
Jianping Wang	Agronomy	Gainesville Main Campus	Developing a rapid molecular method to assess sugarcane mosaic virus (SCMV) load in turfgrass breeding materials
Kevin Kenworthy	Agronomy	Gainesville Main Campus	
Philip Harmon	Plant Pathology	Gainesville Main Campus	

2022-2023

PI/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Brooks Parrish	Environmental Horticulture	Gulf Coast REC	Developing Sterile, Non-invasive Porterweed for the Florida Nursery and Landscape Industry and its Consumers
Zhanao Deng	Environmental Horticulture	Gulf Coast REC	
Sandra Wilson	Environmental Horticulture	Gainesville Main Campus	
Jianping Wang	Agronomy	Gainesville Main Campus	Detecting Genetic Variation of Sugarcane Mosaic Virus (SCMV) in St. Augustinegrass Cultivars
Camila Sanchez	Agronomy	Gainesville Main Campus	
Paul Fisher	Environmental Horticulture	Gainesville Main Campus	Next Level Young Plant Environmental Control
Rachel Mallinger	Entomology & Nematology	Gainesville Main Campus	Developing Water-efficient Pollinator Plants for Florida
Xavier Martini	Entomology & Nematology	North Florida REC - Quincy	
Mica McMillan	Environmental Horticulture	Ft. Lauderdale REC	Palm Nutrition Injection - Does it Work and For How Long?
Kimberly Moore	Environmental Horticulture	Ft. Lauderdale REC	
Adam Dale	Entomology & Nematology	Gainesville Main Campus	Mitigating Risk and Developing More Efficient Management Tactics for Lethal Bronzing
Jacqueline Buenrostro	Entomology & Nematology	Gainesville Main Campus	
Brian Bahder	Entomology & Nematology	Ft. Lauderdale REC	
Carrie Harmon	Plant Pathology	Gainesville Main Campus	
Lance Osborne	Entomology & Nematology	Mid-Florida REC	Monitoring and Testing of Management Strategies for Thrips parvispinus (Karny) in Palm Beach County
Muhammad Ahmed	USDA Agricultural Research Service	Ft. Pierce	
Cindy McKenzie	USDA Agricultural Research Service	Ft. Pierce	
John Roberts	County Extension	Palm Beach County	
Nicole Quinn	Entomology & Nematology	Indian River REC	Implementation of Rapid Testing Kits in Commercialn Nurseries to Distinguish Lebbeck Mealybug (Nipaecoccus Viridis) from Other Mealybugs in Florida
Muhammad Ahmed	USDA Agricultural Research Service	Ft. Pierce	
Lance Osborne	Entomology & Nematology	Mid-Florida REC	
Alexandra Revynthi	Entomology & Nematology	Tropical REC	Evaluation of the Parasitoid Catolaccus hunteri as a Biocontrol Agent of the Hibiscus Bud Weevil

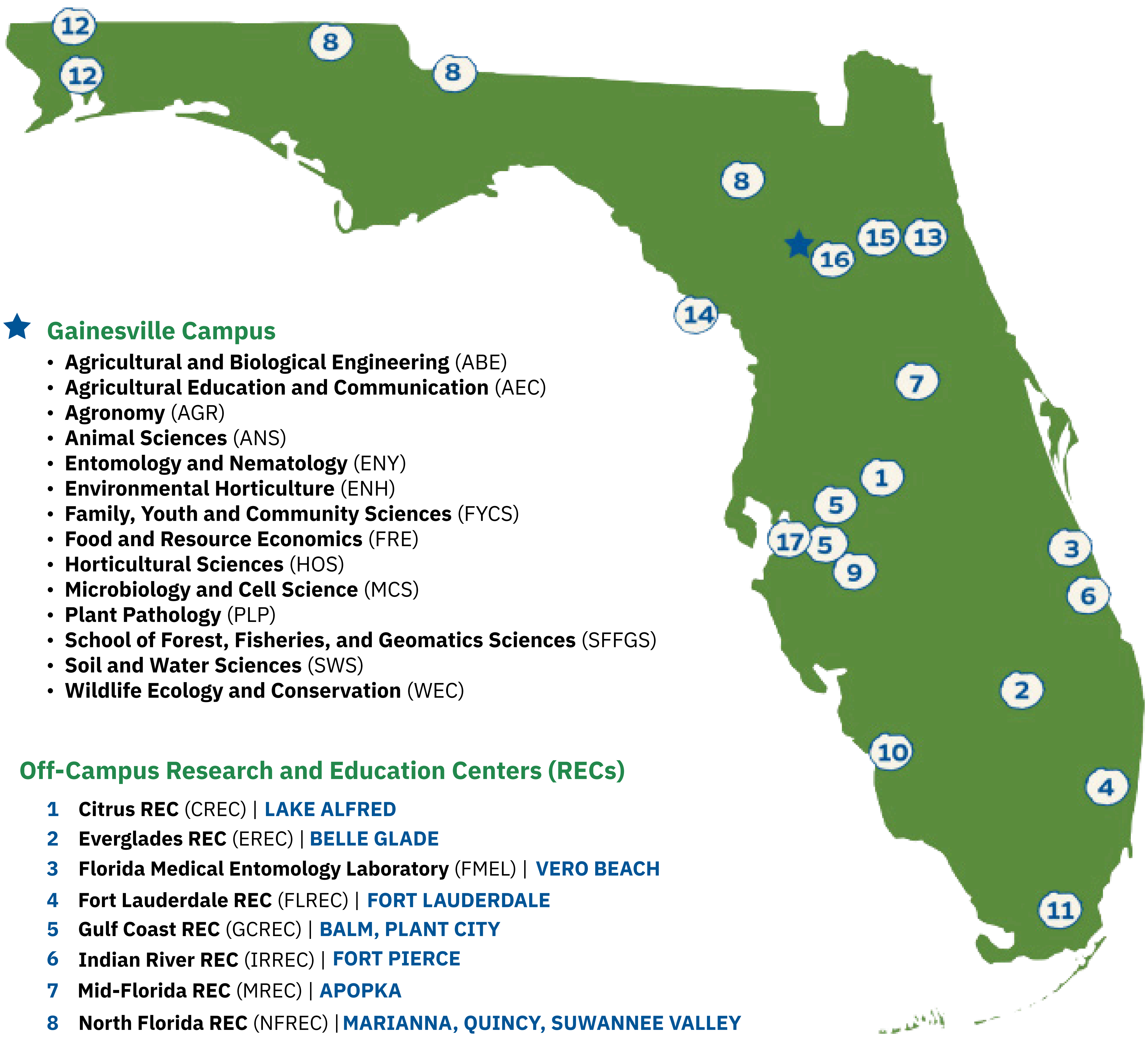
2023-2024

PI/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Zhanao Deng	Environmental Horticulture	Gulf Coast REC	Releasing Sterile, Non-invasive Porterweed for the Florida Nursery and Landscape Industry and its Consumers
Brooks Parish	Environmental Horticulture	Gulf Coast REC	
Sandra Wilson	Environmental Horticulture	Gainesville Main Campus	
Heqiang "Alfred" Huo	Environmental Horticulture	Mid-Florida REC	Trial Test for Heat-tolerant Wax Begonia Hybrids for Florida's Nursery and Landscaping Industry
Elizabeth Felter	Extension	Central Florida	
Jamielyn Daugherty	Extension	Lake County	
Marco Shiavon	Environmental Horticulture	Fort Lauderdale REC	Blackout Fertilizer Period and Soil Amendments for Reduced Supplemental Irrigation for Residential Turfgrass in Florida
Alejandra Sierra	Environmental Horticulture	Fort Lauderdale REC	
Marco Shiavon	Environmental Horticulture	Fort Lauderdale REC	Nutrient Leaching from St. Augustinegrass Lawns Associated with Reclaimed Effluent Water
Pat McLoughlin	Environmental Horticulture	Fort Lauderdale REC	
Brian Bahder	Environmental Horticulture	Fort Lauderdale REC	Development of molecular Diagnostic Tools for Plant Pathogens that Pose a Risk to Florida Agriculture
Gilles Basset	Horticultural Sciences	Gainesville Main Campus	Screening of Potent New Herbicides for Weed Control
Braham Dhillon	Plant Pathology	Fort Lauderdale REC	Assessment of Biologicals, Funigicides, and Nanopesticides to Manage Three Lethal Fungal Pathogens of Palms
Chris Marble	Environmental Horticulture	Mid-Florida REC	Finding, Evaluating, and Fine-tuning Herbicide Alternatives to Glyphosate for the Florida Landscape Industry: Part III
Mica McMillan	Environmental Horticulture	Ft. Lauderdale REC	Using Drone Imagery to Assess Palm Health

2024-2025

PI/Co-PI NAME	HOME UNIT	LOCATION	TITLE
Yilin Zhuang	Agricultural and Biological Engineering	Mid-Florida REC	Envisioning a water-efficient green industry through stakeholder engagement
Ondine Wells	Extension	Marion County	
Brian Bahder	Entomology and Nematology	Ft. Lauderdale REC	Development of a diagnostic test for quantification of oxytetracycline in palm tissue
Adam Dale	Entomology and Nematology	Gainesville Main Campus	Improving the prevention and management of phantasma scale on landscape palms
Henry Mayer	Extension	Miami-Dade County	
Michael Orfanedes	Extension	Broward County	
Abolfazl Hajihassani	Entomology and Nematology	Ft. Lauderdale REC	A novel biological control agent for pest snails in Florida
Pawel Petelewicz	Agronomy	Gainesville Main Campus	Optimizing preemergence doveweed [Murdannia nudiflora (L.) Brenan] control strategies in Florida turfgrass
Andrew Koeser	Environmental Horticulture	Gulf Coast REC	Demand assessment for tree species utilized in Florida landscapes
Ryan Klein	Environmental Horticulture	Gainesville Main Campus	
John Roberts	Extension	Palm Beach	
Alfred Huo	Environmental Horticulture	Mid-Florida REC	Screening of novel Begonia genotypes for non-invasiveness
Sandra Wilson	Environmental Horticulture	Gainesville Main Campus	
Zhanao Deng	Environmental Horticulture	Gulf Coast REC	
Xingbo Wu	Environmental Horticulture	Tropical REC	Breeding industry-suitable tropical Hibiscus cultivars in Florida
Alexandra Revynthi	Entomology and Nematology	Tropical REC	
Jiangxiao Qiu	School of Forest, Fisheries, and Geomatic Sciences	Ft. Lauderdale REC	Developing artificial intelligence-based framework for optimal site selection to scale up urban food production
Carrie Adams	Environmental Horticulture	Gainesville Main Campus	Providing plants that best stabilize coastlines: Seeking smooth cordgrass (Spartina alterniflora) traits for Living Shorelines
Laura Reynolds	Soil Water and Ecosystem Sciences	Gainesville Main Campus	

UF/IFAS Research Units



★ **Gainesville Campus**

- **Agricultural and Biological Engineering** (ABE)
- **Agricultural Education and Communication** (AEC)
- **Agronomy** (AGR)
- **Animal Sciences** (ANS)
- **Entomology and Nematology** (ENY)
- **Environmental Horticulture** (ENH)
- **Family, Youth and Community Sciences** (FYCS)
- **Food and Resource Economics** (FRE)
- **Horticultural Sciences** (HOS)
- **Microbiology and Cell Science** (MCS)
- **Plant Pathology** (PLP)
- **School of Forest, Fisheries, and Geomatics Sciences** (SFFGS)
- **Soil and Water Sciences** (SWS)
- **Wildlife Ecology and Conservation** (WEC)

Off-Campus Research and Education Centers (RECs)

1 **Citrus REC** (CREC) | **LAKE ALFRED**
2 **Everglades REC** (EREC) | **BELLE GLADE**
3 **Florida Medical Entomology Laboratory** (FMEL) | **VERO BEACH**
4 **Fort Lauderdale REC** (FLREC) | **FORT LAUDERDALE**
5 **Gulf Coast REC** (GCREC) | **BALM, PLANT CITY**
6 **Indian River REC** (IRREC) | **FORT PIERCE**
7 **Mid-Florida REC** (MREC) | **APOPKA**
8 **North Florida REC** (NFREC) | **MARIANNA, QUINCY, SUWANNEE VALLEY**
9 **Range Cattle REC** (RCREC) | **ONA**
10 **Southwest Florida REC** (SWFREC) | **IMMOKALEE**
11 **Tropical REC** (TREC) | **HOMESTEAD**
12 **West Florida REC** (WFREC) | **JAY, MILTON**

Research and Demonstration Sites

13 **Hastings Agricultural Extension Center** (HAEC) | **HASTINGS**
14 **Nature Coast Biological Station** (NCBS) | **CEDAR KEY**
15 **Ordway-Swisher Biological Station** (OSBS) | **MELROSE**
16 **Plant Science Research and Education Unit** (PSREU) | **CITRA**
17 **Tropical Aquaculture Laboratory** (TAL) | **RUSKIN, APOLLO BEACH**

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