Southern Forest
Nursery Management Cooperative

FY 2021
ACCOMPLISHMENTS

As presented to the Advisory Committee of the Southern Forest Nursery Management Cooperative

November 3-4, 2021

AUBURN UNIVERSITY

SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE

FY 2021 ACCOMPLISHMENTS

GOAL A: RESEARCH

Objective 1. Identify, test, evaluate, and promote the registration of cost-effective pesticides for use in forest tree nurseries.

Fusiform Rust Control

A seedling treatment study will be conducted on loblolly and slash, to test new chemistries in conjunction with the US Forest Service Rust Testing Laboratory in Asheville, NC. Seed will be sown at Auburn into USFS container systems until germination at which time the seedlings will be treated prior to being challenged with basidiospores of fusiform rust (April – Nov 2021) (Stokes/ ~~Nadel~~/ Enebak)

- ***Accomplishments: Loblolly and slash seedlings were treated with one potential new chemistry, Protect DF with standard Proline and water checks to determine the efficacy of the new chemistries to control fusiform rust. This study was a seedling treatment study. 6 weeks post sowing seedlings were treated and sent to the USFS Rust testing Laboratory where they were challenged with 30,000 basidiospores of Cronartium quercuum f.sp fusiforme. The final amount of infection will be recorded in November and determined by treatment with a final Research Report in Jan 2022.***

Nanocellulose/Lignin Impregnated with Insecticides to Control Pine Tip Moth

Dependent on the results obtained from the 2020 sampling. We aim to determine whether this technique can be used with other chemicals. (Peresin/~~Nadel~~/Stokes)

- ***Accomplishments: Nanocellulose suspensions with varying chemical composition were impregnated with Fipronil at different doses, injected into one-year seedlings, and kept under controlled conditions in the greenhouse until sampling. A year after injection, the residual Fipronil in the new pine needles of the seedlings was extracted from 196 samples and analyzed using UPLC-MS/MS. Preliminary data indicates the presence of Fipronil when combined with nanocellulose showing that our system enables to retain more efficiently the pesticide in the needles, thus extending the life of the pesticide in the tree. Currently, we are focusing on the effect of nanocellulose on the performance of Prothioconazole and Imidacloprid. Following the same procedure, nanocellulose with different chemical composition were impregnated with the pesticides in different ratios, and 400 seedlings were injected with the solutions. After two months of the injection day, sample collection was performed and stored at -20 °C until further UPLC-MS/MS analysis. Additionally, samples will be collected after four months of the injection day to study the lifetime of the pesticides in the pine needles.***

Nursery Weed Control

At the recommendation of SFNMC member nurseries, trials will be designed and installed to investigate weed control methods, including use of herbicides in bareroot and container growing systems. Several trials proposed are continuations or expansions of trials currently in progress.

- **Post-emergent herbicide timing trial in bareroot pine targeting yellow nutsedge:** Replicated

timing trials of 3 post-emergent herbicides not currently labeled for forest-tree nurseries will be conducted in member bareroot pine nurseries. These herbicides list yellow nutsedge on their product labels as being controlled and have been included in previous post-emergent herbicide screenings. This trial will be designed to spray at earlier times in the growing season when yellow nutsedge plants are small (less than 4 inches) in order to increase herbicidal efficacy. Information from participating nurseries on appearance of earliest yellow and purple nutsedge growth will be used to determine the spray schedule. (Payne)

- ***Accomplishments: With input from members, we pivoted from testing 3 products to testing 1 new product (Vexis®) labeled specifically for postemergent use on nutsedge. As of September 2021, visual field inspections of this trial show tolerance of loblolly and slash pine to the product as well as good control of yellow nutsedge. Final seedling quality measurements and weed counts will be made at the end of the growing season to quantify the applicability of Vexis® use in bareroot growing systems and determine if further testing should be done.***

- **Continued testing of pre-emergent herbicide (flumioxazin) at sowing in hardwood nurseries:** A second year of replicated studies using flumioxazin will be installed at the time of sowing in member hardwood nurseries in those species identified in the 2020 trial as being tolerant. Additional hardwood species and SFNMC member nurseries will be included if feasible. (Payne)

  - ***Accomplishments: This testing was not continued in 2021 as the nursery involved in the 2020 trial determined that results from that study were sufficient to begin using flumioxazin operationally in certain hardwood species. Another hardwood nursery located within reasonable traveling distance of Auburn was not interested in installing this trial due to lack of need for additional weed control.***

- **Ronstar®Flo timing trial in container pine:** A replicated timing trial using Ronstar®Flo in a post-emergent application will be conducted in member container pine nurseries. This herbicide has been successfully tested in pre-emergent applications in SFNMC member nurseries for 3 years. Certain weeds, such as oxalis, are presenting larger populations more efficiently controlled by herbicide than by hand-weeding if a safe, effective herbicide can be identified. (Payne)

  - ***Accomplishments: This trial was installed in May 2021 at one container nursery on 8-week-old loblolly and slash pine seedlings and on 9- and 10-week old longleaf pine seedlings. As of September 2021, visual results showed no damage to pine seedlings. Final seedling measurements and weed counts will be made at the end of the growing season to quantify the effectiveness of Ronstar®Flo in this application.***

- **Modified sowing operations:** A study comparing current order of operations during sowing to a modified version applying herbicides to beds days prior to sowing and barking will be installed in a member bareroot nursery. In those nurseries where labor and equipment is limited, the ability to expand the number of days for sowing operations will alleviate pressures of completing all sowing operations within a narrower period of time. (Payne)

  - ***Accomplishments: A trial was installed in 1 bareroot nursery in April 2021. Half of the prepared seedling beds were sprayed with herbicide and irrigated 3 days prior to sowing and mulching, while the remaining beds were sown operationally, with sowing, herbicide application, mulching, and irrigation accomplished in 1 day. Frequent visual inspections during the growing season have revealed no differences in seedling quality or weed populations between the 2 methods of sowing. Seedling quality measurements and weed inspections will be made at the end of the growing season, with results used to determine if this modified sowing regime is suitable for use.***

- **Weeds/weed seed source management**: This is a 'by request' service to assist nurseries in identifying

sources of weeds/weed seeds and recommending sanitation practices to lessen their impact and production. (Payne)

- ***Accomplishments: Weed identification questions and requests for information on herbicide active ingredients have been handled in a timely manner.***

Nematicide Trial

This trial with Broadform™ (fluopyram + trifloxystrobin) will be continued in 2021 at the Bullard Texas nursery if nematode control and seedling tolerance is satisfactory as determined from results of the 2020 study. This will also be installed at the Jesup Nursery in Georgia using 2020 results. Adjustments to the 2020 spraying regime (rates, timings, number of sprays) may be made in order to focus applications on those shown to be most effective in 2020. (Payne/Stokes)

- ***Accomplishments: A single trial of Broadform™ was installed at the ArborGen Bullard, Texas nursery to quantify nematode control and seedling tolerance to the pesticide. A spray regimen of 3 spray applications (at sowing, at 21 days later, and at 21 days after the second spray) in larger test plots was used this year. Soil samples taken prior to sowing and at 4 times during the growing season have identified small quantities (<30 per plot) of nematodes being present in the study area. Final seedling quality measurements will be made at the end of the growing season to quantify seedling tolerance to this nematicide. A final research report with management implications will be released in January 2022.***

Objective 2. Identify and develop economically feasible nursery cultural practices that enhance seedling quality.

Seedling Counting/Measuring

Researchers at AU's Biosystems Engineering Department will continue to examine and develop a system to count seedlings for inventory using new technologies. Nursery Cooperative funds will not be used on this project. (Bao/McDonald/~~Nadel~~/Stokes)

- ***Accomplishments: The Nursery Cooperative staff continues to work with the agricultural-cyber-physical engineering research lab on the next generation smart agriculture to count bareroot seedlings. A prototype has been developed with machine learning models to detect and count seedlings. Further development is being made to allow the measurements of seedling RCD and height. Two field data collection trips have been completed in the spring with germinating seedlings and two more field data collection trips are planned for this fall.***

Objective 3. Develop methodologies to minimize the environmental impact of nursery cultural practices while maximizing their effectiveness including the development of integrated pest management programs.

Hardening Off Practice of Reducing Water Availability and Its Impact on Root Health

Root heath and root hydraulic conductivity is of importance to outplanting success. With this study we aim to determine whether the hardening off practice of reducing water availability, prior to the lifting of seedlings, may inadvertently (in warmer winters) increase the vulnerability of seedlings to develop embolisms. Continue with ongoing study, focusing on model development and carbohydrate analyses and its implications on potential outplanting growth and survival. (~~Nadel~~/ Stokes/Via).

- ***Accomplishments: Under drought conditions, drought hardened seedlings had reduced size, growth, and stem water potential reached critical levels of hydraulic failure. Loblolly pine may***

lack a mechanism to refill embolized xylem conduits which can delay growth of the seedlings and make them more vulnerable to future droughts. Additional work is required to determine whether we can identify a specific level of drought hardening that would result in optimum survival of loblolly pine after outplanting. A full report is available: Research Report 21-04.

Cold Storage Effects on Seedling Physiological Quality and Outplanting Vigor

~~The physiological quality of seedlings can be affected by seedling cold storage, which may lead to a reduction in outplanting vigor and success. Seedlings' stored carbohydrates and water status can negatively impact its storability. Warmer winters may result in increased maintenance respiration before lifting occurs, resulting in a partial depletion of stored carbohydrates prior to seedlings placed in cold storage. The outplanting of seedlings with depleted carbohydrate levels may result in delayed growth once outplanted. This study aims to determine the effects cold storage (1 – 4 weeks) on seedling carbohydrate reserves and water status and in turn on outplanting growth (Stokes / Nadel)~~

- ***Accomplishments: Due to personnel changes within the Nursery Cooperative staff, this project was not initiated. There are no plans to continue with this project in the near future.***

Objective 4. Further define the "optimal seedling" to maximize the cost effectiveness of artificial regeneration forestry systems.

Assessing Loblolly Root Development in Ellepot Container Trays

~~Manufacturer sponsored study. The design of their container trays/ system is very different than the more traditional container sets requiring more intensively management irrigation. Seedling quality will be evaluated. The containers have been modified since our previous study and now used in South America and South Africa. (March – Dec 2020) (Nadel)~~

- ***Accomplishments: Due to the departure of Dr. Ryan Nadel in January 2021 from Auburn, this industry-sponsored project was not initiated in FY 2021. There are no plans to continue this avenue of container research.***

Impact of Genetics on Cold Hardiness

In collaboration with the Tree Improvement Program at North Carolina State University, as well as the Forest Products Development Center at Auburn University, we want to assess the impact that genetics has on cold acclimation and freeze tolerance. Building on from the collaborative research project undertaken at the Nursery Cooperative in which we showed near infrared spectroscopy to monitor variations in soluble sugars after cold acclimation, we wish to assess whether this model be used for various genetic families of Loblolly pine. If successful, nursery managers could assess the freeze tolerance of seed-lots before outplanting using NIR spectroscopy. (~~Nadel~~/Stokes/Via/Payn - NCSU)

- ***Accomplishments: Ten genotypes of loblolly pine were exposed to either a control (no freeze) or freeze treatment. Seedlings were separated into stems, roots, and foliage and dried. Ground samples were scanned using near infrared spectroscopy (NIR). Analysis is currently underway to examine if the NIR can model the variation in soluble sugars.***

GOAL B: TECHNOLOGY TRANSFER

Objective 1. Serve as a clearinghouse of information related to nursery production and tree planting.

Methyl Bromide

In collaboration with MBr manufacturers, the Methyl Bromide Industry Panel (MBIP), the Chloropicrin Manufactures Task Force (CMTF) and applicators, the Nursery Cooperative staff will continue to keep abreast of EPA actions and/or possible legislative initiatives that may affect the future availability of soil fumigants. We will continue to inform the membership through the Advisory Committee to keep the membership knowledgeable of these activities

The Nursery Cooperative staff will continue to keep abreast of activities related to the Quarantine pre-shipment (QPS) process. We will inform the membership of any EPA initiatives and continue to work with the AF&PA, the Crop Protection Council, USDA and APHIS to provide input and influence the QPS process if necessary.

The Nursery Cooperative staff will continue to work with the AF&PA, and USDA to inform and influence the EPA deliberations regarding pesticide regulation as it pertains to the soil fumigation re-registration decisions that were released in the 2013. (~~Nadel~~/Enebak)

- ***Accomplishments: There were no requests or questions to the Nursery Cooperative staff concerning the use of soil fumigants, MBr, Chloropicrin, etc from federal or state agencies in FY21. The Nursery Cooperative continues to monitor pesticide regulations as it pertains to soil fumigants and will keep track of soil fumigation trends in forest-tree nurseries. However, two research reports were written from the 2016-2018 trial from Elberta, Alabama (Research Report 21-07) and the 2019-2020 trial in Magnolia, Arkansas (Research Report 21-08).***

Re-registration of Nursery Pesticides

The Nursery Cooperative staff will continue to follow the re-registration process for pesticides currently under review under the Food Quality and Protection Act (FQPA) used in seedling production and will provide information to the necessary regulatory agencies (USDA, APHIS, EPA) when necessary. (Enebak/ ~~Nadel~~/Payne/Stokes)

- ***Accomplishments: There were four specific requests for data on pesticide use from USDA-APHIS and EPA in seedling production systems. These included Ronstar®Flo (oxadiazon), PTM (fipronil), Goal (oxyfluorfen) and Proline (prothioconazole). Working with members and cooperators, the Nursery Cooperative submitted letters to the agency indicating the use of these compounds in nurseries and the importance to the industry. Those that make decisions on pesticide use are now up to date with how seedling production would be affected without these important pesticides.***

Maintain and Update Nursery Cooperative Website

The Nursery Cooperative staff will continue to update the Nursery Cooperative website for use by Nursery Cooperative members. (Bowersock)

- ***Accomplishments: The Southern Forest Nursery Management Cooperative website was updated to include all outreach efforts (Research Reports, Contact Meetings, Short Course) to members of the Cooperative.***

Leveraging Nursery Cooperative Data

The Nursery Cooperative staff will continue to stress the importance of Cooperative membership and

when possible, leverage Cooperative information for grant proposals and data cite license for the seedling production survey. (Staff)

- ***Accomplishments: The Nursery Cooperative had a fourth year added to the 5-yr agreement to share seedling production data under a Cite License. For an annual fee of $10,000, seedling production data will be given to USFS Washington Office for them to use in their planning and reporting programs. Funds are used towards Elizabeth Bowersock's salary to compensate for her time. With the addition of Dr. Lindsay Colegrove, USFS State and Private Forestry, to replace George Hernandez after his retirement, southern forest nurseries have added a new voice to address forest seedling production issues that can be used for leveraging Cooperative dues.***

Objective 2. Efficiently and regularly transfer the results of cooperative research to the membership.

Contact Meeting

The 2021 Southern Forest Nursery Management Cooperative Contact Meeting will be conducted as a 2-day program in July 2021. As usual, the agenda will cover presentations by Nursery Cooperative staff on current research activities and results. Details will be worked out with nursery members with meeting information outlined in the Spring 2021 Newsletter. (Enebak/Bowersock)

- ***Accomplishments: The 2021 Nursery Cooperative Contact Meeting was held on July 19, 2021 during a half-day online program via Zoom. What was to be a 2-day meeting simply could not be planned in the midst of the pandemic and uncertainty in early April 2021. At its peak usage, there were 32 members who participated in the event. Planning ahead (and not breaking the contract with the hotel), the 2022 Contact Meeting will be conducted as a ½ day program to be held in conjunction with the Southern Forest Nursery Association in Charleston, SC.***

Information Sheets

"A Closer Look" is a new outreach document for the SFNMC. This information sheet on pests/ diseases will be produced biannually and will become the centerpiece for each newsletter. (Nadel/Staff)

- ***Accomplishments: A "Closer Look" document was prepared and distributed to Nursery Cooperative Members in the Spring 2021 (Nematodes) and Fall 2021 (White Grubs) Newsletters.***

Research Reports

We plan on producing Research Reports and Technical Notes in FY21. (Staff)

- ***Accomplishments: Nursery Cooperative staff produced 8 Research Reports and 1 Technical Note that covered the following topics:***
  - ***Nursery trials assessing the efficacy of two new synthetic fungicides for the control of Fusiform Rust over two years of seedling production 2019-2020. RR 21-01. Nadel, Stokes, Payne & Enebak. 14 pp.***
  - ***Tolerance of 13 hardwood species to at-sowing applications of flumioxazin. RR 21-02. Payne, Bowersock, Stokes and Enebak. 7 pp.***
  - ***Rapid determination of freeze damage to loblolly pine seedlings. RR 21-03. Stokes, Nadel, Aspinwall, Payn, Payne and Enebak. 12 pp.***
  - ***Impacts of planting drought hardened loblolly pine seedlings under various drought conditions.***

RR 21-04. Stokes, Nadel, Payne and Enebak. 15 pp.

- ***The effect of multiple applications of fluopyram (Broadform™) on nematode control and loblolly pine seedling characteristics. RR 21-05. Payne, Bowersock, Stokes and Enebak. 6pp.***

- ***Supplementary trials of three post-emergent herbicides in loblolly and slash pine seedling beds. RR 21-06. Payne, Bowersock, Stokes and Enebak. 9 pp.***

- ***Evaluation of five MBr alternatives on seedling production and quality over two growing seasons at the Rayonier tree nursery in Elberta, Alabama: 2016-2018. RR 21-07. Stokes, Enebak, Payne and Nadel. 10 pp.***

- ***Evaluation of five MBr alternatives on seedling production and quality over two growing seasons at the Weyerhaeuser Magnolia Nursery, Arkansas: 2019-2020. RR 21-08. Stokes, Payne, Nadel and Enebak. 9 pp.***

- ***Forest-tree seedling production in the southern United States for the 2020-2021 planting season. TN 21-01. Enebak and Newell. 18 pp.***

Newsletters

Newsletter distributions are planned for March and September 2021. Members are encouraged to submit articles and organizational updates. (Staff)

- ***Accomplishments: Two newsletters were produced and distributed via electronic delivery to 84 contacts within the Nursery Cooperative membership in March and September 2021.***

Objective 3. Provide a limited consultancy function to the membership in the area of nursery seedling production and outplanting.

Individual and Organization Contacts

An on-going activity and is handled as individual situations within each organization within the Nursery Cooperative as cases arise during the growing and planting season. (~~Nadel~~/Enebak/Payne/Stokes)

- ***Accomplishments: Staff participated in the following one-on-one contacts with members.***

	Payne	Enebak	Newell	Stokes
Phone calls	**+/- 50**	**17**	**NA**	**40**
Letters	**0**	**1**	**NA**	***0***
Emails	**+/- 200**	**34**	**NA**	***63***
Site Visits	**15**	**0**	**NA**	***6***
Diagnosis	**0**	**12**	**NA**	***0***

Seedling Production Survey

The Nursery Cooperative staff will continue the seedling production survey initiated in FY 03. The same questionnaire will be used to obtain production figures for the 2020 to 2021 planting season. The survey will be sent out in June 2021. (Enebak/Bowersock)

- ***Accomplishments: A mailing list that included 53 nurseries was sent in May 2021 throughout the southern US to gauge seedling production for the 2020-2021 planting season. Data was compiled and put into Technical Note 21-01 that will be distributed to all participating nurseries in late November 2021.***

Nursery Customer Meeting Presentations

Over the past several years as schedules and travel permits, Nursery Cooperative personnel have participated customer (internal and external) meetings at nurseries in an effort to encourage and improve customer relations and educate nursery customers on seedling planting and successful plantation establishment. 30-minute presentations such as "*Why Did My Seedlings Die*?" and "*The Ten Commandments of Seedling Survival*" are presentation the staff have made. (Staff)

- ***Accomplishments: No invitations to speak at nurseries or stakeholders were requested for FY 21.***

Short Course

We will send out a request in January 2021 to gauge interest. If enough interest, we will offer another Short Course in September 2021. (Staff)

- ***Accomplishments: Restrictions on travel for both participants and invited speakers continues to get in the way of successfully conducting this informative and important workshop for new nursery personnel. While Zoom/remote is an option, I've been asked by a number of members and speakers to avoid that process with this training session. We will send out a request in January 2022 to gauge interest and availability. If enough interest is shown, and presenters can/will attend, we will offer another Short Course in September 2022.***

GOAL C: COOPERATIVE DEVELOPMENT

Objective 1. Provide for the continual relevancy and efficiency of the Cooperative research and technology transfer programs.

Advisory Committee Meeting

The FY22 Advisory Committee Meeting will be held on November 3-4, 2021. A two, half-day meeting will be planned. (Enebak/Bowersock)

- ***Accomplishments: The Nursery Cooperative Advisory Meeting will be conducted on November 3-4, 2021 at Auburn University's School of Forestry and Wildlife Sciences.***

Nursery Cooperative Membership

The Nursery Cooperative staff will continue to recruit new members among those nurseries that will benefit from activities of the Nursery Cooperative. This would include the Florida Division of Forestry, PRT in Atmore, AL, and Kentucky State Nursery. There is also discussion with non-nursery production members to include an Associate status. (Staff)

- ***Accomplishments: No new members joined the Nursery Cooperative. We continue to have conversations with PRT, that operates the container nursery in Atmore, AL, and the Florida Division of Forestry. There have been some conversations with smaller nurseries and consulting forestry companies with respect to Associate Membership.***

Update the Cooperative Membership and Nursery Directories

An on-going activity with an updated directory distributed annually to each member. (Bowersock)

- ***Accomplishments: The Nursery Cooperative Membership Directory was updated and sent to Cooperative members in November 2020.***

Objective 2. Increase the visibility and effectiveness of the Cooperative as a source of information on issues related to seedling production and plantation establishment.

Presentations at Meetings

Nursery Cooperative staff will continue to be encouraged to participate as a speaker or attendee in regional and national meetings related to artificial regeneration. (Staff)

- ***Accomplishments: Travel restrictions and remote meeting offerings limited Nursery Cooperative's staff involvement with research meetings during 2021. Nina Payne did attend the 2021 Association of Consulting Foresters Meeting and shared Nursery Cooperative information to others in attendance.***

Publications

Nursery Cooperative staff is encouraged to publish results outlined in annual Research Reports and Technical Notes in scientific journals after a period of 2-3 years have elapsed. (Staff)

- ***Accomplishments: No peer-reviewed publications were submitted in FY 2021.***

Extramural Funding of Nursery Cooperative Projects

Nursery Cooperative staff will continue to be encouraged to locate and generate extramural funding opportunities directly related to artificial regeneration. (Staff)

- ***Accomplishments: Two extra-mural competitive grants were prepared and submitted for research funding on the following topics by Nursery Cooperative staff.***

  - "*An AI-Powered Ground-Based Vision System for Automated Inventory and Quality Assessment of Bareroot Pine Seedlings for Forest Tree Nurseries*." Bao, Y., Enebak, S., McDonald, T. and Tang., L. USDA – AFRI

  - "*Temperature Adaptations and Acclimation in Southern Pine Conifers*". Aspinwall, M. Enebak, S., Payn, K., Raley, F. and T. Martin. USDA-AFRI

Interaction with other Research Cooperatives

The Nursery Cooperative staff will make efforts to interact, attend, work with other regional and national forest research Cooperatives to broaden and strengthen research ties that can benefit seedling production. (Staff)

- ***Accomplishments: Currently undertaking a study with the Tree Improvement Cooperative (NCSU) regarding looking at the impact of genetics on cold hardiness (Stokes) and infrared imagining as described above.***

International Nursery Research Collaboration

Working with joint nursery research in other regions of the world, a 5-8 day trip that allows interaction of Nursery Cooperative members with other nursery production systems in South Africa will be identified and planned for Summer 2021. (Nadel)

- ***Accomplishments: Dr. Ryan Nadel had put together a trip that involved a number of forest seedling nurseries, outplanting sites and reforestation efforts in three different plantation forestry regions across South Africa that include the growth of pines and eucalypts. The tour included the opportunity for view African wildlife in two distinct landscapes and world heritage sites in South Africa. While Ryan is no longer with the Nursery Cooperative, his contacts are still in place and he is still willing to participate in this process. We will try again for the late summer of 2022, pandemic allowing.***