2024

ANNUAL REPORT

NATIONAL HORTICULTURE FOUNDATION

ABOUT US

Dedicated to Enhancing the Lives Within the Horticulture Industry Since 1987

For over 37 years, National Horticulture Foundation has been an innovator in enhancing the horticulture industry. The National Horticulture Foundation (NHF) continues to deliver research and education to a broad base of industry members. Comprised of an esteemed team of contributors, the Foundation is dedicated to seeing the industry grow and thrive well into the future. NHF understands the meaning of paying it forward and needs your help to continue its mission.

ANNUAL REPORT

OUR VISION

Guided by a vibrant network of industry professionals, the Foundation is committed to fostering the growth and sustainability of the horticulture sector for future generations. Through research initiatives, strategic partnerships, marketing strategies, and educational support, the Foundation empowers students and emerging leaders to thrive in horticulture-related fields. We are proud to play a key role in developing the next generation of industry leaders, ensuring that the industry not only survives but flourishes in the years to come.

OUR MISSION

The National Horticulture Foundation is a 501 (c)(3), non-profit organization providing funding for research and education. Its mission is to embrace the opportunity to seek out and provide support to projects relevant to the nursery and landscape industry along with addressing issues related to a diverse and changing horticulture industry.

01. Solving Industry Challenges

02. Building Future Leaders

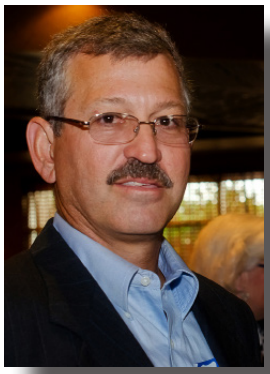
03. Focusing on A Sustainable Future

04. Securing Industry Legacy

2024 NHF BOARD OF DIRECTORS

Executive Committee

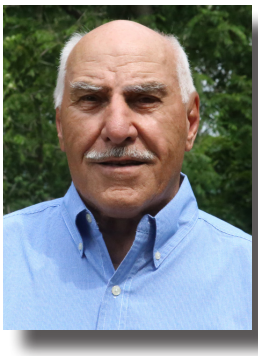
IMMEDIATE PAST PRESIDENT
Mike Marshall
Marshall Tree Farm



NHF PRESIDENT
Ed Bravo
Big Trees Plantation

TREASURER
Austin Bryant
Heart of Florida Greenhouses

Board of Directors



Dr. Joseph Cialone
Tropical Computers, Inc.

Chuck Cruse
Farm Credit of Florida

George Hackney
Hackney Nursery Inc.

Peter James
No Worries Landscape

David G. Liu
Foliage Design Systems, retired

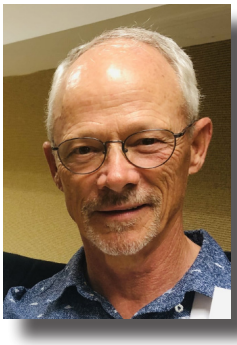
John Mendozza
Amerivest Business Brokers

Dr. John Peterson
Retired University of Florida

Dr. Wayne Mackay
Retired University of Arkansas

Kevin Riley
Retired Rockledge Gardens, Inc.

Manny Rodriguez
Plants In Design



William "Mick" Ross
Ross Garden Design

Mike Senneff
Natura

NHF Executive Director Linda Reindl
FNGLA

National Horticulture Foundation,
1533 Park Center Drive,
Orlando, FL 32835.

If you have additional questions, contact Linda Reindl, lreindl@fngla.org or call 407/295-7994 or 800/375-3642.

Ex-officio Board Members

Dr. Wagner Vendrame
University of Florida

Dr. Kirsten Pelz-Stelinski
UF | Mid Florida REC/Apopka

Liz Felter
Mid Florida REC/Apopka

LETTER FROM OUR PRESIDENT

2024 has been a whirlwind [pun intended] for the National Horticulture Foundation (NHF) and its dedicated team of volunteers, board members, directors, and staff. Despite facing significant challenges — from a contentious presidential election to the devastation of sixteen named storms and three powerful hurricanes — NHF has remained steadfast in its mission. These storms have reshaped communities, disrupted industries, and caused widespread damage. But the full impact is still unfolding, with potential long-term effects on horticultural crops and landscapes yet to be fully realized.

As NHF's past president Mike Marshall often says, "NHF takes its role of investing in the future of horticulture very seriously through research, scholarships, and education." And this year, we have remained true to that commitment. Our mission is more vital than ever as we work to solve industry challenges through research, provide scholarships to the next generation of horticultural leaders, and ensure a sustainable future for our industry.

Despite the obstacles, the NHF and our Board of Directors have achieved some exciting milestones this year. We launched a dynamic marketing campaign, featuring a 5-minute commercial produced by Pioneer Productions. This video, part of the "Viewpoint" series, will be broadcast nationwide on PBS throughout 2025. We also created shorter vignettes that will be used to promote NHF at industry events. Our marketing committee is also busy updating our website and kicking off a new E-campaign to encourage wider participation in NHF's mission.

In 2024, our Scholarship Committee reviewed 40 outstanding applications and awarded $33,836.58 in scholarships. We're also thrilled to announce the creation of the "Taking Root Scholarship," with a generous contribution of $50,000 provided by Arborjet/Ecologel, to support students pursuing studies in Arboriculture. The interior Industry Growth Fund [IIGF] also grew in principal with over $150,000 in additional contributions. In two years, this fund has grown to over $500,000, thanks to a very forward thinking sector of the industry.

On January 23rd, we will honor Mr. Joe Cialone at the International Plantscape Awards Gala at TPIE in Ft. Lauderdale. Joe has been an invaluable mentor and a driving force behind the growth of NHF and the new IIGF. His selfless service to the horticulture industry, FNGLA, and NHF will have a lasting impact for generations to come. Joe, we extend our deepest gratitude for your unwavering dedication.

Finally, NHF's endowment continues to grow, thanks to the generosity of our supporters and the careful stewardship of our volunteer board and advisors. Our board reviews financial reports quarterly, ensuring that our investments are managed responsibly to sustain the future of horticulture.

It is my great honor to serve as NHF President for the 2024-2025 term. I could not do this without the wisdom, experience, and dedication of the incredible individuals who serve on our board and committees. Their contributions are the driving force behind NHF's success.

Respectfully,
Ed Bravo, NHF President
Big Trees Plantation

FINANCIAL REVIEW

National Horticulture Foundation COMBINED Portfolio Performance

NHF Funds are overseen by NHF's investment subcommittee and managed by Edward Jones

NHF has been tasked with supporting projects in the areas of production, marketing, utilization, and distribution with an emphasis on research needs of Florida's horticulture industry. NHF was named a "national" foundation because it not only supports the horticulture industry in the state of Florida but seeks to protect the plants grown and exported to states across the country.

- In 2024, NHF supported two research project with total funding of $69,264.00
- In 2024, NHF provided 30 scholarships totalling $33,836.58
- In 2024, NHF provided $10,000 to Green Plants For Green Buildings for AIA project

TOTAL CONTRIBUTIONS SINCE 1987	$3,094,453.02
TOTAL NEW CONTRIBUTIONS IN 2024	$229,873.47
2024 SUPPORT FOR RESEARCH AND SCHOLARSHIPS	$103,100.58

ASSETS HELD AT EDWARD JONES	2022	2023	2024	2025 as of Jan. 15	Since 2009
Year Ending	$3,201,911.78	$3,546,818.01	$3,943,008.70	$3,960,796.01	$3,943,008.70
Rate of Return	–14.36%	12.24%	10.97%	–0.32%	7.12%

National Horticulture Foundation Graduate Assistantship

Graduate Assistantship Funds are managed by the University of Florida's Foundation.

CONTRIBUTION	$525,000.00
ENDOWMENT PRINCIPAL VALUE	$669,632.05

Graduate Assistantship Funds are managed by the University of Florida's Foundation. The National Horticulture Foundation's complete financial reports are available upon request from the NHF office.

2024/25 SCHOLARSHIP RECIPIENTS

On an annual basis, NHF's scholarship program continues to establish pathways for qualified students in need of financial support. It allows students to gain experience and expertise, earn post high school degrees and become active members and leaders in the horticulture industry.

Scholarships are available through the

- James H. Davis Memorial Scholarship
- NHF General Scholarship
- Hoskin/McDougald Scholarship
- NE FNGLA Chapter's Billy Barwald Scholarship
- Arborjet | Ecologel's Taking Root Scholarship

Luke Anderson
West Texas A&M University

Chauncey Barber II
North Carolina State University

Megan Bichotte
Florida Atlantic University

Whitner Bobo
Abraham Baldwin Agriculture College

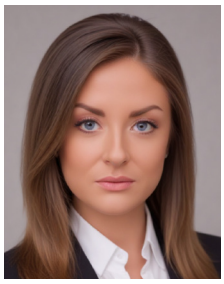
Cash Ciliento
Palm Beach State College

Sarah da Silva Benevenute
University of Florida

Cristi Demnowicz
Colorado State University

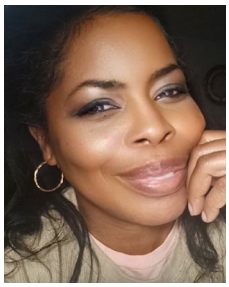
Yvonne Elmore
Indian River State College

Landon Erbrick
Auburn University



Jessica Ervien
Florida Gateway College

Tori Guarino
University of Florida



Dana Harris
North Carolina State University

Nathan Hawks
Michigan State University

Annabelle Horton
Clemson University

Addison Kust
Fox Valley Technical College

Olivia Laws
University of Kentucky

Sophie LeBard
Washington State University

Katelyn Medlin
North Carolina State University

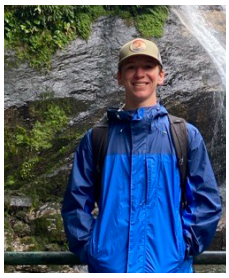
Mase Olivia Merkel
University of Florida

Ellie Miller
California Polytechnic State University

Stanley Oleckna
University of Florida

Caleb Olmstead
Tarleton State University

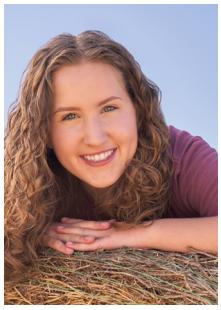
Amanda Profera
Farmingdale State College



Andrew Raffenberg
University of Florida

Philip Shaske
University of Florida

Bella Smith
Colorado State University



Carissa Sohm
Kansas State University

Cassie Valenti
University of Washington

Celia Wilson
Michigan State University

Reece Wineinger
Purdue University

The following students received scholarships but photos were not provided:
DeAree Harris, Southern University and A & M College, Hailey Martin, The University of Mount Olive; Sonya Williams Cankdeska Cikana Community College; AveryWolf, University of Alabama.

Annual Deadline for all scholarships is January 15th. Scholarships are announced in April for the following Fall/Spring Semesters

A Brand New Scholarship Opportunity for the 2025/2026 school year

One student will be awarded $2,500.

With a generous contribution of $50,000, Arborjet | Ecologel has joined forces with NHF to support the mission of providing vital funds for students pursuing careers in horticulture. NHF is excited to administer this new scholarship opportunity, which will help foster the next generation of industry leaders.

While this is a new partnership for NHF, Arborjet | Ecologel is no stranger to giving back, having already provided 54 scholarships and over $100,000 in funding to students. By teaming up with Arborjet | Ecologel, NHF aims to raise awareness for this and other scholarships available through the foundation, creating even greater opportunities for aspiring professionals.

Ideal applicants should have a passion for arboriculture or plant health care, and a desire to study science and technology that will advance the industry. We're seeking candidates with a demonstrated commitment to community engagement and a curiosity about exploring plant health care, including fields such as plant pathology, entomology, chemistry for invasive insect and disease management, arboriculture, urban forestry, horticulture, and landscape architecture. This scholarship is an exciting chance to make a real difference in the future of plant science and sustainability.

RESEARCH

Minimizing the Incidence of Edema in Ornamental Foliage Plants

Funded in 2024, two-year project conducted by Dr. Jianjun Chen, at the University of Florida's Mid-Florida Research and Education Center, in Apopka, FL, aims to further understand and mitigate edema in ornamental foliage plants.

Edema or intumescence injury is a physiological disorder occurring primarily in plant leaves. Its symptoms include abnormal, translucent, warty growth bulging out of the leaves or a water-soaked appearance with swollen areas. Edema has been reported in a wide range of horticultural crops produced in protected culture, including important ornamental foliage plants, such as Aphelandra, Begonia, Bromeliads, Dianthus, Ficus, Hibiscus, Impatiens, Pelargonium, Peperomia, Philodendron, Ruellia, Sansevieria, and Tibouchina. Since ornamental plants are priced by their aesthetic appearance (Chen et al., 2005), any growth abnormality could substantially reduce their value. Thus, minimizing the incidence of edema in foliage plants will sustain their marketability.

This project aims to evaluate how different environmental factors and cultural practices affect edema and develop methods for minimizing the incidence of edema in ornamental foliage plants.

Dr. Jianjun Chen is a professor of plant physiology in the Department of Environmental Horticulture. He is a researcher and educator who focuses on how plants function. He is specifically interested in how genetic, environmental, and cultural factors influence the growth and development of specialty crops. By better understanding how plants interact with their surroundings, horticulturalists will be able to improve current plant breeding and production practices to minimize environmental impact.

Chemical Control of the Invasive Pest Thrips *parvispinus*

Florida continues to be threatened by the invasive thrips species, Thrips *parvispinus*. Given the regulatory implications, its rapid expansion and injury, chemical control should be explored. The goal is to identify efficacious conventional and biorational insecticides against T. parvispinus. Results will be shared with ornamental growers in a workshop.

The goal is to identify efficacious conventional and biorational insecticides against T. parvispinus.

- Objective 1: Evaluate conventional insecticides under laboratory conditions
- Objective 2: Evaluate biorational insecticides under laboratory conditions
- Objective 3: Evaluate the most efficacious conventional and biorational insecticides under greenhouse conditions
- Objective 4: Inform ornamental producers about the findings of this study

Principal Researcher
Dr. Alexandra Revynthi, Tropical Research and Education Center

Dr. Revynthi is an Assistant Professor at Tropical Research and Education Center, in Homestead. She holds a PhD in acarology from University of Amsterdam with specialization in behavioral ecology of predatory mites. Dr. Revynthi has a keen interest in arthropod behavior, population dynamics, chemical ecology, biological control and IPM in ornamental crops. Current research and extension efforts focus on developing an IPM program to control the Hibiscus bud weevil (Anthonomus testaceosquamosus), a new invasive species affecting the hibiscus industry in south Florida. Moreover, Dr. Revynthi explores the potential of a predatory mite as a biocontrol agent of the Ficus whitefly (Singhiella simplex). Additionally, she studies acarine pests of agricultural importance and aim to develop IPM programs to control them. Acarine pests of interest include new invasive species such as the Lychee erinose mite (Aceria litchii) and the Hemp russet mite (Aculops cannabicola), as well as established pests.

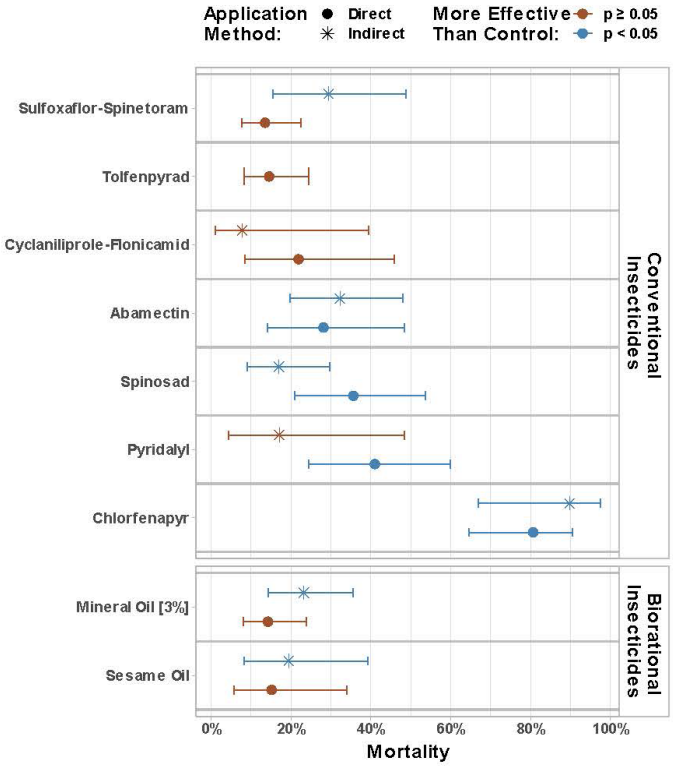
Annual Report (12/2024): Greenhouse Evaluation of Conventional and Biorational Insecticides for Managing the Invasive *Thrips parvispinus* (Thysanoptera: Thripidae)

Last year, we evaluated 32 conventional and biorational insecticides for their efficacy in reducing the survival and feeding activity of *T. parvispinus* in larval and adult stages under laboratory conditions. Twenty-one chemical insecticides, ten horticultural oils, and one insecticidal soap were tested. The nine most effective products were spinosad, chlorfenapyr, sufloxaflor-spinetoram, pyridalyl, tolfenpyrad, abamectin, cyclaniliprole-flonicamid, mineral oil [3%], and sesame oil (Table 1). In this follow-up study, we tested these products in greenhouse conditions on two primary *T. parvispinus* ornamental hosts: gardenia (*Gardenia jasminoides*) and mandevilla (*Mandevilla splendens*). We conducted contact toxicity experiments using two exposure methods: (i) direct application (curative approach) of these products on plants infested with larvae and adult thrips and (ii) indirect exposure (prophylactic approach) by evaluating residue toxicity through the application of these products on plants before infesting them with larvae and adults. In both cases, the insecticides were applied until run-off using a manual sprayer, but the infestation time was different for each exposure method. In direct application assays, ten larvae and ten adults were released two weeks before the treatment application. After treatment, we assessed the efficacy of each product by scoring the number of dead thrips obtained from three leaves harvested from the bottom, middle, and top canopy at 24 h, 7 days, and 14 days post-treatment. For residue assays, plants were first sprayed with insecticides, and ten larvae and ten adults were introduced 24 hours later. Three leaves from the bottom, middle, and top canopy were harvested 24 h, 7 days, and 14 days post-infestation. We assessed the number of live and dead thrips for each leaf and used these values to calculate the proportion of dead thrips. Fig. 1 presents the cumulative proportion of dead thrips observed on mandevilla plants across all time points (24h, 7 days, and 14 days), while Fig. 2 for gardenia plants. The experiments were carried out twice for each host plant, i.e., two blocks, each block consisting of six replicates per treatment, totaling 12 replicates ($N = 12$), including the water control. Please note that statistical analyses were performed differently for each plant species dataset. The greenhouse evaluations for gardenia (shown in Fig. 2) were just finished and therefore, a preliminary statistical analysis is presented. A similar statistical analysis to the generalized linear mixed models (GLMM) performed for mandevilla (shown in Fig. 1) is underway.

Mortality data in mandevilla plants (Fig. 1) showed that the pesticides chlorfenapyr (direct: $P \leq 0.001$; indirect: $P \leq 0.001$), abamectin (direct: $P = 0.006$; indirect: $P \leq 0.001$), and spinosad (direct: $P \leq 0.001$; indirect: $P = 0.004$) caused the highest thrips mortality in both exposure methods. However, while chlorfenapyr caused 80 to 100% mortality, spinosad caused 10 to 50% mortality, and abamectin caused 20 to 50% mortality, indicating in this case that the first was more lethal than the other two. Among horticultural oils, mineral oil [3%] (direct: $P = 0.015$; indirect: $P \leq 0.001$) and sesame oil (direct: $P = 0.33$; indirect: $P = 0.007$) promoted increased mortality in residue toxicity assays only, and mortality was below 40%. Preliminary statistical analysis using the non-parametric model Kruskal-Wallis with the thrips mortality dataset of gardenia plants showed that the pesticides chlorfenapyr ($P \leq 0.001$), pyridalyl ($P \leq 0.001$) and sufloxaflor-spinetoram ($P = 0.05$) caused the highest mortality in direct assays when compared to other products and the control (Fig. 2a). In the residue toxicity assays, none of the treatments were significantly different from the control ($P = 0.08$, Fig. 2b). Overall, a low quantity of thrips and mortality rates were obtained in the toxicity residue assays. Additionally, for both host plants tested, the majority of live and dead thrips were found in the top part of the canopy (Fig. 3). In mandevilla (Fig. 3a), the average number of thrips was significantly higher at the top compared to the middle ($P \leq 0.001$) and bottom ($P \leq 0.001$) canopy with a significant difference also observed between the middle and bottom ($P \leq 0.001$). Similarly, in gardenia (Fig. 3b), the average number of thrips was higher at the top than at the middle ($P \leq 0.001$) and bottom ($P \leq 0.001$), but no difference was observed between the middle and bottom ($P = 0.18$) canopy. Altogether, these results confirm the highest potential of chlorfenapyr, abamectin, sulfoxaflor-spinetoram, pyridalyl, and spinosad for efficacy against *T. parvispinus*. Still, they also show that each product performs differently depending on the host plant. Thus, a rotation program with these promising products is suggested, exploiting their diverse modes of action and minimizing the risks of resistance development.

Table 1. The nine products tested against *Thrips parvispinus* under greenhouse conditions. Water was used as control.

Product Name	Active Ingredient	IRAC Group	Rate
Piston	Chlorfenapyr	13	10 fl oz/ 100 gal
Xxpire	Sulfoxaflor-Spinetoram	4C-5	2.75 oz/ 100 gal
Conserve SC	Spinosad	5	0.1 fl oz/ 1 gal
Overture	Pyridalyl	Unclassified	8 oz/ 100 gal
Hachi-Hachi	Tolfenpyrad	21A	27 fl oz/ 100 gal
Timectin 0.15 EC	Abamectin	6	8 fl oz/100 gal
Pradia	Cyclaniliprole-Flonicamid	28-29	17.5 fl oz/ 100 gal
Ultrafine	Mineral oil	Unclassified	3%
Bee Safe 3-in-1	Sesame oil	Unclassified	3 fl oz/ 1 gal



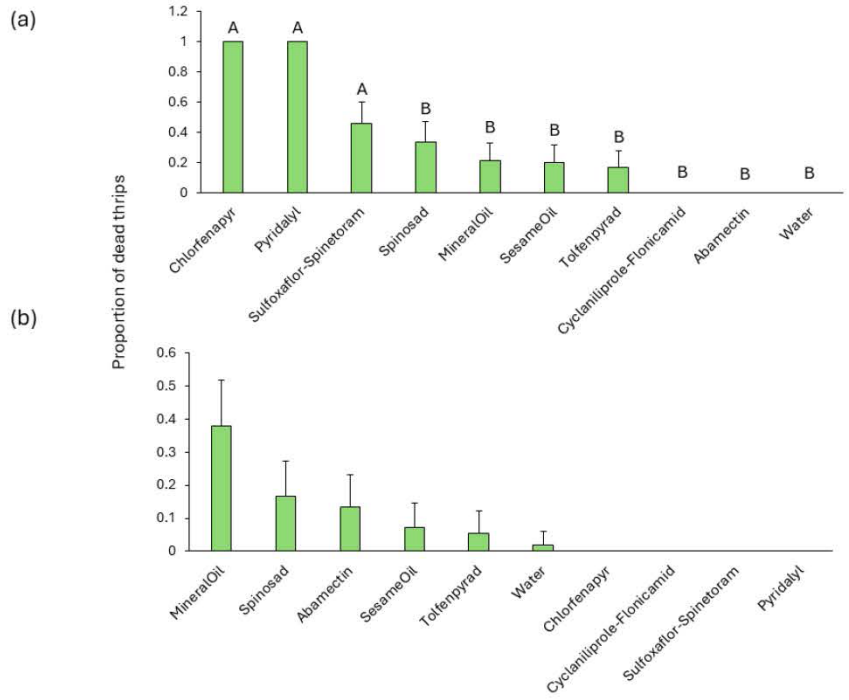


Fig. 2 Cumulative proportion of dead *Thrips parvispinus* caused by conventional and biorational insecticides on gardenia plants across all time points (24h, 7 days and 14 days). Panels illustrate the mortality larvae and adult thrips in both direct (a) and residue toxicity assays (b). Different letters denote significant differences among treatments ($p \leq 0.05$; Kruskal-Wallis).

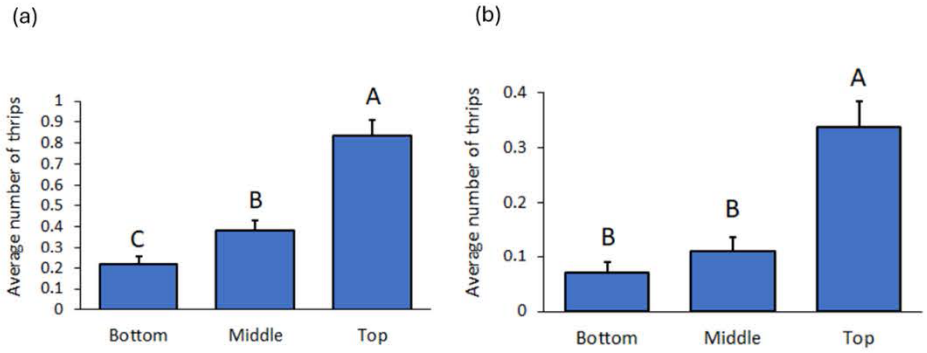


Fig. 3 Mean number of thrips sampled from bottom, middle and top part of mandevilla (a) and gardenia (b) plants. Panels show the cumulative numbers of dead and live *Thrips parvispinus* across all timepoints (24h, 7 days and 14 days) and exposure methods (direct and residue toxicity assays). Different letters denote significant differences among treatments ($P \leq 0.05$; GLMM).

GRADUATE ASSISTANTSHIP

As a commitment to the strong partnership that already existed with the University of Florida's Environmental Horticulture Department, a portion of the National Horticulture Foundation's portfolio moved to the University of Florida Foundation where it received a 50% match in state funds to develop NHF's graduate assistantship program. With just over $500,000 in principal, its first graduate-student project was started in 2010.

NHF Board of Directors continues to serve as an advisory committee and provides guidance to each selected NHF graduate student and faculty member involved at the University of Florida. This assistantship provides a two or three-year funding source to students working on their masters or PhD.

Meet NHF's Current Graduate Student

Fangchen Liu,
Ph.D. Student
Environmental Horticulture
University of Florida

Ms. Liu's plan at the University of Florida has been designed to build upon her strong foundation in biological sciences from the University of California, Davis, where she graduated with the highest honors and a GPA of 3.98. Now at the University of Florida, her education, through several specialized courses, will support her research into the genetic engineering of horticultural crops. She maintains a 4.0 GPA and has actively apply the concepts learned to her research on modifying flower coloration in petunias using advanced technologies.

She began her PhD studies in horticultural genetics at the University of Florida in August 2023, with an anticipated graduation date in the fall of 2028. Over the next few years, her research will focus on advancing plant biotechnology to enhance color variations in petunias without integration of transgene. This endeavor aims to explore the aesthetic and commercial potential of this popular ornamental plant. The timeline set is designed to efficiently manage her research goals alongside her academic requirements.

Enhancing Petunia Varieties through Advanced Genetic Techniques: Modifying Flower Colors via Gene Editing and Gene Overexpression

Graduate Student: Fangchen Liu, Major Advisor: Dr. Alfred Huo

Enrolled Semester: Fall, 2023

B.S. in Biological Sciences, University of California, Davis, 2023.

Abstract

This report presents two innovative genetic modification strategies aimed at expanding and enhancing the color palette of petunia. Utilizing CRISPR-Cas9 technology, we target specific pigment-related genes for precise, transgene-free editing, while parallel efforts involve traditional gene overexpression to intensify and diversify floral colors. These methods support the development of enhanced petunia varieties that meet both aesthetic and commercial cultivation standards without relying on traditional approaches.

Introduction

Petunia is one of the most economically important ornamental plants worldwide, prized for its diverse flower colors and extended blooming period in gardens, containers and urban landscapes. Petunia contribute substantially to the horticultural sector's economic performance in the United States, representing a significant portion of the annual wholesale market for ornamental plants. According to the USDA's 2020 Floriculture Crops Summary, petunias sold in pots generated a wholesale value of over $55 million, with more than 26 million pots sold in 2020. Among the various petunia cultivars, the Supertunia series, especially Supertunia Vista Bubblegum, is particularly notable for its vigorous growth habit and exceptional flowering performance. However, introducing additional traits of interests such as flower color into these elite commercial varieties through the conventional hybridization and selection is challenging due to their highly heterozygous nature. Traditional breeding approaches risk disrupting existing desirable traits, necessitating innovative genetic strategies to enhance these varieties while preserving their superior characteristics.

Petunia flower coloration is primarily dictated by the biosynthesis of anthocyanins, a complex process involving several key enzymes and regulatory genes. This pathway includes crucial structural genes such as Chalcone Synthase (CHS) and Dihydroflavonol 4-Reductase (DFR), as well as various MYB transcription factors that regulate their expression (Fig.1). Our transgene-free gene editing project aims to manipulate this pathway by targeting specific genes to modify flower color. We will focus on editing MYB repressors that negatively regulate anthocyanin synthesis to enhance color intensity. Additionally, we plan to edit Flavonol Synthase (FLS) to potentially increase anthocyanin accumulation by redirecting the metabolic flux away from flavanol synthesis, thus intensifying pigmentation. Modification of DFR and Flavanone 3-Hydroxylase (F3H) could lead to white flowers by disrupting key steps in the anthocyanin biosynthesis pathway. By editing MYB genes that negatively regulates anthocyanin synthesis,

we aim to enhance color intensity. Furthermore, targeted editing of Flavonoid 3'-Hydroxylase (F3'H) and Flavonoid 3',5'-Hydroxylase (F3'5'H) can alter the hydroxylation patterns of anthocyanin molecules, potentially shifting the color spectrum and expanding the range of achievable flower colors.

To expand the color palette of petunia flowers, we are implementing strategic gene overexpression approaches. By heterologously overexpressing ROSEA1 and DELILA from snapdragon (*Antirrhinum majus*), we aim to enhance anthocyanin biosynthesis to develop purple and dark purple flower phenotypes. In parallel, overexpressing a synthetic RUBY gene from sugar beet (*Beta vulgaris*) will produce betalain, generating novel bright red and dark red coloration. Additionally, enhanced expression of F3'5'H will increase delphinidin accumulation, leading to more pronounced blue flower colors. These complementary genetic engineering strategies are designed to create a diverse spectrum of flower colors, significantly enhancing both the commercial and aesthetic appeal of petunia varieties.

Recent advancements in genetic engineering, particularly the development of CRISPR/Cas9 gene-editing technology, have provided promising new methods for enhancing petunia varieties. One advantage of CRISPR genome editing over traditional genetic engineering is that transgene-free modifications can be achieved.

Several transgene-free gene editing methods have been developed. For example, Ribonucleoprotein (RNP) delivery introduces pre-assembled CRISPR/Cas complexes directly into plant cells, particle bombardment uses high-velocity particles to deliver editing components into plant tissue, and virus-based vectors employ viral particles for efficient delivery of gene-editing tools. Despite these advancements, each method has drawbacks: RNP delivery often struggles with low editing efficiency, particle bombardment can cause cell damage and inconsistent delivery, and virus-based vectors face limitations in virus-host specificity and can trigger immune responses. Unlike other transgene free methods, our proposal offers a novel transgene-free approach with broad applicability across diverse plant species through targeted manipulation of DNA repair pathways. The pivotal component of our methodology is the strategic suppression of DNA Polymerase Theta (POLQ), a key enzyme in alternative DNA repair mechanisms. POLQ plays a dual role in plant genome modification: it mediates microhomology-mediated end joining (MMEJ) during DNA repair and facilitates T-DNA integration into host genomes.

Recent studies have shown that POLQ is essential for T-DNA integration through its involvement in double-strand break repair pathways. By transiently suppressing POLQ expression during CRISPR/Cas9-mediated genome editing, we can decrease the frequency of T-DNA insertion during the CRISPR/Cas9 editing process while maintaining efficient gene editing via the classical non-homologous end joining (NHEJ) pathway. This approach is particularly valuable for developing non-GMO edited crops, as it minimizes the risk of foreign DNA persistence in the plant genome.

The significance of this method will be exemplified in our current work with Supertunia Vista Bubblegum, an ornamental variety with a complex genetic background derived from multiple

interspecific hybridizations. Due to its highly heterozygous nature and exclusive vegetative propagation, traditional breeding approaches are ineffective for trait improvement while maintaining its unique horticultural characteristics. Our POLQ suppression strategy enables precise genetic modifications without transgene integration, thereby preserving the plant's non-GMO status. This approach not only satisfies regulatory requirements but also addresses market demands for non-GMO ornamental varieties while allowing for targeted trait enhancement. Furthermore, this methodology can be adapted for other vegetatively propagated crops where maintaining genetic fidelity while introducing beneficial traits is crucial.

These two projects are designed to harness this sophisticated technology to enhance the commercial viability and aesthetic appeal of petunia, ensuring these popular plants continue to thrive in gardens worldwide and maintain their competitive edge in the global market for ornamental plants.

Objectives

The goal of this project is to modify the flower color through genetic engineering approaches. Three objectives are proposed to achieve this goal.

- **To Modify Flower Color by Editing Structural Genes in Anthocyanin Pathway without Transgene Integration**

  Modifying flower pigmentation by targeting structural genes such as F3H, F3'5'H, F3'H, DFR, and FLS. Editing F3H and DFR can limit colored compound formation, while changes to F3'5'H and F3'H adjust hydroxylation, expanding hue diversity. Modifying FLS aims to reduce the production of flavonols, allowing greater anthocyanin accumulation.

- **To Intensify Flower Pigmentation by Knocking Out Transcription Factors That Act as Repressors in the Anthocyanin Biosynthesis Pathway**

  Intensifying flower pigmentation by regulating transcription factors such as MYB27, MYB-FL, and MYBx, which function as repressors in the anthocyanin biosynthesis pathway. Editing these transcription factors aims to alleviate their suppressive effects, enhancing the expression of downstream structural genes involved in anthocyanin production.

- **To Diversify Flower Coloration by Overexpressing Key Genes Involved in Pigment Production**

  Utilizing the pOX135 binary expression vector to overexpress genes such as ROSEA1, DELILA, and RUBY to intensify and diversify flower colors. Overexpressing ROSEA1 and DELILA aims to boost purple and dark purple hues by increasing anthocyanin synthesis. RUBY is targeted to enhance betalain production, introducing unique red and

dark red tones. Additionally, overexpressing F3'5'H will increase delphinidin production, leading to more pronounced bluish flower colors. This strategic overexpression complements the gene editing project and broadens the potential color palette.

Research Progress

Objective 1: To Enhance Flower Color by Editing Structural Genes in the Anthocyanin Pathway without Transgene Integration

- The construction of vectors PHN-DFR, PHN-FLS, and PHN-FLS-POLQ, for targeted editing of structural genes, has been completed. Stable transformations using PHN-DFR and PHN-FLS have been achieved in Mitchell, Carmine Velour, and Petunia Wave Pink varieties. We are currently observing these plants for phenotypic changes, with the aim of assessing the effects of structural gene knockouts on flower pigmentation. Additionally, the construction of vectors targeting the F3H, F3'H, and F3'5'H genes is ongoing.
- Regeneration protocols for *Supertunia Vista Bubblegum* are under optimization to support effective transformation. Upcoming steps involve using POLQ-mediated constructs in *Supertunia Vista Bubblegum* to ensure that edits are transgene-free, aligning with non-GMO standards.

Objective 2: To Intensify Flower Pigmentation by Knocking Out Transcription Factors That Act as Repressors in the Anthocyanin Biosynthesis Pathway

- Completed the construction of vectors targeting transcription factors MYB27, MYB-FL, and MYBx. These vectors have been stably transformed into *Mitchell*, *Carmine Velour*, and *Petunia Wave Pink*. Observations are ongoing to evaluate the impact of these gene knockouts on pigment intensity.

Objective 3: To Diversify Flower Coloration by Overexpressing Key Genes Involved in Pigment Production

- Successfully transformed pOX135 vectors containing ROSEA1, DELILA, RUBY, and F3'5'H into *Mitchell*, and F3'5'H into *Petunia Wave Pink*. Overexpression of these genes has resulted in notable color enhancement: ROSEA1 has intensified purple hues, while RUBY has introduced vibrant pink coloration. Additionally, F3'5'H overexpression has further enriched pink shades in *Petunia Wave Pink*, demonstrating the potential for expanded color diversity (Fig. 2).

Table: Key Genetic Targets and Project Progress

Target	Vector/Construct	Project Type	Transformed Varieties	Status	Remarks
MYB27, MYB-FL, MYBX	PHN-MYB27, PHN-MYBFL, PHN-MYBX, (both with and without POLQ)	Gene Editing	*Mitchell, Carmine Velour, Petunia Wave Pink*	Stable Transformation Completed	Awaiting phenotype observations
DFR, FLS	PHN-DFR, PHN-FLS, PHN-FLS-POLQ	Gene Editing	*Mitchell, Carmine Velour, Petunia Wave Pink*	Stable Transformation Completed	Awaiting phenotype observations
F3'H, F3'5'H	PHN-F3'H, PHN-F3'5'H (preparing to add POLQ)	Gene Editing	-	Plasmid construction	Awaiting ligation of POLQ to the plasmid
F3H	-	Gene Editing	-	gRNA design & sequencing	Awaiting gRNA design
ROSEA, RUBY, DEL	POX-ROSEA, POX-RUBY, POX-DEL	Overexpression	*Mitchell*	Successful transformation	Purple and pink colorations achieved in white flowers
F3'5'H	POX-F3’5’H	Overexpression	*Mitchell, Carmine Velour, Petunia Wave Pink*	Color changes observed, ongoing transformation	Intensified color observed in Petunia Wave Pink

Educational Achievements and Coursework

I obtained my bachelor's degree from the University of California, Davis, graduating with the highest honors and a GPA of 3.98 in Biological Sciences. This strong foundation has been vital in preparing me for advanced scientific inquiries and research.

At the University of Florida, I have furthered my education by completing several specialized courses that directly support my research in genetic engineering of horticultural crops. These courses include:

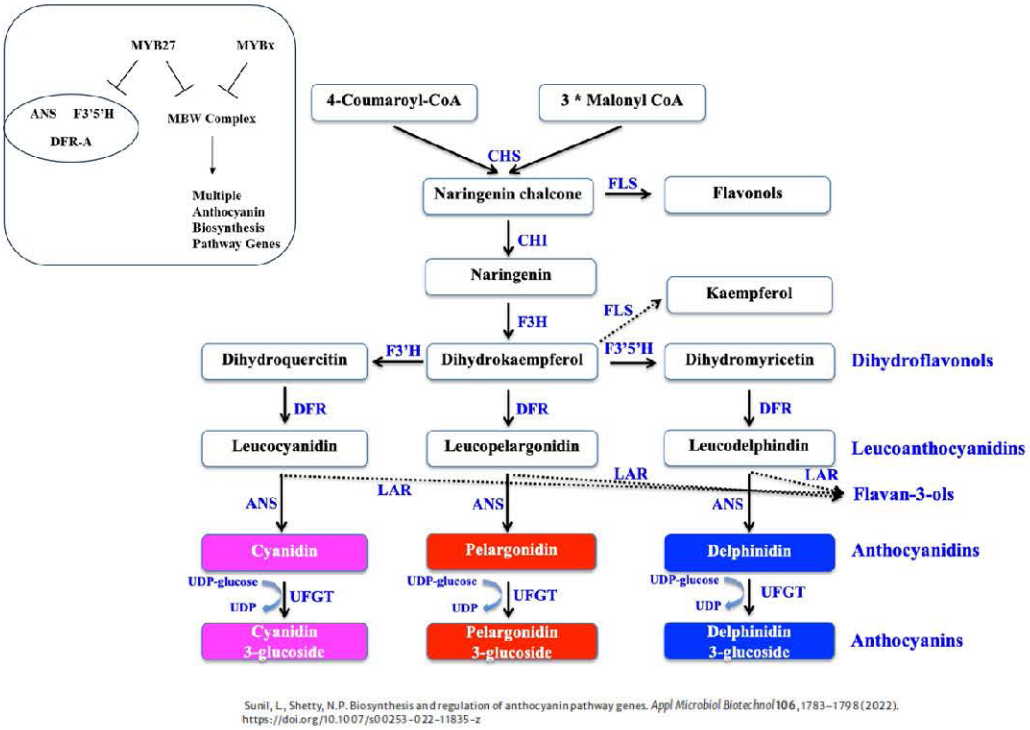
- PLS5222C (30398) - Propagation of Horticultural Crops
- AGR5307 (24456) - Molecular Genetics of Crop Improvement
- PCB5530 (16626) - Plant Molecular Biology and Genomics
- STA6093 (16790) - Introduction to Applied Statistics

I am currently enrolled in PLS5222C and maintain a 4.0 GPA, continuously applying learned concepts to my ongoing research on modifying flower coloration in petunia using advanced gene-editing technologies.

Timeline and Future Directions

I began my PhD studies in horticultural genetics at the University of Florida in August 2023, with an anticipated graduation date in the summer of 2028. My qualifying exam is expected to schedule in the summer of 2025. Over the next few years, my research will concentrate on advancing plant biotechnology to enhance color variations in petunia. This timeline is designed to efficiently manage my research goals and academic requirements, leading up to the preparation and defense of my dissertation in 2028.

Figures



Sunil, L., Shetty, N.P. Biosynthesis and regulation of anthocyanin pathway genes. *Appl Microbiol Biotechnol* 106, 1783–1798 (2022). https://doi.org/10.1007/s00253-022-11835-z

Fig. 1, Biosynthetic pathways of anthocyanins. CHS, chalcone synthase; FLS, flavonol synthase; CHI, chalcone isomerase; F3H, flavanone 3-hydroxylase; F3′H, flavonoid 3′-hydroxylase; F3′5′H, flavonoid 3′,5′-hydroxylase; DFR, dihydroflavonol 4-reductase; ANS, anthocyanidin synthase; LAR, leucoanthocyanidin reductase; UFGT, flavonoid 3-O-glucosyltransferase; UDP-glucose, uridine diphosphate glucose; asterisk indicates multiplication (Sunil et al., 2022). MYB repressors may directly limit the expression of structural genes and disrupt the formation of the MBW complex, thereby repressing anthocyanin biosynthesis.

Fig. 2, Comparative display of Petunia flowers showing the wild type (left) with a standard pink hue and a genetically modified variant (right) with a deeper pink color due to the overexpression of the F3'5'H gene.

References

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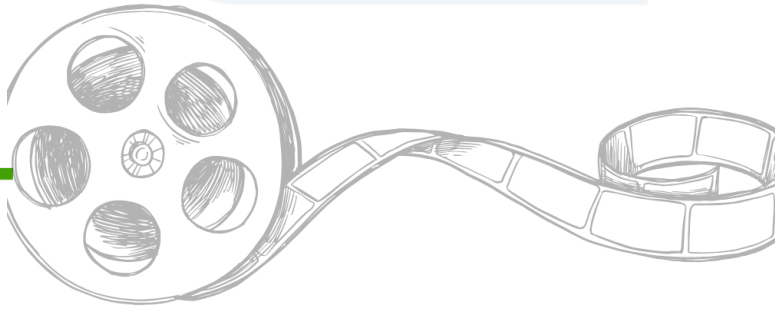
Sunil, L., & Shetty, N.P. (2022). Biosynthesis and regulation of anthocyanin pathway genes. *Applied Microbiology and Biotechnology, 106*(5), 1783–1798. https://doi.org/10.1007/s00253-022-11835-z

USDA-NASS [U.S. Department of Agriculture-National Agricultural Statistics Service]. (2020). *USA sales of annual bedding plants and herbaceous perennials*. Washington, DC: USDA/NASS QuickStats Ad-hoc Query Tool.

SPECIAL PROJECT

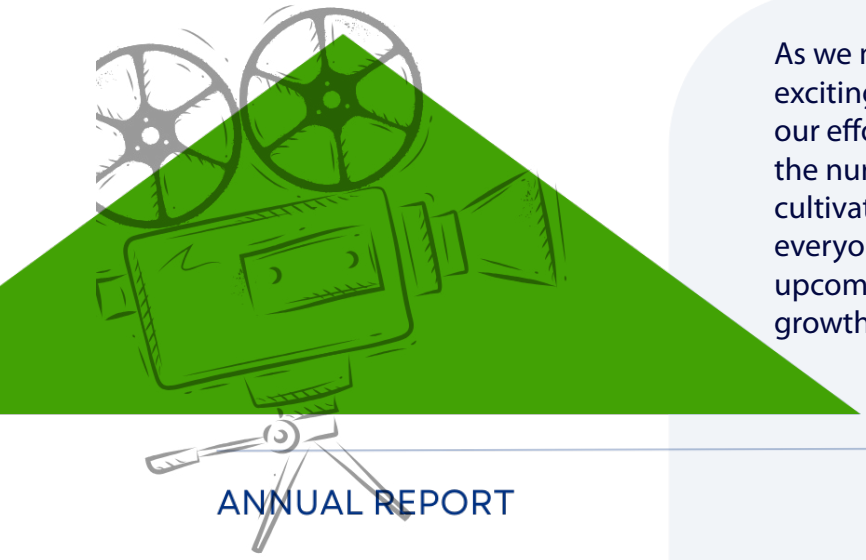


NHF At Work Developing Our Story & Highlighting the Industry We Serve

At the National Horticultural Foundation (NHF), we recognize that storytelling is more than just a way to share information—it's a powerful tool to educate, inspire, and connect. Our journey to enhance how we communicate our mission began almost a year ago when we received an exciting call from a South Florida production company. They asked if we would be interested in creating a documentary. Without hesitation, we saw it as the perfect opportunity to further our mission of supporting industry professionals and nurturing the next generation of leaders in horticulture.

The two-day film shoot not only set the stage for the documentary but NHF's team produced a 5-minute video, 30-second commercial and 6 video vignettes for NHF to use to promote the foundation's efforts and move its mission forward. The documentary, which aired on public television this past October, provides us with a unique platform to reach a wider audience. It showcases the vital role that horticulture plays in our communities and the environment. By shining a light on the stories of passionate professionals and the tangible impact of their work, we aim to inspire viewers to engage with and appreciate the world of horticulture.

More than just a promotional tool, this documentary is a testament to the vibrant community we proudly support within the horticulture sector. Each station that airs the documentary has the right to broadcast it for a full year, providing invaluable exposure and amplifying our message. The awareness generated is not only vital for NHF's mission, but also for generating the financial support that will allow us to continue advocating for the industry.



As we move forward, we invite you to join us in this exciting chapter. Your support is integral to advancing our efforts in research, education, and advocacy for the nursery and landscape industry. Together, we can cultivate a thriving horticultural community that benefits everyone. We encourage you to get involved in our upcoming initiatives and contribute to the continued growth of this essential sector.















In addition to our engaging video production and vignettes, we launched an email campaign that reached up to 1 million opt-in subscribers, effectively delivering an inspiring overview of our mission. This powerful outreach not only gave us the opportunity to highlighted our commitment to sustainable communities but allowed us to potentially capture the attention of a new audiences who share our vision for a brighter, more sustainable future. With this initiative, we've expanded our reach and connected with passionate individuals who are ready to be part of the change.

CAMPAIGN REPORT

Campaign Summary

Name: The National Horticulture Foundation

From/Brand:	The National Horticulture Foundation		
Headline:	The Future of Horticulture Starts Here – Join NHF's Mission		
Broadcast Date:	11/14/2024		
Audience:	1,000,000	**ID:**	2189674
Views:	60,121	**Clicks:**	2,818
View %:	6.01%	**Click %:**	0.28%

Campaign Creative

CAMPAIGN STATS

Views | 6.01 % *Total Views 60,121*

Clicks | 0.28 % *Total Clicks 2,818*

CTVR | 4.69 %

Clicks by Device

Desktop	**38.68%**	**1,090**
Mobile	**61.32%**	**1,728**

CLICKS BY WEB BROWSER

1,367	**Chrome**	**137**	**Edge**	**161**	**Firefox**	**748**	**Safari**	**405**	**Other**

INVESTING IN THE HORTICULTURE INDUSTRY

Through Research, Scholarships, Education and Marketing

Our Mission:

- **Solving Industry Challenges**
  NHF supports horticulture research focused on addressing the needs of all industry segments.
- **Building Future Leaders**
  NHF offers scholarships to support students pursuing careers in horticulture.
- **Securing Industry Legacy**
  NHF provides a pathway for industry members to leave a legacy for future generations.
- **Focusing on A Sustainable Future**
  NHF promotes awareness of practices that protect the environment and support biodiversity.

NATIONAL HORTICULTURE FOUNDATION®

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www.nationalhorticulturefoundation.org

INTERIOR INDUSTRY GROWTH FUND CONTRIBUTORS

The Interior Industry Growth Fund (IIGF) is comprised of numerous company and individual endowments. The Fund's earnings will be dedicated to advancing research, supporting professional education, and executing strategic marketing efforts aimed at influencing key decision-makers and industry leaders. A robust and well-supported IIGF ensures that interior landscape services are recognized as essential by the leaders of high performing organizations. By thoughtfully investing in the IIGF, you help secure the future of the interior landscape industry and contribute to its continued growth and relevance.

Silver Builder Level
$35,000-$49,999

- Cityscapes Endowment
- Senneff Family Endowment

Builder Level
$25,000-$34,999

- Architectural Supplements and Feinman Family Endowment
- Blondie's Treehouse Endowment
- FIHRE Endowment
- Mangum Family Endowment
- New Pro Containers Endowment
- Planterra Endowment

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- Gsky Plant Systems Endowment
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- National Interiorscape Network Endowment

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- Botanical Designs Legacy Endowment
- Les and Catherine Love Endowment
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- Leafscape Connell Family Endowment
- Plant Solutions, Inc. Endowment
- Plantscaping Endowment
- Scott & Diane Barron Family Endowment

Donations

- Foster Plants
- Foliage Design Systems

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- Raimondi Horticulture Group and Family Endowment

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- Anything Groes
- Batch-O Blooms
- Buckingham Greenery
- Greenery Office Interiors
- Interior Plantscapes
- Plantscapes, Inc.
- Seattle Plant Company
- Steve Stanford
- Texas Tropicals

Pledges and Contributions As of January 17, 2025

Interior Industry Growth Fund At Work

Guided by a vibrant network of business professionals, Green Plants for Green Buildings (GPGB) and NHF are dedicated to positioning the Interior Landscape industry through the Interior Industry Growth Fund, to thrive well into the future. It is positioned to help support research initiatives, professional education, and targeted marketing to influencers and decision-makers.

In June, NHF provided $10,000 to support GPGB efforts at the American Institute of Architecture 2024 conference, in Washington, D.C.

Their booth showcased the integration of green plants into building designs, highlighting their environmental and aesthetic benefits. The financial assistance played a pivotal role in covering a range of essential expenses, ensuring that industry presence at the conference was both impactful and memorable. Their efforts at the AIA Conference have set a high standard for what can be achieved when partnering together to prioritize the natural world in our architectural endeavors.

Positioned As A Sponsor

As a gold sponsor, GPGB showcased its commitment to promoting biophilic design and the integration of natural elements into built environments. GPGB's presence at the conference highlighted its mission and demonstrated the growing importance of sustainable practices in architecture and urban planning.

Engaging Speaker Lineup

The GPGB booth hosted a series of talks by renowned experts in the field of biophilic design. Bill Browning, Dr. Tuwanda Green, and Janice Goodman delivered compelling presentations on topics such as the psychological and physiological benefits of biophilia and the science behind plants and brain function. Their insights captivated the audience, sparking meaningful discussions and a deeper interest in integrating natural elements into architectural design.

Looking Ahead

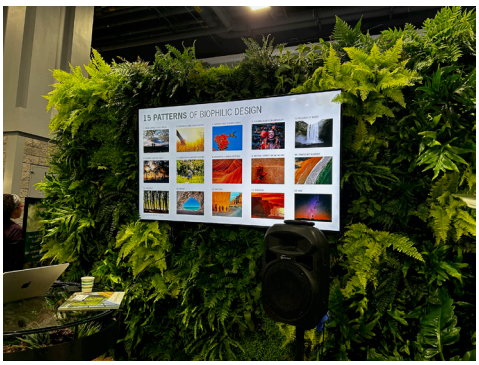
GPGB's website saw an enormous increase in website traffic during the AIA Conference with approximately 83,000 year-to-date event counts on the site as of July 3, 2024. This was a significant increase from the 47,000 event counts from January 2024-May 2024. In June, GPGB's Instagram saw a 38.6% increased reach, Facebook had a 38.6% increase in reach, and LinkedIn had an increase of 533% impressions. Thousands from the Architecture, Engineering, and Construction sector were reached through the marketing efforts and on-site efforts of GPGB at AIA24.

The positive reception of GPGB's initiatives at the AIA Conference is a promising sign for the future of biophilic design and sustainable building practices. As awareness of the benefits of green buildings continues to grow, GPGB's work will likely inspire more architects, designers, and developers to incorporate natural elements into their projects.

Credits: This article was inspired by the Planter Trends Monthly Newsletter, published June 8, 2024, by Jean-Pierre Sijmons, Architectural Supplements







An Interior Industry-specific endowment is the best approach to provide a permanent source of funding to grow the size and profitability of the Interior Landscape Industry and future-proof it for new generations.

The Interior Industry Growth Fund will provide research initiatives, professional education, and targeted marketing to influencers and decision-makers. A well-endowed Fund will assure interior landscape services are deemed essential by informed leaders of top-performing companies. Thoughtful investment in the IIGF will help to future-proof the interior landscape industry.

NATIONAL HORTICULTURE FOUNDATION

An endowment is much more than just a fund—it's a lasting investment in the future, a powerful resource that continues to give long after it's made. NHF holds strong in its mission to never spend the principal of the foundation's funds, only its earnings. By contributing to an endowment, you're not just supporting immediate projects, you're helping to shape the growth and sustainability of horticulture for generations to come.

Thanks to the generosity of donors, NHF has been able to build a legacy of success, one that empowers the next wave of horticulturists, researchers, and educators to push boundaries and cultivate new possibilities.

No contribution is too small, and it's never too early to begin your own legacy. Every gift, no matter the size, helps strengthen the foundation that supports the future of horticulture.

NHF is incredibly proud and grateful for the unwavering support of industry members who share the vision of a thriving, innovative future. Together, we are cultivating the seeds of success that will continue to flourish for years to come.

Names highlighted in green have made contributions to their endowment in 2024

Platinum Level

$100,000 +

- Hoskin/McDougald Scholarship Endowment
- Hughes Memorial Fund Endowment
- Interior Industry Growth Fund
- James H. Davis Memorial Scholarship Fund
- June and Richard Rosacker Endowment
- Richard Fuhr Endowment

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- FNGLA Northeast Chaper Endowment
- Olive Hill Greenhouses Endowment
- Phillip Matalon/Fancy Flora Endowment
- Raymond P. Oglesby Endowment
- TPIE Golf Classic/Allied Division

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- Bolusky Family Endowment
- Cityscapes Endowment
- Dorothy and Richard Entorf Endowment
- Florikan Endowment
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- Senneff Family Endowment

Builder Level

$25,000-$34,999

- Architectural Supplements & Feinman Family Endowment
- Howard Freilich - Blondies Treehouse Endowment
- FNGLA Broward Chapter Endowment
- FIHRE Endowment
- Theo & Christina Bryant Endowment
- Jose Costa Memorial Endowment
- Mangum Family Endowment
- Palm Beach Growers Classic Endowment
- Planterra Endowment

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Hackney Nursery Endowment
Dick Ott Endowment
Gsky Plant Systems, LLC Endowment
Joel and Teri Pesapane Family Endowment
National Interior Network Endowment
New Pro Containers Endowment
McRae Anderson Endowment
Tropical Plant Industry Exhibition

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Ambius Endowment
Florida Nurserymen And Growers Association
Florida Potting Soils Endowment
Les & Catherine Love Endowment
Mike and Cecilia Rimland Endowment
Past Presidents' Endowment
Peckett Family Endowment
Shannon Rinck Memorial Endowment
Verlite Co. Endowment

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Amilings Endowment
Anthony Frumento Endowment
Batson's Greenhouse Endowment
Botanical Designs, LLC
Central FL Marketing Research Endowment
Foliage Design Systems Endowment
FNGLA - Treasure Coast Chapter Endowment
FNGLA - Palm Beach Chapter
Frank H. Abrahamson Endowment
Green Plants for Green Buildings Endowment
John Mini - Distinctive Landscape LTD
Leafscape Connell Family Endowment
Ned & Kim Bradford Endowment
Oasis Plantscapes/Dehaven & Whitting Endowment
Parrish Family Endowment
Prolific Plants Endowment
R.A. Chris Christiansen Endowment
Kevin & Theresa Riley (Rockledge Gardens) Endowment
Scott & Diane Barron Family Endowment
The Scotts Company
Wekiwa Gardens Endowment
Van Donnan Endowment

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Grundy's Plantscaping/Sean Campbell Endowment
Helen and Harold Martin Endowment
Hermann Engelmann Endowment
Hughes Memorial (Budwood Contributions)
John E. Brown Endowment
Kerry's Bromeliad Nursery Endowment
Lerio Corporation Endowment
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Sunshine Foliage World Endowment
Tran Trex Foliage Endowment
Twyford Laboratories Endowment
Whistling Pines Inc. Endowment

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N.G.M. Productions, Inc.
Silver Krome Gardens
Stepping Stone Nursery, Inc.
Sunshine Tropical Foliage
Universal Enterprise Supply

Giver Level

$1,000-$2,499
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Arvida Nurseries Corp of Kendall
Batch of Blooms
Benchmark Foliage, Inc.
Big Trees Plantation
Blalock Foliage Inc.
Buckingham Greenery
Combustion Service Co., Inc.
Cultivate Wealth Management
Deroose Plants, Inc.
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Frederick Gloeckner
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Joseph Hill
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Plantscaping, Inc.
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The Jungle Nursery
Traymax Inc.
David and Karen Wheeler

(CONTRIBUTIONS LISTED WERE MADE PRIOR TO 1/31/2024)

WORK WITH US

EMAIL
Info@nationalhorticulturefoundation.org

WEBSITE
www.nationalhorticulturefoundation.org

PHONE
+407-295-7994

ANNUAL REPORT