NATIONAL HORTICULTURE FOUNDATION

ANNUAL REPORT 2021

SERVING THE HORTICULTURE INDUSTRY SINCE 1987

www.nationalhorticulturefoundation.org

The National Horticulture Foundation embraces 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.

Led by our vibrant network of business professionals, the Foundation is dedicated to seeing the industry thrive and survive well into the future.

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PRESIDENT'S LETTER

It is hard to believe 2021 has ended and we are beginning a new year in 2022. We have overcome so much over the last two years and not sure when it all will end. I can guarantee you, as an industry, we will continue to find solutions and remain relevant. In January, I passed the torch to Mike Marshall, Marshall Tree Farm, as he becomes the next NHF president. It has been my pleasure to serve my two-year term as president. The two years have gone quickly and there always seems to be so much more to accomplish.

NHF has been serving the industry since 1987 so as I take my seat as Immediate Past President, I look forward to seeing how NHF will continue to serve the industry for the next 35 years and beyond. As I said before, the Years 2020/2021 taught us that a foundation's path is never about a single destination…it is about the long-term journey. It is an investment in the future of the industry and a clear understanding of the importance of giving.

National Horticulture Foundation's board made a commitment to be good stewards of the industry's contributions. Our board seeks out new ways to give back to the industry. Our portfolio has weathered wavering financial markets and continues to be strong. We are diverse in our investments and proud to support the nursery and landscape industry on an annual basis. NHF will continue to support research and education.

NHF strives to fund research that specifically deals with horticulture-related issues. I hope you will take the time to read the researchers' reports provided in this annual report. We are dedicated to help the academic community tackle industry challenges. We want to see your business continue to be successful and the industry to grow stronger.

This year, the NHF provided more than $18,000 in scholarships to students pursuing a career in horticulture. It is our mission to provide a pathway for these students so they can help make this industry thrive in the future.

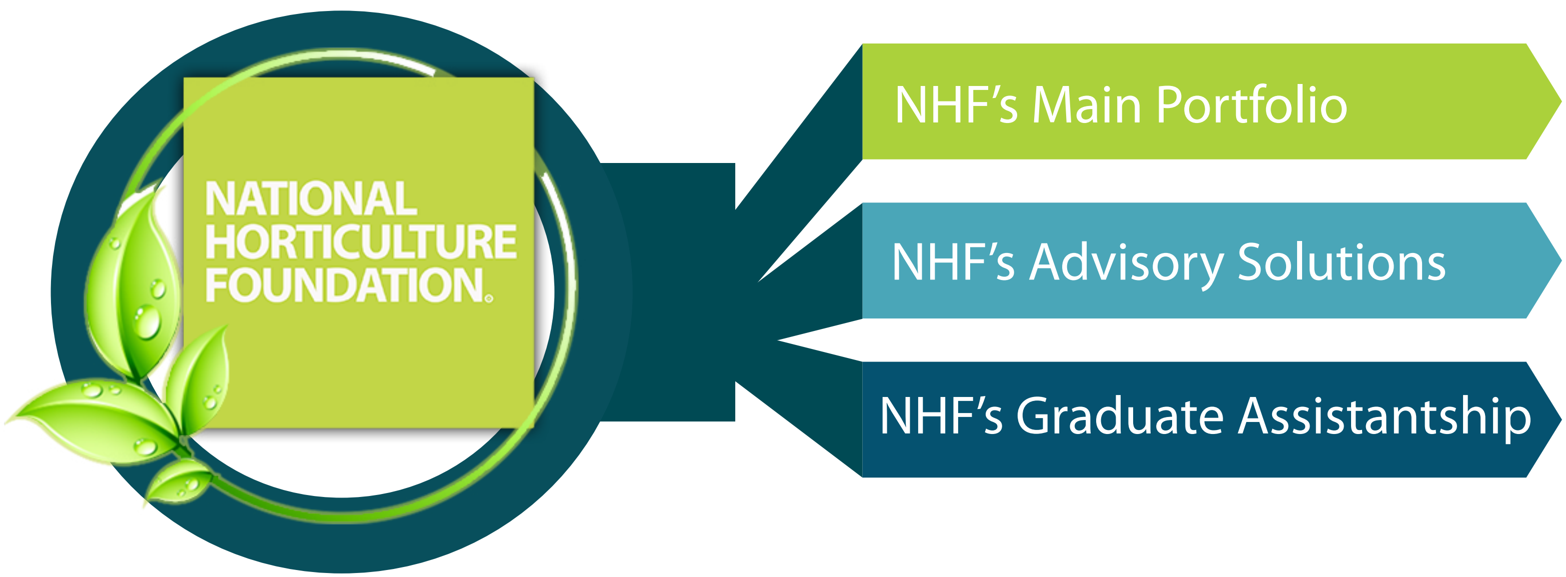
In closing, I would like to share a quote about giving by H. Jackson Brown, Jr, "Remember that the happiest people are not those getting more, but those giving more". I wish you much happiness in 2022. We have a responsibility to give back to the industry that has been so good to us. Choose now to become an annual supporter of NHF. You can make an impact with any size of a gift. Happiness is right around the corner.

To contribute now please reach us by visiting www.nationalhorticulturefoundation.org/contribute,
or by calling 800-375-3642. Ask about how you can set up your plan for giving.

Sincerely,
George Hackney, NHF President
Hackney Nursery Inc.

FINANCIAL STABILITY

The Foundation's focus has broadened to reach new audiences over the years, yet it has never lost sight of the importance of research and education. The Foundation is comprised of three investment funds: NHF's Main Portfolio, NHF's Advisory Solutions and NHF's Graduate Assistantship managed by the University of Florida Foundation



NHF's Main Portfolio

Cash & Money Market	$94,165.39
Mutual Funds - Held At Edward Jones Investments	$2,892,647.71
Asset & Mortgage Backed Securities	$21,922.26
Current account value:	$3,008,735.36
Account value as of December 2020	$2,748,863.53

ASSETS HELD AT EDWARD JONES	2019	2020	2021	Since 2009
BEGINNING BALANCE	$2,279,366.75	$2,593,041.62	$2,819,846.14	$1,301,644.17
PERSONAL RETURE OF RETURN %	16.59%	11.49%	12.09%	8.05%
ENDING BALANCE	$2,593,041.62	$2,819,846.14	$3,007,391.16	$3,052,049.46

NHF's Advisory Solutions

Cash & Money Market	$11.20
Mutual Funds - Held At Edward Jones Investments	$410,601.82
Current account value:	$410,613.02
Account value as of December 2020	$392,656.59

ASSETS HELD AT EDWARD JONES	2019	2020	2021	Since 2010
BEGINNING BALANCE	$273,099.07	$335,080.70	$385,584.90	$158,649.94
PERSONAL RETURE OF RETURN %	22.70%	15.07%	13.46%	9.01%
ENDING BALANCE	$335,080.70	$385,584.90	$437,470.14	$419,556.43

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.

Over $800,000 has been given towards research. NHF strives to fund research that specifically deals with horticulture-related issues. Research can be done in Florida or out of state. 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.

NHF seeks to support research with positive outcomes and a greater return on investment for the green industry. Whether understanding how to improve plant quality and longevity during transportation, increase purchasing motivation of consumers to increase demand for horticulture products, NHF's goal is to make a difference for the industry.

In 1996, we received a large contribution from the estate of James H. Davis that launched our scholarship program which has now grown into three different types of scholarships. We are able to fund approximately 25 students on an annual basis but we would like to see that number grow to over 50 students a year. There has been almost a half a million dollars in scholarships given over the years.

RESEARCH

The National Horticulture Foundation (NHF) seeks to support research with positive outcomes and a greater return on investment for the horticulture industry.

Research projects conducted during 2020-2021

Evaluation of soil fungi inoculants as biofertilizers for foliage plants
Dr. Sarah Emery, University of Louisville, Louisville, KY

Using LEDs to Improve Longevity of Living Green Walls
Dr. Celina Gomez and Dr. Paul Fisher, University of Florida, Gainesville, FL

Improved Precision Irrigation of Trees in Planning and Managing Florida Friendly Landscapes
Dr. Richard Beeson and Hang Duong, Mid Florida Research and Education Center, Apopka, FL

Tipping Bucket Rain Gauge for Measuring Leaching Fraction in a Container Nursery
Dr. Tom Yeager, University of Florida, Gainesville, FL

Research provides sound science for everyday decision making.

Evaluation of soil fungal inoculants as biofertilizers for foliage plants

Dr. Sarah Emery, University of Louisville

Abstract:

Eighty percent of land plants form symbiotic associations with soil micro-organisms called arbuscular mycorrhizal fungi (AMF), and there are many commercial products currently on the market that use AMF as biofertilizers. However, very little is known about the potential for AMF to benefit foliage plants. In a series of lab experiments, this research evaluates the biofertilizer effects of AMF on vegetative growth and foliage coloration of several cultivars of foliage plant taxa including Aglaonema spp., Sedum spp., and Plectanthrus scutellarioides (Coleus). I found that AMF can have positive biofertilizer effects on foliage plants. Sedum and Coleus plants showed increased vegetative growth, and Aglaonemas showed increased red leaf variegation when inoculated with some types of AMF. Later analyses will examine whether these benefits are correlated with increases in plant defensive chemistry, particularly leaf anthocyanins.

Objective:

Main research objective was to evaluate the biofertilizer effects of different AMF species on vegetative growth and leaf color of indoor foliage plants.

Methods:

Experiment Set #1

In my first set of experiments, I tested effects of two commercial AMF biofertilizers on growth and leaf coloration of multiple cultivars of Sedum (Jelly Bean, Burrito Burro's Tail), and Aglaonema (Siam, Sparkling Sarah, Emerald Beauty). Nursery plants were transplanted into 4" nursery pots (Aglaonema) or plug trays (Sedum) filled with standard potting mix (Jolly Gardener C25). Pots were inoculated with one of three biofertilizer treatments: 10ml of a commercial product containing the single AMF species Rhizophagus intraradices (product name withheld), 10ml of the product Mycobloom (mycobloom.com), which contains 7 AMF species, or 20ml of sterilized (autoclaved) inoculum. Each biofertilizer treatment was replicated 4-5 times. Plants were placed under LED grow lights on 16h light/8h dark cycles in ambient room conditions (65-75°F/18-24°C) and watered frequently. Height, number of leaves, date of first flowering, and total flowers per plant were recorded biweekly for 16 weeks. The newest fully-open leaf on the two cultivars of Aglaonema that produce red variegation were photographed and image analysis (ImageJ) was used to calculate the % red color per leaf. Aglaonema and Sedum plants will be harvested in December 2021 for biomass measures. For all cultivars, leaf anthocyanin concentration will be quantified in spring 2022 using a spectrophotometric approach.

Experiment Set #2

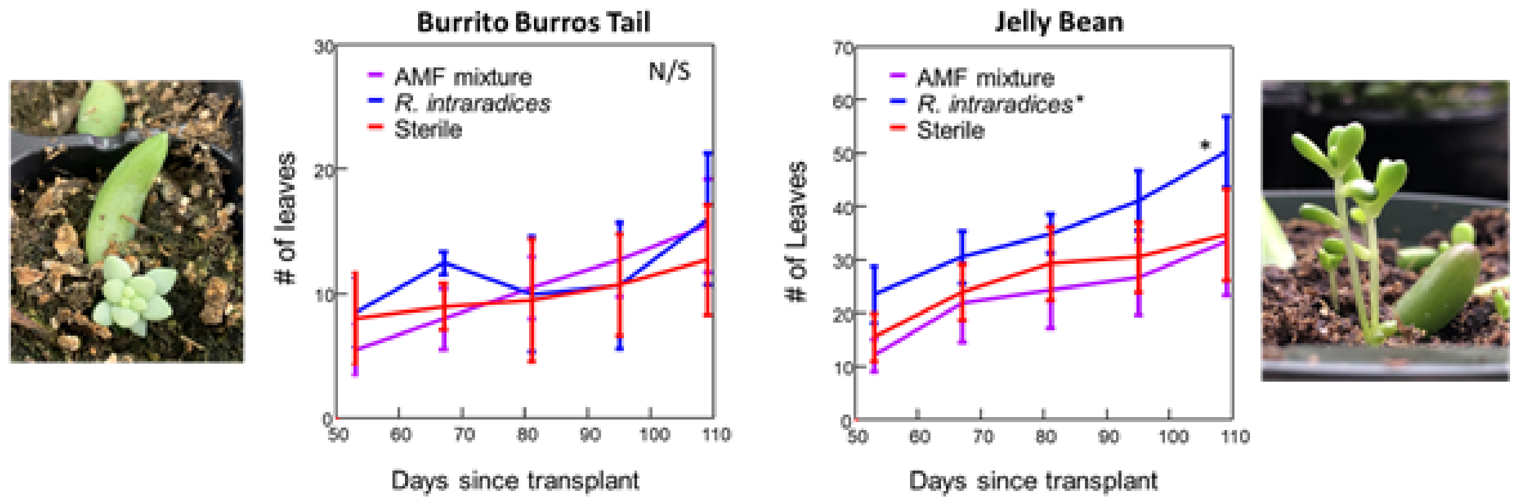
A second set of experiments has started to test effects of individual AMF species on plant growth and leaf coloration. This experiment has been completed using 4 cultivars of Coleus (Wizard Scarlet, Wizard Jade, Watermelon, Lime Delight) and will be conducted on two sedum cultivars starting in January 2022. Due to COVID-19 supply chain issues, I have been unable to secure enough Aglaonema plants from my industry suppliers for experiment set but will keep reaching out to potential wholesalers.

For this experiment, I used 10 soil inoculation treatments: Eight single AMF species (4 expected biofertilizers and 4 expected bioprotectors), a mix of all 8 AMF species, and a sterile treatment (autoclaved mix of 8 species). AMF species included: Giaspora margarita, Rhizophagus intraradices, Clariodeoglomus lamellosum, Claroideoglomus claroideum, Funneliformis mosseae, Acaulospora spinosa, Cetraspora pellucida, and Racocetra fulgida. All AMF cultures for experiments were provided below cost by Dr. Liz Koziol, owner of Mycobloom. Small conetainers (164ml capacity; 1.5 x 8.25") were filled with standard potting mix and inoculated with one of 10 treatments above. 15ml of single-AMF species cultures, or 2ml of each species culture for the mix treatment were added to conetainers and seeds were planted. Each treatment combination was replicated 5 times, for a total of 200 pots (4 Coleus varieties x 10 biofertilizer treatments x 5 reps). Conetainers were placed under LED grow lights in ambient room conditions and watered frequently. Time to germination, height, number of leaves, date of first flowering, and total flowers per

Results

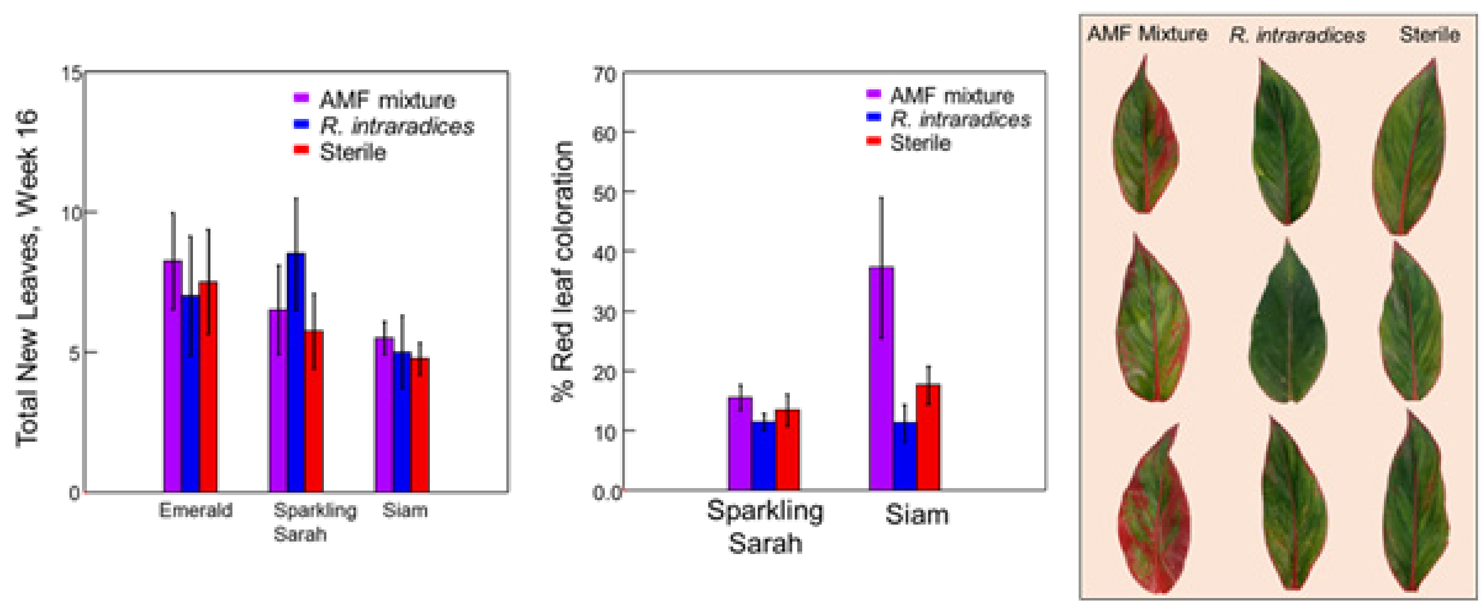
Experiment #1: Sedums
The commercial biofertilizers had no effects on growth of the Burrito Burros Tails cultivar, but the biofertilizer containing Rhizophagus intraradices increased growth of the Jelly Bean cultivar by 48% (Figure 1). Image analyses are difficult with succulent leaves, but I plan to analyze leaves for anthocyanin content in Spring 2022.

Figure 1. Effects of AMF biofertilizer products on Sedum growth.



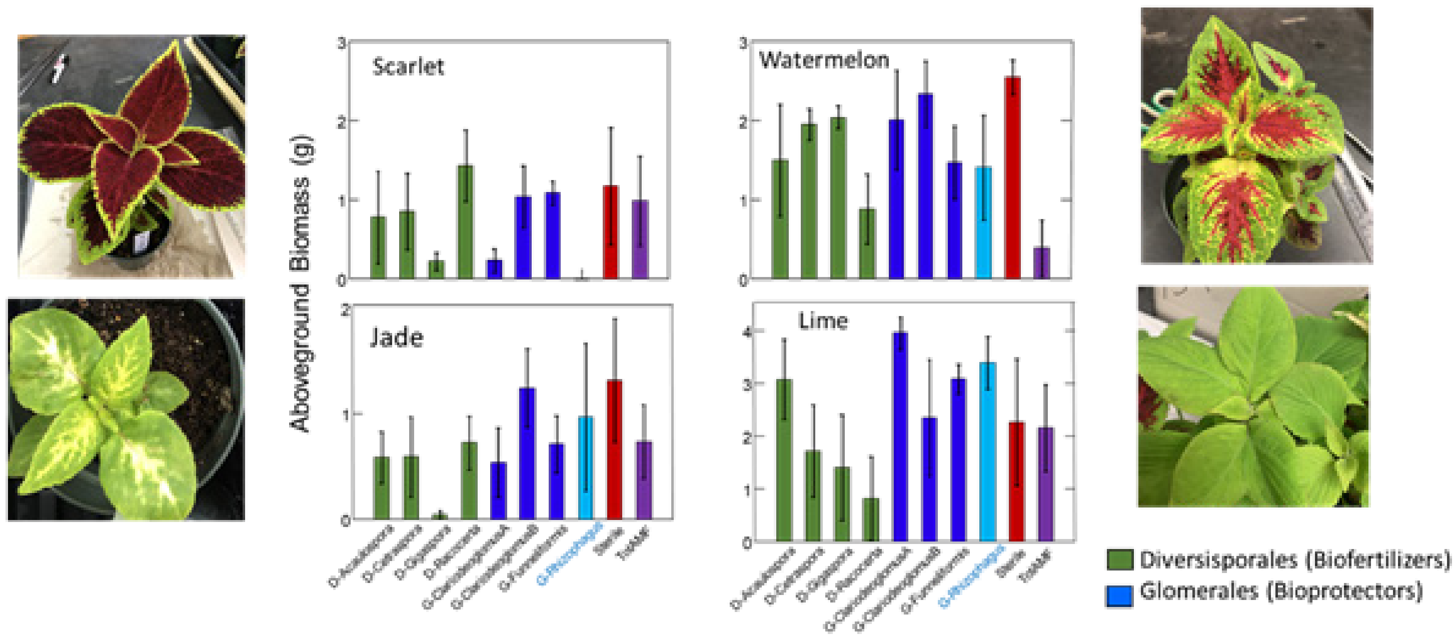
Experiment #1: Aglaonemas
The commercial biofertilizers had no effects on growth of the three Aglaonema cultivars over time, but the AMF mixture increased red leaf coloration in the Siam cultivar by 160% (Figure 2). Plants will be harvested in December 2021 for biomass data and additional image analysis. Leaf anthocyanin content will be measured in preserved leaves in spring 2022.

Figure 2. Effects of AMF biofertilizer products on Aglaonema growth and leaf coloration.



Experiment #2: Coleus:
Individual AMF species had variable effects on aboveground growth of the different Coleus cultivars (Figure 3). Overall, species in the order Diversisporales, which I expected to have strong biofertilizer effects, were less beneficial to plants than species in the order Glomerales, which I expected to act more as bioprotectors. Rhizophagus intraradices had inconsistent effects on plant growth, despite the fact that it is extremely common in commercial biofertilizer products. Root biomass, leaf image analyses, and anthocyanin analyses will be finished in spring 2022. I plan to conduct a second round of this experiment design using two cultivars of Sedums starting in January 2022.

Figure 3. Effects of AMF single-species cultures on Coleus growth.



Conclusions

Preliminary results from these experiments indicate that AMF can have positive biofertilizer effects on foliage plants. Sedum and Coleus plants showed increased vegetative growth, and Aglaonemas showed increased red leaf variegation when inoculated with some types of AMF. Later analyses will examine whether these benefits are correlated with increases in plant defensive chemistry, particularly leaf anthocyanins. Possible next steps for this project include assessing AMF as bioprotectors for foliage plants by evaluating their contributions to plant drought tolerance and pest resistance.

Dr. Sarah Emery is a plant ecologist at the University of Louisville. Her own collection of house plants inspired her research proposal. Her proposal is studying what the potential benefits of a biofertilizer containing Arbuscular Mycorrhizal Fungi (AMF). Her project is using aglaonema and sedum and looking for improved growth and foliage color.

Using LEDs to Improve Longevity of Living Green Walls

PI: Celina Gómez, Environmental Horticulture Department, University of Florida

Abstract:

White light-emitting diode (LED) fixtures were used to compare growth and quality of nine ornamental species grown indoors for 4-mo in a green wall planter. Our findings indicate that 50 µmol·m−2·s−1 is a good light intensity to maintain plants indoors. Considering that only minor differences were measured in plants grown under three broadband white LED fixtures (warm-, neutral-, and cool-white), the recommendation is to purchase fixtures that have a high efficacy and good economic value.

Objectives:

In two separate experiments, this project evaluated the use of broadband white LEDs to grow ornamental plants in indoor living green walls. One experiment compared plant growth and quality under three photosynthetic photon flux densities (PPFD; light quantity). The other experiment compared the same parameters under three colors (quality) of white LED fixtures.

Methods

Two Florida growers (Oglesby and Agri-Starts) were asked to provide plant material that could be used for indoor living green walls. Figure 1 shows the different plant species that were shipped for the experiments, which included 1) Homalomena 'Emerald Gem', 2) Anthurium 'Baby Red', 3) Syngonium 'Coral', 4) Medinilla sp. 'Gregori Hambali', 5) Syngonium 'Mango Allusion', 6) Syngonium 'Glo Go', 7) Stromanthe 'Burle Marx', 8) Heucherella 'Gold Zebra', and 9) Schefflera 'Amate Soleil'. Both experiments started in mid-April 2021, immediately after receiving the plants.

Figure 1. Plants evaluated in the study.

One plant of each species was randomly transplanted into individual 0.6-L pockets within 3 × 3 green wall planters (Figure 2). Pockets were filled with a peat-based substrate and a controlled-release fertilizer was top-dressed after transplanting. Plants were hand-watered as needed throughout the duration of the experiments, and the frequency of irrigation events was recorded for each species within each experiment.

Both experiments were conducted indoors in separate 12-m2 growth rooms. Each growth room was equipped with four opposite shelving units (blocks), each with three treatment compartments (replications). Each compartment held two green wall planters, for a total of eight planters per treatment. Both growth rooms were set at a constant 22 ± 1 °C and relative humidity was maintained at 50 ± 10%. In both experiments, plants were grown under a 12-h photoperiod.

Figure 2. Representative planter at the beginning of the experiments.

In the experiment evaluating light quantity, PPFDs of 25, 50, and 75 µmol·m–2·s–1 were used, resulting in daily light integrals (DLI) of 1.1, 2.1, and 3.2 mol·m–2·d–1. Neutral-white LED fixtures with 19% blue light were used for that trial, controlled by dimmers.

In the experiment evaluating light quality, warm-, neutral-, and cool-white LEDs were used, providing approximately 11%, 19%, and 28% of blue light, respectively. All treatments delivered and average PPFD of 50 µmol·m–2·s–1.

Plants were grown until mid-August (4 mo). Data collected included growth (plant width, leaf no. and area, shoot and root dry mass), quality (SPAD, colorimetry, and carbohydrates), and photosynthesis.

Results

Preliminary results indicate that as expected, higher PPFDs increased growth of most plants. Figure 3 shows results for shoot dry mass, which generally represent the trends measured in most other growth variables. Plants grown under 25 µmol·m–2·s–1 were small and did not fill in the planters, likely making them less attractive to consumers. Further, leaf-level photosynthesis was highest under 50 µmol·m–2·s–1. These findings suggest that an intermediate PPFD could be sufficient to maintain plants indoors with limited active growth. Considering that larger plants will likely require more maintenance (e.g., due increased pruning and irrigation frequency), 50 µmol·m–2·s–1 is recommended as an adequate light intensity for living green walls use. However, further studies should evaluate the effect that limited PPFDs have on variegation patterns and leaf color, as studies have shown that low light intensities can negatively affect some of those quality attributes in plants.

Preliminary results from the light quality experiment show only minor differences among treatments, indicating that all three LED fixtures are appropriate for indoor living green-wall use. Figure 4 shows results for shoot dry mass, which indicate that Heucherella 'Gold Zebra' was the only type of plant affected by light quality, for which neutral-white LEDs increased growth compared to cool-white LEDs. Small differences in leaf area and yellowness were measured for a few other species. Considering that light quality had minor effects on the growth and quality of these plants, fixture efficacy and cost should be the deciding factor when purchasing fixtures. In addition, human perception of plant quality and health under the different types of fixtures may be an important factor to consider for interiorscaping applications.

Conclusions

Our study shows that 50 µmol·m–2·s–1 is a good target PPFD to maintain plants indoors for living green-wall use. Considering that only minor differences were measured in plants grown under the three broadband white LED fixtures evaluated, the recommendation is to purchase fixtures that have a high efficacy and good economic value. Future studies should evaluate the response of mature plants that would enable the evaluation of light on maintenance responses. We also recommend evaluating plants with similar growth habits and water requirements. Regarding plant type, Homalomena 'Emerald Gem' and Schefflera 'Amate Soleil' had the best growth and quality in both experiments, as they nicely filled in the planters. In contrast, Syngonium 'Mango Allusion' is not recommended for living green-wall use due to its vertical growth habit.

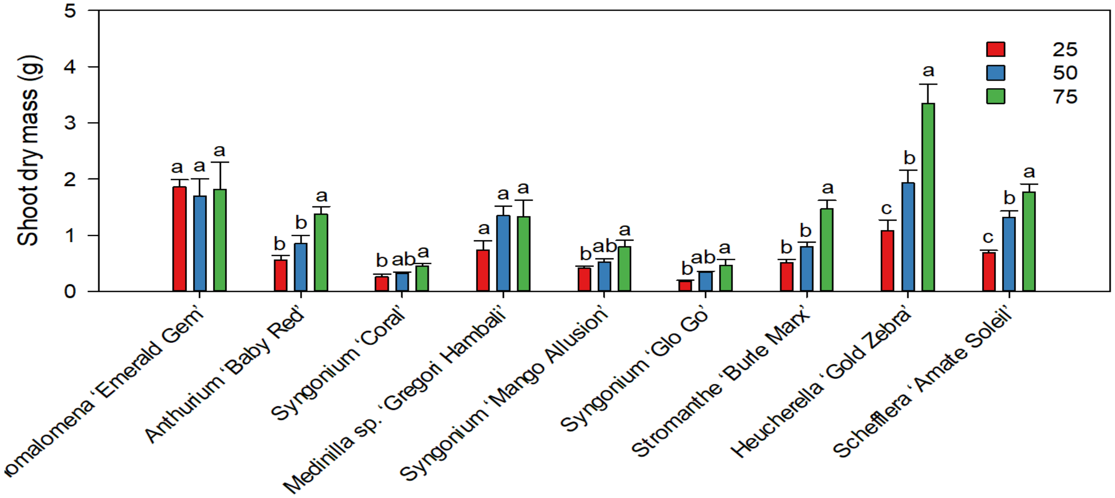


Figure 3. Shoot dry mass of nine species grown indoors under three photosynthetic photon flux densities.

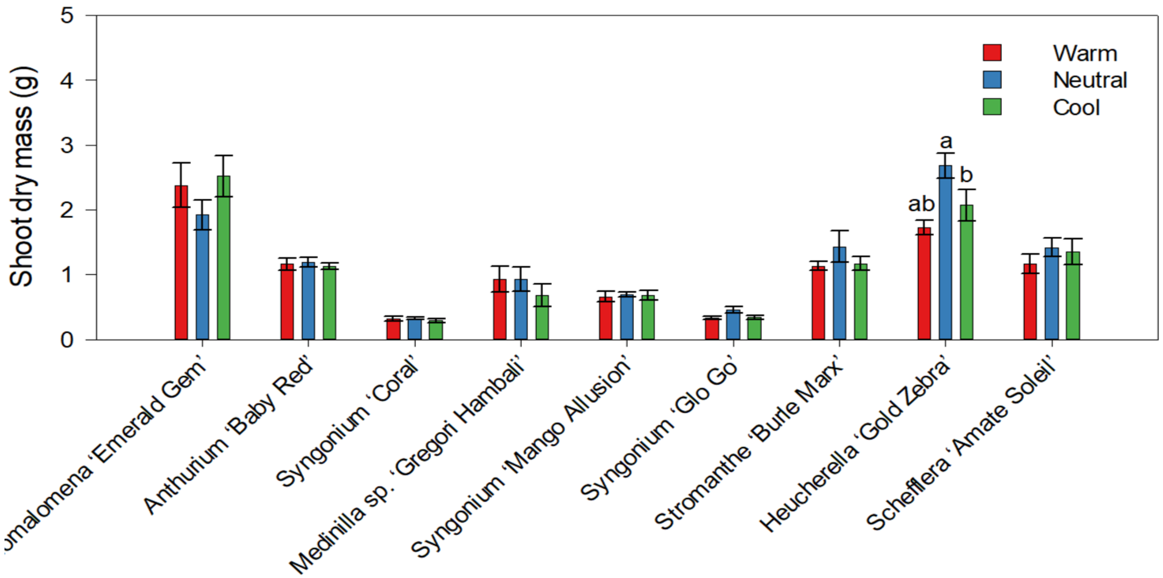


Figure 4. Shoot dry mass of nine plant species grown indoors under three types of broadband white LEDs.

Dr. Gómez has research and teaching responsibilities in the Environmental Horticulture Department at the University of Florida. The research component of her program includes evaluation of new crops and innovative production systems for the controlled environment horticulture industry. She leads several projects that typically belong to one of three subject areas: 1) indoor propagation of high-value crops, focused on leveraging indoor farming technologies to acclimate hard-to-root young plants; 2) urban gardening, focused on supporting the increasing consumer interest in growing vegetables in residential environments; and 3) lighting for indoor plant production, focused primarily on evaluating plant responses to light spectrum or quantity. In collaboration with industry partners, she established the 'Research on Urban Gardening' (RUG) consortium to help develop research-based solutions for the horticulture industry and for consumers in the edible gardening sector. Dr. Gómez is also involved in other projects that are of interest to Florida growers.

Improved Precision Irrigation of Trees in Planning and Managing Florida Friendly Landscapes - *PI: Richard Beeson, Hang Duong, University of Florida/Mid Florida Research and Education Center*

ABSTRACT

Increased water use from a growing population is straining Florida's limited water supplies. Florida-Friendly LandscapingTM (FFL) can reduce the strain with the right plant in the right place. Water demand of FFL plants during drought, particularly valuables trees, is largely unknown. The purpose of this research is to quantify minimum water demand by comparing two signature landscape trees, southern magnolia and live oak, with and without water stress grown in containers using a sophisticated weighing lysimeter system. A second study tracked canopy and root growth of water stressed trees in large containers. Finally, a model was derived for water use strategies and risk of water stress in these two species in order to predict the probability of seasonal irrigation needs of a FFL. We found that southern magnolia and live oak have different strategies to cope with water stress. Southern magnolia appeared to be the conservative species, minimizing water use by closing stomata, and maintaining thriving roots in the shallow soil profile to accommodate water replenishment schedule. In contrast, live oak sustained water use by keeping stomata open to the point of shedding their leaves to reduce projected conductance and protect them from hydraulic failure. Live oak invested in a deep root system, which included more fine roots to explore the water resource in the deeper soil layer. Live oak required more water (50-55% of the optimum demand) to stay green, compared to magnolia (35-40%), However, tree size will be reduced significantly in magnolia under severe deficit irrigation and it will affect the values of this tree species in the landscape even though the leaves remain green.

OBJECTIVES

This study consists of three different parts using the two most popular landscape tree species in Florida: anisohydric live oak (Quercus virginiana) and isohydric southern magnolia (Magnolia grandiflora), with the aim to:

- Study the behavior of stomatal conductance (related to transpiration), photosynthesis, and predawn leaf water potential (how tightly water is held) of these two species under progressive water stress
- Study above-ground growth and root growth (root depth, number of fine roots, ratio of root/shoot) under deficit irrigation conditions (defined as 30% of well-watered irrigation)
- Apply the results of research on oak and magnolia by analyzing in the context of changes in reference transpiration (ETo) and the frequency of dry periods in central Florida in recent decades.

METHODS

Part 1. Three progressive dry-downs were conducted from 2019 to 2020 in early and late dry seasons using a weighing lysimeter system that precisely measured changes in tree-container weight due to transpiration. Six trees of each species were suspended from a 2-m high tripod lysimeter in a metal basket holding the container from an electronic load cell sensor that measured weight changes. Load cells were wired to a data logger system that measured lysimeter weight every half hour for irrigation data. The data logger calculated water loss from the previous day's (ETA), which was relayed to solenoids valves for durations of irrigation and replaced water loss. For water stressed live oak trees, the datalogger replaced only 90% of water loss, imposing a slow dry down. For water stressed magnolia trees, the amount of water replaced was adjusted within a range of 90% to 20% to speed up the stress levels when necessary because magnolia uses less water than live oak, leading to a slower dry down process. A dry down was finished when measures of water stress (reduced transpiration, increased xylem water tension, and visual quality) and daily water use was about 40% of the well-watered trees. There were three dry-downs for each species: two in early dry and one in late dry season. New sets of trees were used in each dry-down. After each dry-down, trees were removed from the lysimeter baskets and well-irrigated. Growth was measured at the end of four to six months to assess long-term impact on each species.

Part 2. The root study experiment ran for 14 months, concurrent with the three dry-down studies described in Part 1. Eight trees, four for well-watered four for drought of each species were grown in meatal barrels (85cm height, 58cm diameter) to allow root growth more representative of an in-ground landscape setting. Five trees of each species were assigned to a water stress treatment where they were being deficit irrigated at 30% of the control, well-watered trees were irrigated at full replacement of local evapotranspiration. Impact of water stress was measured every three weeks by changes in photosynthesis, transpiration, internal water tension and growth (height, trunk diameter). At the end of the experiment, measurements of total leaf area, shoot elongation, and trunk growth were recorded. To assess the ability of the root systems to exploit soil water, maximum root traits such as total root length, root diameter, root volume, total fine root length, root dry weight by depth, and functional root traits such as root length density and specific root length were recorded. The results will compare how the two species, differ anisohydric versus isohydric water use strategy, allocate carbon between root growth and top growth in response to drought.

Part 3. Historical daily rainfall and evapotranspiration (ETo) data from 1970 were collected from four weather stations from north, central and south Florida. I will analyze these data for length and intensity (rainfall minus ETo) of dry periods, both during the drier winter and wet summer seasons, through a machine learning-based approach. Machine learning has become a powerful tool to handle large climate data sets to determine the scale of potential drought, and potential changes over time. I will then link results from the previous two studies on tree water use with contrasting water use strategies (isohydric magnolia and anisohydric oak) under water stress to analyze the risk of dry periods across a scale of duration and intensity on tree growth. This analysis can improve both planning and management of water in Florida Friendly Landscapes.

RESULTS

R1. Behavior of stomatal conductance, photosynthesis and predawn leaf water potential of these two species under progressive water stress

Magnolia's stomatal conductance (gs) readings were significantly lower than that in live oak. Generally, magnolia's gs decreased throughout the day, highest in the mid-morning and lowest in the mid-afternoon; the values of gs at noon and mid-afternoon were very close and significantly different from that in the morning in both dry-downs. The difference between mid-morning stomatal conductance and noon, and/or mid-afternoon were much higher in magnolia water stressed trees compared to that in well-watered trees. Meanwhile, live oak's gs did not show this pattern, except in the second dry-down (2020-2021) in water-stressed trees. Live oak's gs mid-morning and mid-noon were almost similar, even mid-noon gs were higher than mid-morning gs in well-watered trees.

In magnolias, gs of water-stressed trees quickly declined in comparison to that of well-watered trees, as soon as water reduction started. The difference in gs in between the two treatments gradually increased along with the progressive dry-down (figure 1-A). This trend was translated and reflected in water use/transpiration of this species

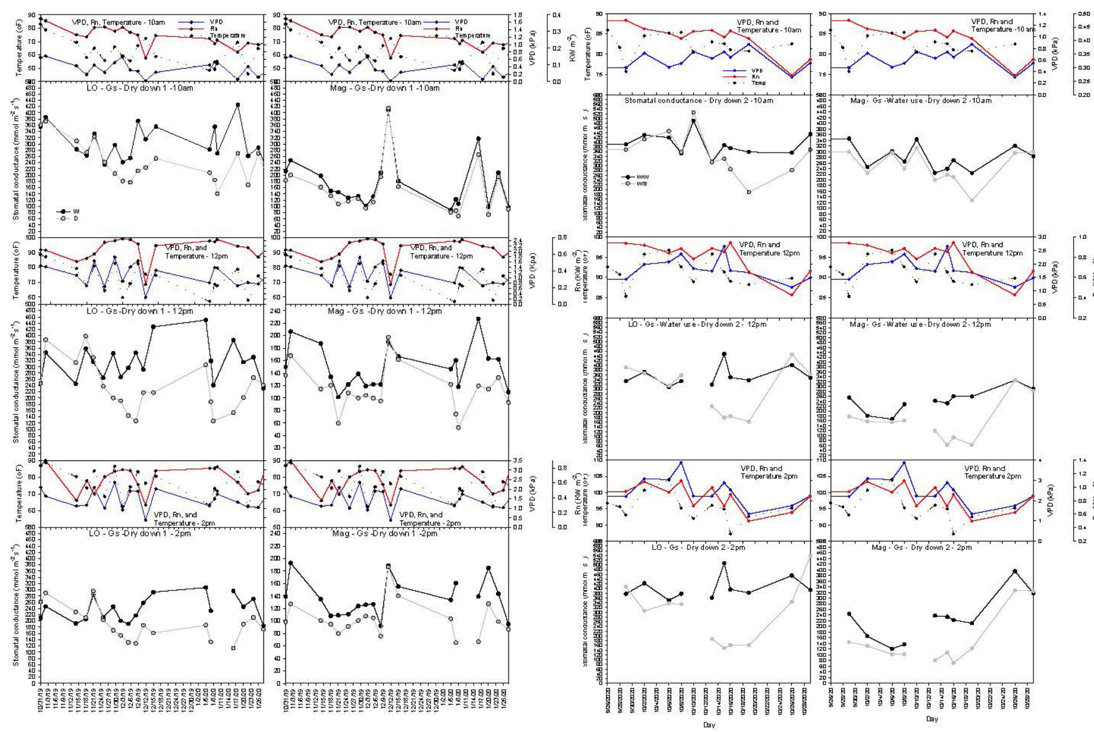


Figure 1. A-left. Stomatal conductance and microclimate data (VPD, Rn, Temperature) mid morning, mid noon, and mid afternoon in dry down 1-right. Stomatal conductance and microclimate data mid morning, mid noon, and mid afternoon (VPD, Rn, Temperature) in dry down 2

Daily water use was reduced in water-stressed trees right after the onset of the dry-down, and progressively declined throughout the dry-down. Water stressed live oaks' gs, in contrast, did not decline compared to the well-watered live oaks, and even increased on the first weeks of the dry down until leaf water potential (LWP) reached around -4 Mpa. Gs decreased a great deal suddenly in both dry-downs. Together with the sudden decrease in gs, some leaves started to turn brown and dropped, which is a typical characteristic reported in most deciduous trees;

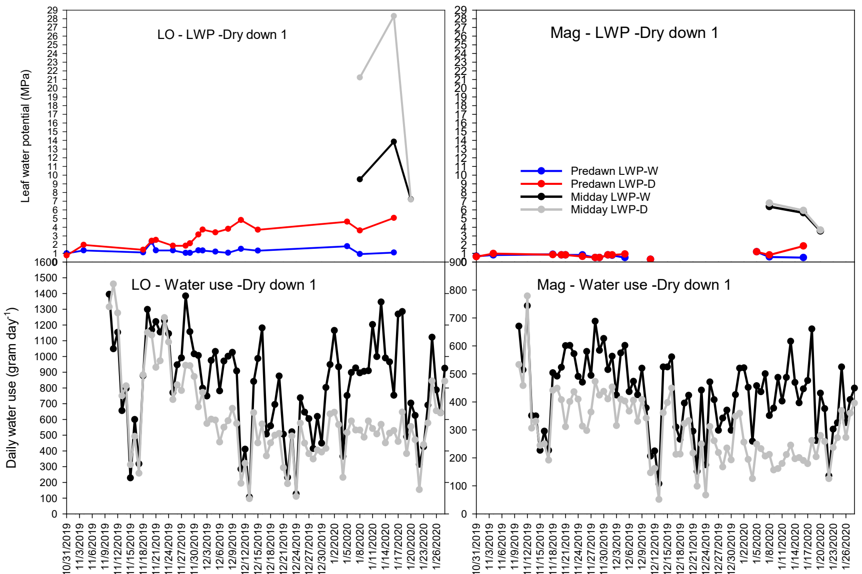


Figure 2. A. Predawn, midday leaf water potential, and daily water use of live and magnolia in dry down 1.

stress – shedding the part that loses water as a trade-off with photosynthesis. With live oak, shedding leaves is also a mechanism to reduce projected losses in conductance; thus, has the potential to improve tree hydraulic failure. This gs change pattern was also translated into daily water use in this species in two dry-downs (figure 2B).

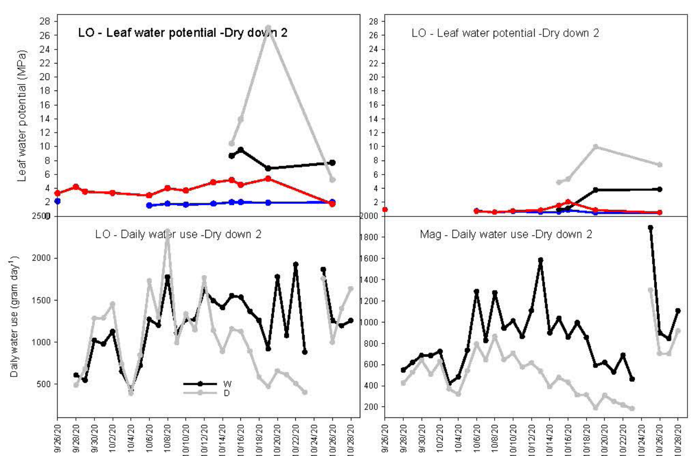


Figure 2. B. Predawn, midday leaf water potential, and daily water use of live oak and magnolia in dry down 2.

Changes in gs in these two species were opposite with the changes in predawn leaf water potential (LWP). As soon as irrigation was reduced, predawn LWP in live oaks went more negative and progressed over time of the dry-down; meanwhile, predawn LWP in water-stressed magnolia stayed at the same level as the well-watered trees for a much longer time, then gradually became more negative with the progress of the dry-downs. In the third dry-down (2021), in late dry season, we managed to adjust the amount of water irrigated back to the pots so that the very similar predawn LWP were achieved in both species. In this case, the same pattern in water use was shown. Even though gs was not measured in this dry down, it is likely that gs would have the same pattern with the two previous dry-downs in both species. Mid-day LWP in magnolia were much lower than that in live oak, with the similar values of predawn LWP. These values tell us that live oak represents very isohydric traits, meanwhile, magnolia showed more of the anisohydric characteristics.

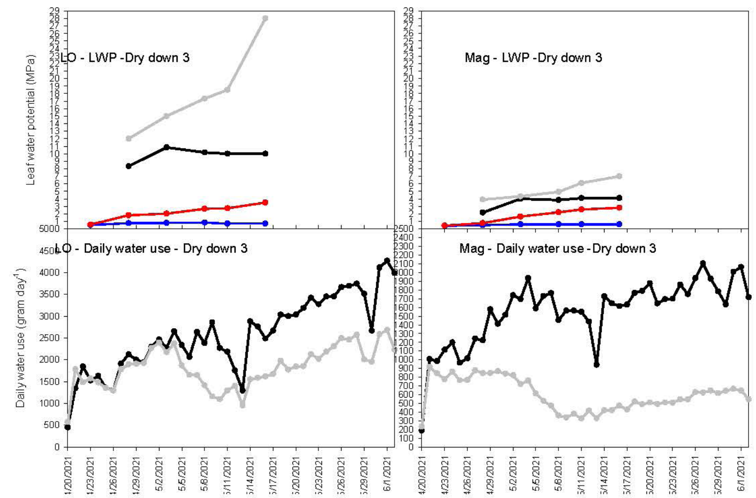


Figure 2. C. Predawn, midday leaf water potential, and daily water use of live oak and magnolia in dry down 3.

Growth subsequences during water stress and after being well-watered under progressive dry down

During the dry down, growth in projected canopy area (PCA), and trunk crossed sectional area (TCSA), and height were not affected by drought for both species in early dry season, which is the time of the year that trees' growth almost ceased. However, growth was apparently affected by drought in late dry season (April – May) in both species (figure 3). Months after being well-watered, PCA and TCSA of water-stressed grew more slowly in the previous drought of exposed trees compared to those in well-watered trees in both species. Height and growth, however, were in contrast. Subsequent growth in height in WS live oak were similar to that in well-watered trees, even grew taller in water-stressed magnolia in the first two dry-downs conducted in early dry season. In the third dry down, in late dry season, all trees' growth parameters declined during the dry down in both species. In comparison with live oak, water-stressed magnolias' growth was much more significantly decreased. However, watered-stressed magnolia showed faster subsequent growth rate than that in well-watered trees, almost reaching the same height, the same PCA and TCSA with the well-watered trees.

Gas exchange and Fluorescence

Non-photochemical quenching (NPQ) is a photoprotective process that removes excess excitation energy within chlorophyll-containing complexes and prevents the likelihood of formation of damaging free radicals. "This type of quenching competes with both fluorescence and photochemical quenching, and acts as a 'safe' mechanism for dissipating substantial levels of chlorophyll excitation energy, depending on the prevailing conditions and species" (Demmig-Adams and Adams, 2006). Our results showed that NPQ measured at the end the first two dry-downs in magnolia were always higher than that of live oak. At PAR 1400 μmol m-2 s-1, NPQ increased from 3.3 to 4.6 with the increase of PAR from 1200 to 1400 μmol m-2 s-1 in magnolia on average on both well-watered and water-stressed plants. Meanwhile, the difference in this parameter in live oak was much lower and had contrasting results between well-watered and stressed plants: NPQ decreased from 3.1 to 2.9 in well-watered plants and increased from 2.8 to 3.4 in water-stressed plants. This could be the explanation for the faster growth rate in WS magnolia after being well-watered, compared to live oak.

Table 1. Non photochemical quenching in live and magnolia

Non photochemical quenching			
Species	*Water treatment*	*Light intensity (PAR) (μmol m^{-2})*	
		1200	***1400***
Magnolia	W	3.37	4.56
	D	3.33	4.77*
Live oak	W	3.07	2.85
	D	2.80	3.39*

R2. Study root growth (root depth, number of fine roots, ratio of root/shoot) under deficit irrigation conditions (defined as 30% of well-watered irrigation)

Tree growth

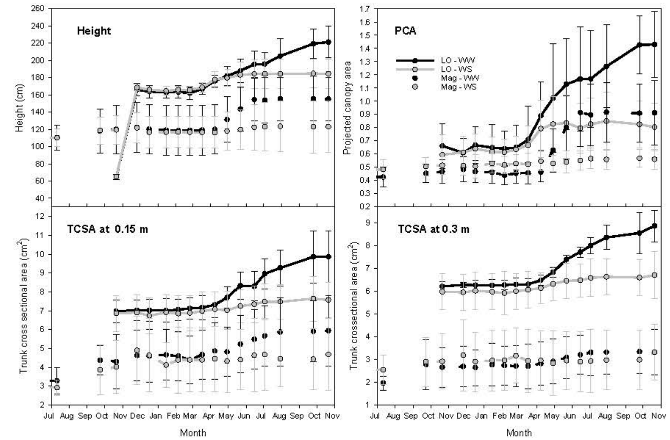


Figure 3. Height, projected canopy, trunk crossed sectional area at 0.15m and 0.3m of live oak and magnolia under long term soil water deficit

Long-term drought had great impact on reducing tree sizes in both species in terms of height, PCA and TCSA at 0.15m. There was no growth in water-stressed magnolia; however, there was still growth in water-stressed live oak from April to June in height and from April to May in PCA compared to well-watered trees (figure 3).

Root traits

Live oak's root diameter was much smaller than magnolia's root (Fig. 4-D). Root diameter decreased under water stress in all soil layers in live oak, but did not change for the top soil layer in magnolia. Total root surface area decreased in water-stressed live oak in all soil layers, in contrast, root surface layer did not change in water-stressed magnolia compared to the well-watered trees. Total root length decreased throughout the soil profile in live oak under deficit irrigation. Total root length of magnolia decreased under deficit irrigation in the middle and bottom layer; however, remained the same as in well-watered conditions. Root length per volume soil stayed the same in the top layer in magnolia and decreased in the next two layers under deficit conditions. In contrast, it remained the same in the bottom layer, but decreased in the top two layers under deficit irrigation in live oak. Very fine root ratio (VFR) at the bottom layer remained the same under drought conditions in live oak (22% and 21% in well-watered and water-stressed trees, respectively). Meanwhile, VFR decreased from 18% to 15% in magnolia under drought conditions.

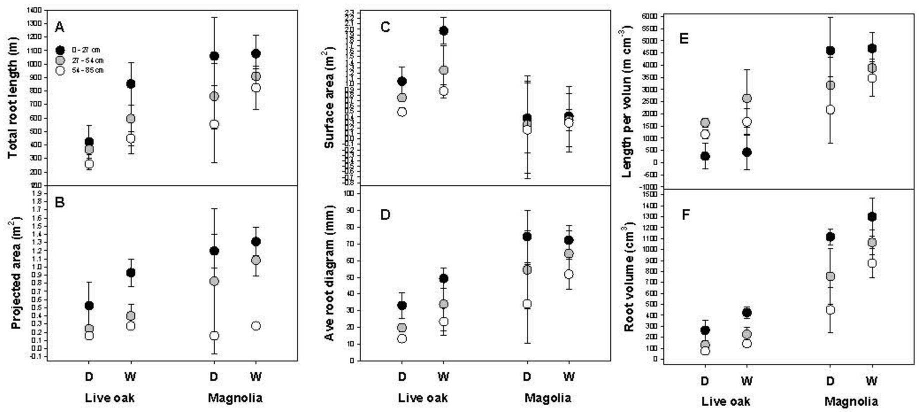


Figure 4. A-F: A. Total root length, B. Projected root area, C. root surface area, D. Average root diagram, E. Total root length per volume, F. Root volume of live oak and magnolia under long-term soil water deficit

Live oak with small mean root diameter and higher specific root length (SRL) associated with strategies for fast acquisition because they allow fine soil exploration for water without high carbon investment per unit of root length. The root tissue (RTD) increases in the deeper soil layer in live oak, most likely due to tissue reinforcement. Florian Fort et al., (2017) reported that this increase was coupled with a decrease in aerenchyma percentage that could allow live oak to survive under water shortage by the production of dense and protected root tissues (Hacke et al., 2001). Deeper roots in live oak trees provided a mechanism of dehydration avoidance, together with light decrease in stomatal conductance, sufficient to maintain leaf turgor. Meanwhile, the major mechanism to avoid dehydration in magnolia is the focus on shallow root, and strong closure of stomata that will keep the tree alive; however, in the long run, the plant will likely stop growing, similar to the bonsai effect (figure 4).

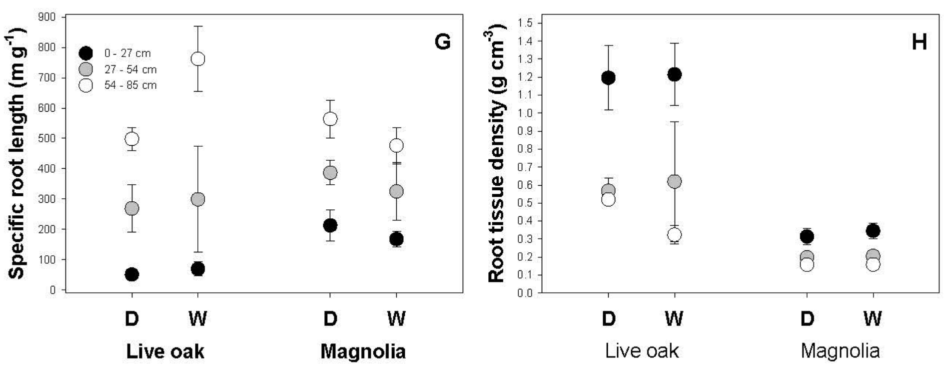


Figure 4 G_H.: G. Specific root length, H. Root tissue density of live oak and magnolia under long-term soil water deficit

R3. Intensity and frequency of dry periods analysis in central Florida in recent decades will include these two contrast trees in terms of water use in this climate context. Currently we are working on this part and planning on completing it in January 2022.

CONCLUSION

Under drought, the main regulation mechanism that limits water loss and buildup of excessive xylem tension in magnolia is through rapid closure of stomata with the cost of limiting carbon assimilation, thus, reducing plant growth a great deal along with the progress of soil water deficit and the length of the drought. Together with early and rapidly closing stomata, magnolia showed the ability to protect its leaves from the likelihood of formation of damaging free radicals by increasing non-photochemical quenching (NPQ), which is a photoprotective process that removes excess excitation energy within chlorophyll-containing complexes, especially under abiotic stresses such as drought. Magnolia appears to be water conservative, consuming the water resource slowly and minimizing water stress over long periods of time. And/however with opportunistic strategies, which focus more on developing roots on more shallow soil profiles, thus relying on shallow water and maximizing transpiration and growth after water was replenished.

On the other hand, live oak appeared to process fast water resource acquisition with more fine and deep roots under soil water deficit. Under soil water stress, live oak stomata remain open, which results in more negative leaf water potential, and potentially risking the excessive xylem tension and loss of turgor. Therefore, live oak rapidly sheds leaves to reduce projected loss of conductance.

Project Ph.D. student Hang Duong has been working on plants and water relations since she started as a lecturer in Vietnam National University of Agriculture. She was studying drought tolerant traits in hybrid rice to provide useful information for rice breeders in Vietnam to produce drought tolerant varieties that survive and produce during Vietnam's spring dry season, a climate fairly similar to central Florida. Her passion for water-plant studies grew over time.

She completed a MS from Utah State University on turfgrass drought stress. Currently, she's working toward her PhD degree at the University of Florida, in the department of Environmental Horticulture.

Tipping Bucket Rain Gauge for Measuring Leaching Fraction in Container Nurseries

Tom Yeager and Jeff Million, Department of Environmental Horticulture, IFAS
Craig Warner, Department of Astronomy, University of Florida, Gainesville, Florida

Abstract

Leaching fraction is the amount of container drainage divided by the amount of water applied to the container expressed as a percentage. Leaching fraction measurements are conducted manually and have been used in container plant production to manage irrigation application amounts. However, due to the current shortage of personnel it is difficult to accomplish the task. Thus, the objective of the proposed work was to develop a technology-based system for automatically conducting leaching fractions.

An Arduino with Bluetooth capability was wired to small tipping rain gauge. The gauge was placed under an elevated container that rests on pizza pan with hole to direct container drainage into the tipping gauge. Each tip was counted by the Arduino. A mobile application was developed that received the tip data from the Arduino via Bluetooth connection. The application calculated the leaching fraction and desired irrigation operation or run time based on user inputs and tip data from the Arduino. Evaluations are currently underway at the University of Florida, IFAS to enhance the functionality of the mobile application and Arduino-based leaching fraction system for determining container plant irrigation needs. Subsequently, evaluations will be conducted in production nurseries.

Introduction

Monitoring the drainage or leachate from a container can be used to determine the amount of irrigation to apply. One method currently used to monitor drainage is conducted in the greenhouse or the field with a few materials such as pizza pan resting on wood supports as seen in Fig. 1

The container drainage after irrigation is collected and the volume or weight determined. The amount of drainage is usually expressed as a percentage of the irrigation applied to the container. This relationship of irrigation applied, and drainage is called the Leaching Fraction (LF) calculated with the following formula: LF = drainage or leachate from container ÷ irrigation applied to container. The intent is to collect as small amount of drainage as possible; however, our research has revealed that a LF of approximately 15% for trade 3-gallon containers and 20-25% for larger containers, such as trade 5 to 15-gallons are good targets.

Even though LF is a simple method for guiding irrigation application amounts, there has been some reluctancy for producers to use LF tests. That reluctancy is primarily due to the set up or preparation time needed for each test. Setup involves placing a reservoir or pan that collects drainage under hole in the pizza pan. During irrigation, drainage flows from the substrate onto the pizza pan and through the hole. Pizza pans are used for large or small containers to direct leachate or drainage as seen in Fig 1. Personnel return to the field after irrigation and physically measure the drainage as a weight or volume, record the value, and calculate the LF. Additionally, rain that occurs after setting up the LF assembly negates the effort as the LF test must be repeated. Thus, the purpose of the proposed research was to overcome the time constraints that result from these difficulties by automating the process for determining the LF.

Fig. 1. Leachate or container drainage moves through a hole in round pizza pan for collection in reservoir below.

Objective: Develop and evaluate a tipping gauge leachate-measuring system for container plants.

The Process or Methods

Tipping bucket gauges are used for measuring rain amounts and offer the ability to accurately measure small volumes of water. So, we purchased tipping gauges like that seen in Fig. 2.

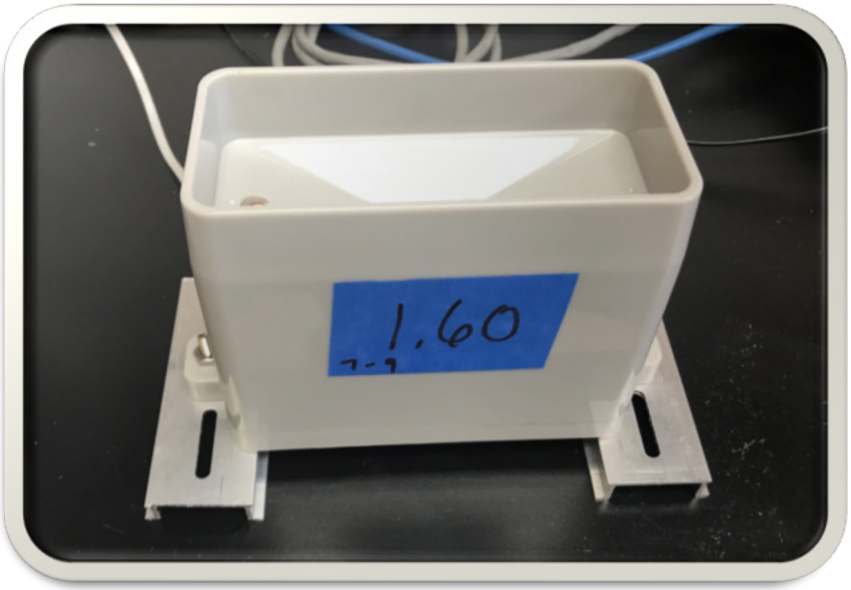


Fig. 2. Tipping gauge used for measuring container drainage is approximately 4.5L x 2.0W x 3.5H inches.

Inside the gauge cover is a rocker that tips once full of water. Each tip of the rocker (Fig. 3) completes the electrical circuit of an energized gauge.

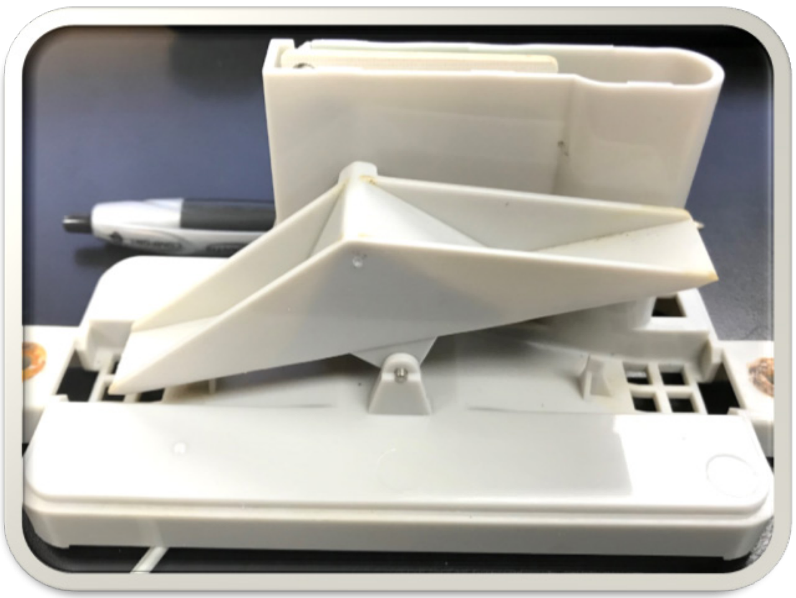


Fig. 3. Rocker tips after filling with drainage or leachate.

Our initial efforts to count the tips were facilitated by electronic digital counters. Counters were connected by wire to gauges, and both were energized with a 9-volt battery (Fig.4).

Fig. 4. Digital counters were connected to gauges, and both were energized with 9-volt battery.

A tipping gauge was placed beneath the 0.5-inch hole in pizza pan (Fig.5a). For sprinkler irrigation systems, irrigation water was shielded from entering the pizza pan by placing medical wrap (Fig. 5b) around the pizza pan lip and lower container sidewall.

Fig. 5a and 5b. Tipping gauge beneath container for micro-irrigation (left, 5a) and for sprinkler irrigation (right, 5b). Medical wrap was placed around pizza pan to inhibit sprinkler irrigation from entering pan.

Calibration tests were conducted, and it was determined that each tip of the gauge equated to 1.6 milliliters of drainage (Fig. 6). The digital counters functioned well; however, it required manually recording the count data for each tipping gauge used to calculate the LF.

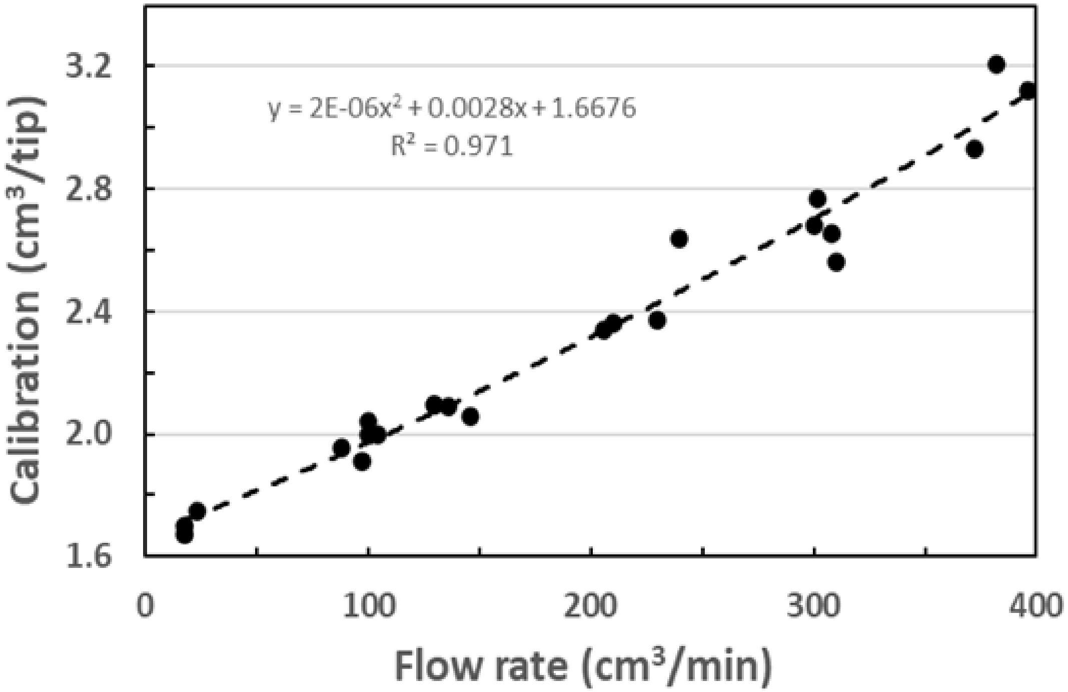


Fig. 6. Calibration tests revealed each tip was 1.6 milliliters (1.6 cm3) when flow was 30 milliliters per minute.

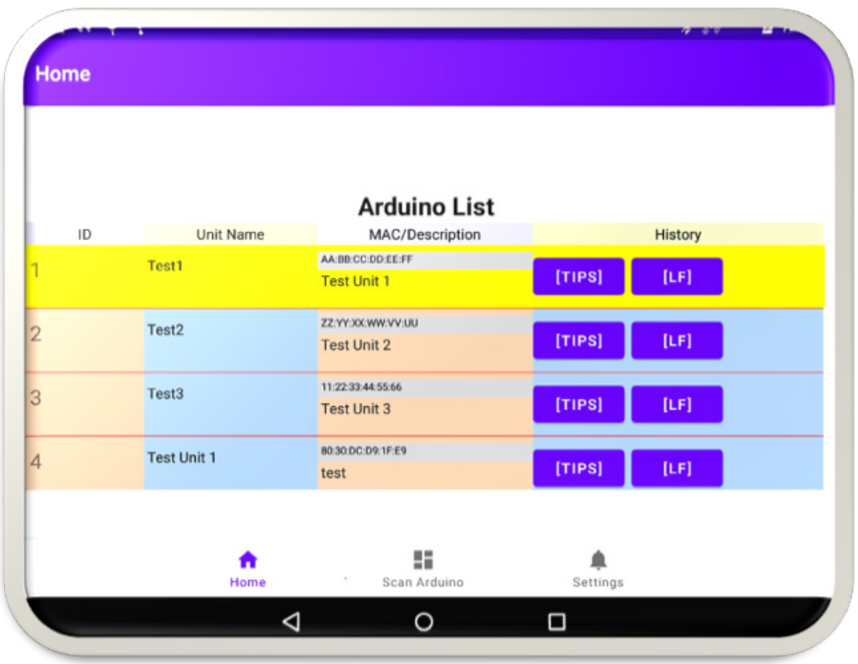


Fig. 7. Arduinos within Bluetooth range are listed on screen of the mobile application.

Results of the Process

To eliminate manually reading and recording tip counts, and further automate the LF procedure for guiding irrigation management, we proposed to use an Arduino microprocessor connected to the tipping gauge. The Arduino has Bluetooth capability and a data shield with memory card for backup data storage. The Bluetooth capability of the Arduino enables communication between an application on a mobile device and the Arduino. Thus, an application was developed to manage tip count data collected by the Arduino.

Users of the application provide inputs such as an Arduino unit name. The Arduino name entered by user will most likely refer to a designated irrigation area or irrigation zone. The screen shot in Fig. 7 represents a scan of the Arduinos within range of the mobile device. The Media Access Control (MAC) number is specific for each Arduino and is automatically assigned by the manufacturer. From the Arduino List screen of the application, the settings can be selected.

An example of the settings is given in **Fig. 8**. The user will enter the irrigation zone description, irrigation application rate and run time or duration, along with container diameter and the desired or target LF (%) for the area or zone under consideration. The application will calculate a new irrigation operation run time (minutes) based on these inputs and the current LF calculated from the previous tip counts. The Arduino records tips at the end of each day; however, the user may initiate a scan anytime to see current tip values.

The LF History screen (**Fig. 9**) reveals the current LF and run time RT, as well as the desired run time (RTT) to achieve the desired or target LF (LFT). The RTT value (minutes) was used to set the irrigation controller to achieve the LFT (%).

Evaluation of the mobile application and Arduino for determining the LF of container plants is currently underway at the University of Florida, IFAS, Gainesville, Florida. The Arduino and battery were placed in water-tight plastic tub and connected to tipping gauge with flexible insulated wire. A photo of an Arduino connected to tipping gauge is given in **Fig 10**. The LF assembly and Arduino remain in the field or irrigation zone, ready for the next irrigation. Hence, the user does not spend time getting ready for the next LF test.

Fig. 8. The user inputs information needed at the settings screen for the application.

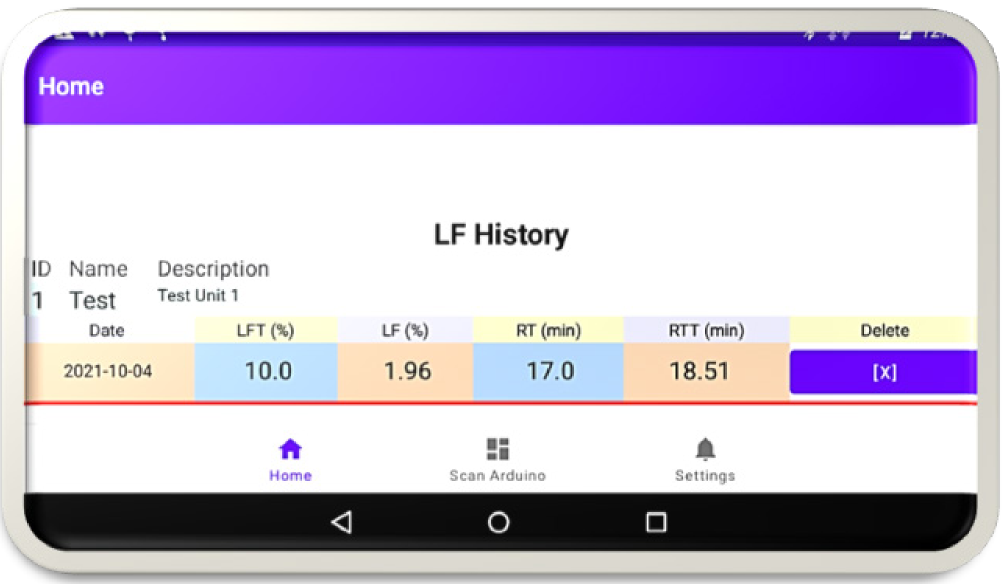


Fig. 9. The RTT value is used to set the irrigation operation time to achieve the desired leaching fraction (LFT) of 10 %.

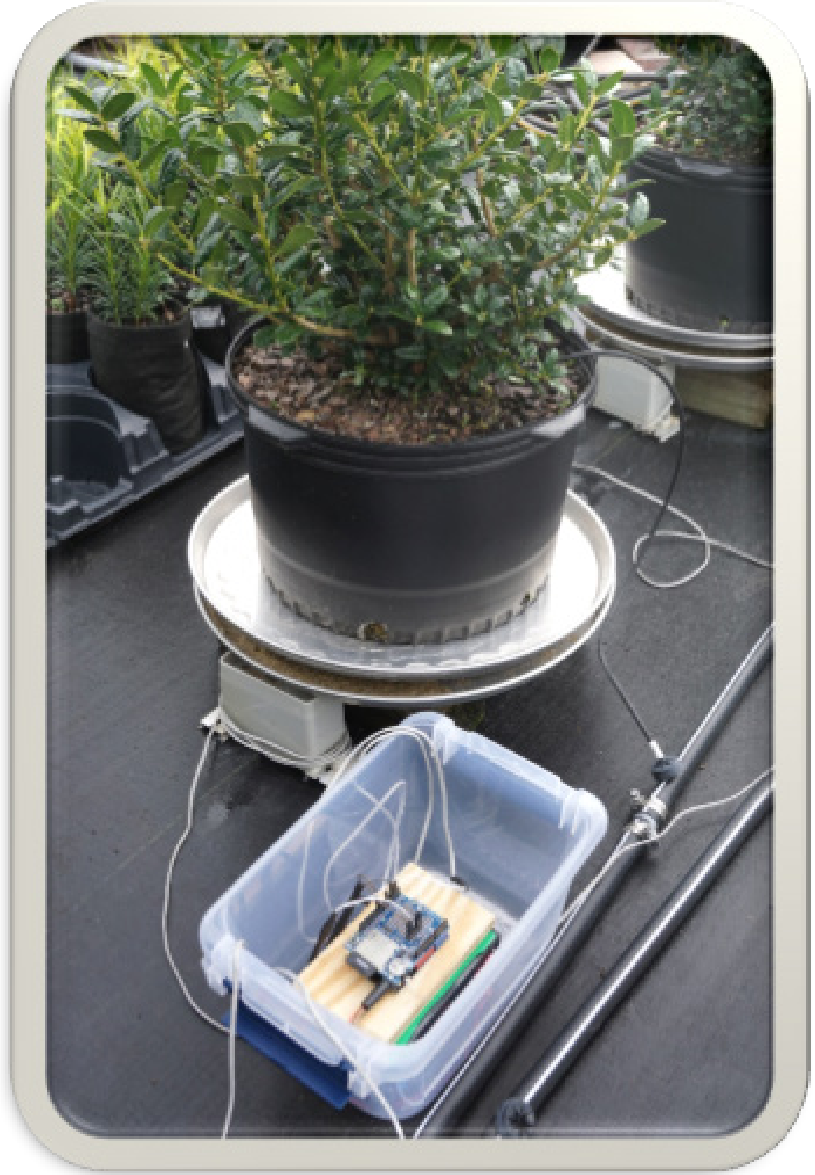


Fig. 10. Arduino in plastic tub is connected by wire to tipping gauge under hole in pizza pan.

Table 1. Preliminary data for average tip counts obtained via mobile application that was Bluetooth connected to Arduinos or electronic digital counters wired to tipping gauges.

Date	Irrigation Line	Arduino with Mobile Application	Electronic Digital Counting
	ID Number	Average Counts for Four Gauges	Average Counts for Four Gauges
Nov. 23, 2021	2	282	284
Nov. 23, 2021	7	307	334

Preliminary counts obtained with tipping gauges at University of Florida are given in Table 1. These limited data indicate a maximum variation of 27 tips that accumulated over two irrigation cycles. Additional data will be collected to help understand the variation in tip counts that might occur in the field.

The Future

Future evaluations in the nursery will provide insight regarding the number of LF assemblies and Arduinos needed for managing an irrigation zone for optimal crop production as well as tailoring the mobile application for efficient use. Producers may relocate LF assemblies and Arduinos as needed or make additional assemblies and purchase components rather than moving them. Currently, Arduino with the data shield that facilitates data storage when power is lost costs approximately fifty dollars and recyclable batteries are twenty-five dollars. Arduinos can be powered off to conserve energy; however, the longevity of battery power has not been determined. A tipping gauge is approximately twelve dollars, depending on quantity purchased. All components have been purchased at websites of vendors. Thus, monitoring LF for two containers requires approximately one-hundred dollars of electrical components compared with a single electronic substrate moisture sensor that exceeds one-hundred dollars. In addition, a moisture sensor should be calibrated and removed from the container before sale. Additionally, the moisture sensor will likely require a network or grid of electronics in the greenhouse or in the field where lightning is a detriment.

How will the producer determine the substrate moisture status or how much irrigation to apply in the future? Whether it is a future of LFs and Arduinos or sensor-based technology - time will tell. However, we can count on a future filled with electronic-based tools not only for managing irrigation, but for accomplishing most tasks in the environmental horticulture industry.

Tom Yeager spent his teenage years helping a neighbor with growing container plants. His inquisitive mind had many questions about why things were conducted a certain way and he often wondered if there was a better way to accomplish the task. After completing undergraduate studies, Tom was employed by a wholesale nursery. That was an opportunity to ground-truth some of his inquisitiveness that later culminated in a move to graduate school where the inquisitive hypotheses could be rigorously tested and new methods developed for growing plants. TOM IS NOW CELEBRATING 40 YEARS WITH IFAS.

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SCHOLARSHIPS

On an annual basis, NHFs 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 Fund
- Hoskin/McDougald Fund,
- NHF General Scholarship Fund.

Industry's Future Leaders

2021-2022 James H. Davis & General Scholarship Recipients

Claire Baglien,
The Conway School, Northampton MA
Using ecological landscape design as the medium, Claire wants to work with people in their own backyards and communities to restore ecological function, build soil health to sequester carbon, and prioritize food production. As the child of two entrepreneurs, she also hopes to someday build my own ecological landscape design firm grounded in these values.

Samuel Bennett,
Abraham Baldwin Agricultural, Tifton GA
Samuel is pursuing a degree in Natural Resource Management-Forestry. While specializing in Forestry, he hopes his degree can lead him into wildlife management, parks and recreation, research, timber production, and much more. One of the things that grabbed his attention in recent months was operating a forest nursery.

Felecia Bryant,
Valencia College, Orlando, FL
A native Floridian, a single mother of two bright young girls and an avid nature lover, & backyard beekeeper, Felicia is currently pursuing an A.S. of Plant Science & Sustainable Agriculture at Valencia College. The hope is to eventually combine her plant knowledge, beekeeping hobby, current Yoga Teacher Certification and future nutritionist certification to establish a Whole Health Nutrition & Mindfulness Center - Garden & Apiary; providing families and individuals of all ages with whole food education, customized nutritional guidance, fresh harvest organic produce & cooking demos, as well as yoga & meditation practices.

Adam D'Angelo,
University of Wisconsin, Madison, WI
A graduate student at the University of Wisconsin, Adam is studying Plant Breeding & Plant Genetics. He is a member of the Goldman Research Laboratory, which works with carrots, onion and beets, but his specific research is focused on breeding for flavor and eating quality in table beets, Beta vulgaris. His project is centered on the genetic control of geosmin, which causes the earthy flavor present in beets. Depending on intended market, increasing or reducing quantities of geosmin present in root tissue can have significant effects on consumer preference. The research will also explore various breeding approaches for reducing levels of oxalic acid, which prevents beets from being eaten raw and can contribute to kidney stone formation.

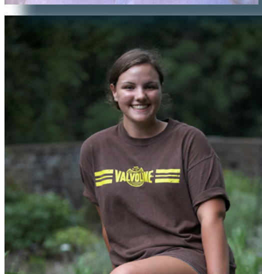
Industry's Future Leaders

Sarah Da Silva Benevenute,
University of Florida, Gainesville, FL
A UF graduate student, Sarah is keeping her research with focus on practices and strategies used to address pests and diseases that threaten agricultural productivity, crop quality, and food security. After finishing graduate school, she would like to become a professor of horticultural sciences on a prestigious university. Her desire is to combine her skills and knowledge acquired during her academic years with her passion in plant science and inspire future generations to become involved as well, make positive contributions to agriculture, and raise awareness about the challenges that agriculture is facing and will deal with in the future on producing food to feed an increasing global population.

Conner Goodwin,
University of Florida, Gainesville FL
As part of his CALS honors program at UF, Conner has recently completed a research proposal under the tutelage of his mentor Dr. Mirian Hay-Roe. His thesis research, which was scheduled to start Spring of 2021, will compare the chemical composition and efficacy of organic matter produced in various worm/larvae composting systems. This experience has shown him the value of focused research in progressing efficacy in targeted horticultural areas. As one of the top Plant Science programs in the country UF has been instilling invaluable practical knowledge regarding plant physiology focusing on the interrelationships between a plant's productivity and its soil, including soil chemical compositions, physical properties, microbial diversity and biodiversity as a whole.

Yuvraj Khamare,
University of Florida, Gainesville FL
After graduation, Yuvraj's plan to work as a successful weed scientist with an agrochemical company or academia, helping to find and develop new methods of weed management. He intends to implement this passion for educating and communicating with the public in his professional career. He hopes to elucidate the often-murky topic of weed management, helping the public to become more competent in the uses and management of weeds in their gardens and landscapes.

Gustavo Kruetz,
University of Florida, Gainesville FL
He is currently a fourth year Ph.D. student working in breeding and genetics of lettuce. Mr. Kreutz has demonstrated great work ethic, commitment, and innovation in his research projects. His long-term goals include, among many things, to become a plant breeder and to help the agricultural industry develop better cultivars that will cause positive impacts in agriculture with a focus on problems including issues related to nutrient utilization.



Virginia McChesney,
Huntington University Huntington IN
Horticulture, particularly greenhouse management, is something Virginia is very passionate about. She thoroughly enjoys any time spent in a greenhouse, garden, seed library, or other such endeavors. It is for these reasons that she has dedicated much of her life thus far to gaining experience and academic knowledge in these areas. It is also why she plans to spend the remainder of her life engaged in horticultural pursuits.

Hoskin McDougald Memorial Scholarship | 2021 Recipients

Hoskin McDougald Memorial Fund named after Bob Hoskin and Sandy McDougald is valued at a little over $140,000 and came from funds raised by FNGLA's Palm Beach Chapter. In 2017, FNGLA's Palm Beach Chapter entrusted NHF with their funds. Over $18,000 in scholarships have been received directly from this enrollment. Bob Hoskins or Sandy McDougald were members of the Florida Nursery, Growers and Landscape Association and made a big impact on the Palm Beach Chapter. Bob was an industry salesman. He suffered from a disease that was very disabling . He had trouble walking , his hands and body shook uncontrollably at times and it got worse over time. Despite his disabilities, he continued to visit growers with a smile on his face, never complained, and never let it interfere with his work. He became an inspiration to all that knew him.

Sandy McDougald became the outgoing part of their family business and industry activities. She was a hard worker and became the face of their nursery. She was one of the nicest and smartest people you will ever meet. She and her husband, Butch ran the nursery that is now run by their son, Jeff.

Both of these individuals are what makes our industry special… They gave of themselves for the betterment of the industry.

Danielle Donovan

Palm Beach State College, Palm Beach, FL

Danielle Donovan is currently in her third year at Palm Beach State College. She switched into the landscape/ horticulture AS program after finding out that nursing was not the career path she wanted to take. She found her passion for horticulture about 5 years ago when she purchased her first plant.

In May of 2020, she started a small business selling plants. This little side business is what's currently helping her pay for school. Danielle has dreams of purchasing some property to expand her business and own her own greenhouse or nursery. She would ultimately like to graduate with a bachelor's degree and use those skills to operate and manage her business.

Lauren Adams

Palm Beach State College, Palm Beach, FL

Lauren Adams is a second time around college student who has finally found a path. She has been enrolled part-time at Palm Beach State College, Palm Beach Gardens campus for almost two full years. At age 18, Lauren went off to University of Maine at Orono without a clue what she wanted to study. She struggled doing well in classes because nothing sparked her interest. Now the second time around, she chose the horticulture program at Palm Beach State because she finally found her passion. She started a vegetable garden at her condo and has an extensive indoor plant collection. In 2020, she started an herb/ small chef garden at a restaurant where she works. By October 2020, she was busy doing a few beautification projects locally around Boynton and Delray Beach and named her business, Sea Glass Landscapes as a start to her own small landscape design business. She hopes to grow and continue this project post-graduation. She is focusing in how to help restaurants start chefs' gardens. She is passionate about local and heavily invested in the agriculture side of horticulture. Working in sustainability, and how we can balance the amount of food we need to be able to provide for our rapidly and steadily increasing world population. Now that she has started this journey on turning a passion into a career, she looks for every opportunity to work with horticulture. Her goal is to start small, but mighty.

GRADUATE ASSISTANTSHIP

Shea Keene

In 2010, NHF's graduate assistantship program generated the level of funding needed for its first graduate-student project. NHF's Board of Directors serves as an advisory committee and provides direction and supervision to each graduate student and faculty member involved.

2021 has been an incredibly busy year as I worked to make up for the time and research lost to the pandemic in 2020. Though it had more than its fair share of challenges, I am proud to look back on all the hard work and accomplishments.

After my qualifying exams wrapped up in mid-December 2020, I took a brief break to spend some time with family before hitting the ground running in the spring semester. After working almost entirely remotely for roughly 9 months, I was finally back in the lab doing hands-on work. I resumed collecting volatiles from my sweet violets, and started seed germination experiments. I was also serving as President of the Environmental Horticulture Graduate Student Association (EHGSA) for the second year in a row. I oversaw the production of 4,000+ coleus plants for EHGSA's annual spring plant sale, which had been cancelled the previous year because of COVID. We completely overhauled the sale format to adhere to COVID safety guidelines, developing a pre-order option with contactless pickup and by-appointment-only greenhouse shopping, and set up websites for both options. The sale was a huge success—our 2021 sale profits were the highest in EHGSA's history!

Over the summer, I worked on developing a method to analyze phenolic acids using liquid chromatography-tandem mass spectrometry (LC-MS-MS). This method was used not only in my own research with Viola, but also in some of my colleagues' research on basil and petunia. Additionally, I performed LC-MS-MS analysis on ubiquinone in Arabidopsis for collaborative research with Dr. Gilles Basset's lab in the Horticultural Sciences Department, which resulted in two publications in 2021.

During the fall semester, I found myself even busier! I welcomed a new undergraduate research assistant into our lab, and she has been a tremendous help with my research. In addition to my own research, I worked on two collaborative volatile projects, one with the Agronomy Department and the other with the Food Sciences Department. Then in December as the semester neared its end, I reached a different type of milestone: I turned 30!

When I think about what 2022 will hold, I am filled with excitement. I will finish up the last of my experiments, write my dissertation, and then…I'll be done! After six years, my graduate school journey will finally come to a close. Post-graduation, I plan on working in some aspect of the horticultural industry. I am particularly interested in Florida's cannabis industry, but will keep my options open.

I am so incredibly grateful for the National Horticulture Foundation and its support of my assistantship through both my master's and my Ph.D. I have gained incredibly valuable experience, skills, knowledge, and connections because of this assistantship. It has opened so many doors and given me so many opportunities. It has completely changed my life, and I am deeply grateful.

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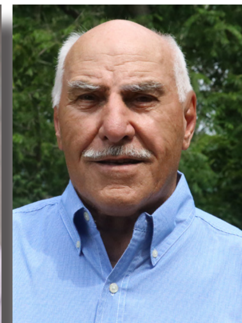

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