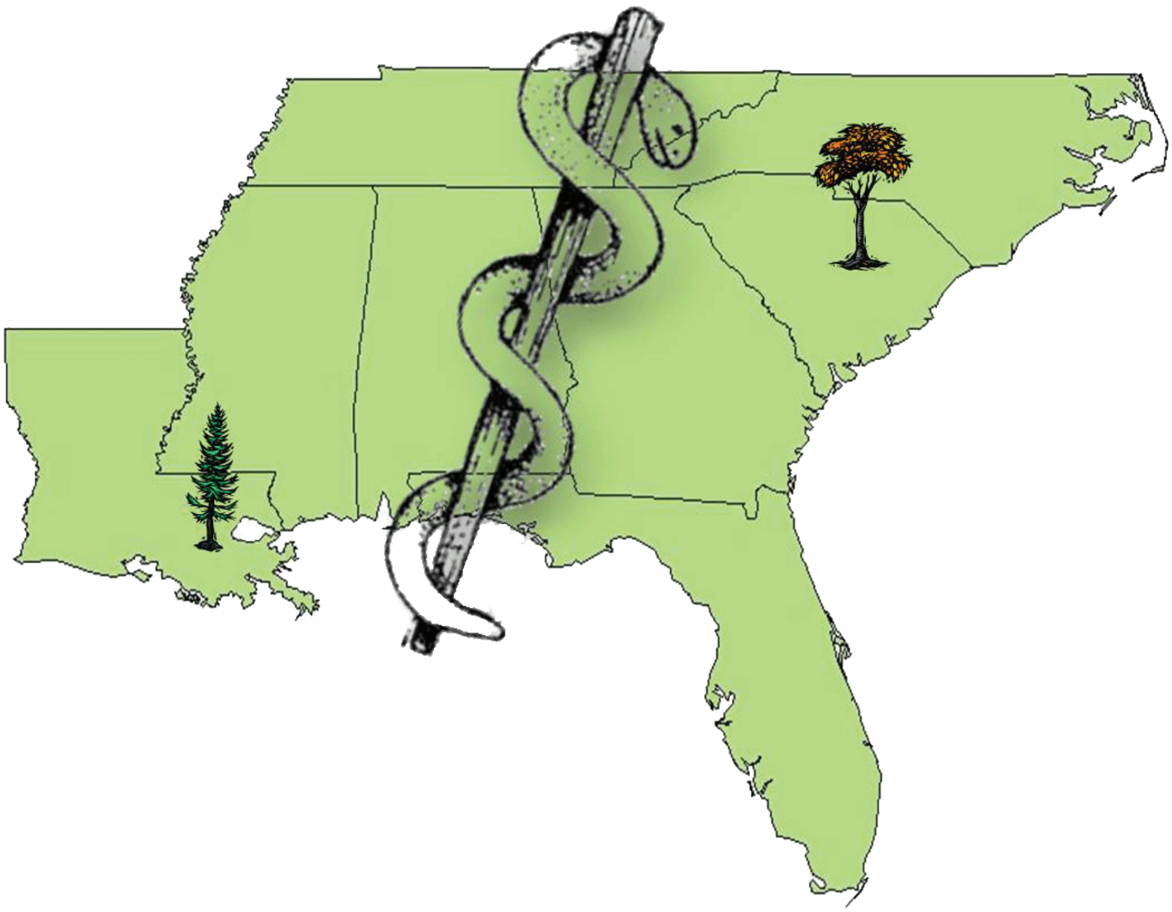
Auburn University
Forest Health Cooperative



FY 2016 Annual Report

EXECUTIVE SUMMARY

They FY18 meeting is set for June 13-15, 2017. It will begin after lunch on Tuesday and adjourn around noon on Thursday. There will be a field trip to the Quantifying Pine Decline study site in Eufaula, Alabama. Place those days on your calendar. More information will be available soon.

RESEARCH

The preliminary results from the Mature Root Inoculation study showed the same level of family difference exists in mature as well as in premature stages of loblolly pine. The final report is being completed.

We have currently tested 130 loblolly families and 11 slash families for tolerance to ophiostomatoid fungi. Year 5 screening is being analyzed and year 6 is underway.

In year 5, the average length of the lesion produced by the fungal treatments were significantly different between the families. Families, L126, L130 and L129 had the longest, and L118 and L09 had the shortest average length of the lesion when treated with *Grosmannia huntii*. Families, L126 and L129 had the longest average lesion length, and L33 and L111 had the shortest average lesion length when treated with *Leptographium terebrantis*. Our results suggest that tolerance to the *L. terebrantis* and *G. huntii* varies between the families and the findings are consistent with the previous years.

The Quantifying Pine Decline project plots were installed. We continue our measurements as scheduled. In 2016 baseline data; namely for site, soil, physiological and insect population was collected. To assist in the monitoring of new root production, mini-rhizotron tubes were installed at the site several months prior to the scheduled inoculation so as to ensure the equilibrium of the soil tube interface occurs prior tree inoculations.

A relationship between *S. nigricornis* and *D. siricidicola* that has not previously been described was seen in this study. Previous findings of *A. areolatum* being associated with *S. nigricornis* were also confirmed. Further studies to determine the broader implications of this new relationship and how that may affect native woodwasp populations are warranted.

Throughout the trapping survey, only the native *S. nigricornis* was captured. The flight season that was observed was in accordance to previous studies. Mean females captured per site in Tuskegee were significantly lower in 2015, perhaps due to prescribed burns in the area.

The RW-19 study found that insect numbers were found to be greater post treatment implementation, although this difference was not statistically significant. A significantly higher number of *Hylastes* beetles was associated with thinning regimes of 200, 300, 500, and no thin treatment. There was a significant effect shown overall with *Ips* spp. post treatment. This study has been extended to analysis with the Productivity Cooperative using tree growth data.

In the conjunction with the Nursery Cooperative a method was developed capable of detecting a single *G. circinata* infected seed for all pine species. The results will assist in developing requirement protocols which must be accepted by the International Seed Testing Association.

ASSOCIATED ACTIVITIES, GRADUATE STUDENTS, COOPERATIVE STAFF, MEMBERSHIP

The Forest Health Cooperative currently has 4 Full Members, 7 Associate Members, 1 Maintaining Member and 4 Sustaining Members. Graduate students' contributions to the program continue to be critical. We continue to teach workshops to members and colleagues at AU and around the southeast.

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DIRECTOR'S REPORT

Another year in the books and I hope that this report finds everyone well. The Advisory meeting was held July 29-30, 2016 in Auburn at the School of Forestry and Wildlife Sciences and was attended by 20 members. A few membership changes, the AFC has increased their membership to Associate, Westervelt has changed to Associate and we gained a sustaining member. All research projects are in progress with no delays. I look forward to seeing everyone at the meeting this upcoming year.

MEMBERSHIP

I have been approaching several companies and consulting firms in the southern U.S. about joining the Forest Health Cooperative. We have shared our membership materials with them and answered a few questions concerning membership. The Forest Health Cooperative currently has 4 Full Members, 7 Associate Members, 1 Maintaining Member and 4 Sustaining Members.

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MEMBERSHIP LIST

FULL MEMBERS

Federal
United States Forest Service – NFS

Forest Industry
Hancock Forest Management
Rayonier
Weyerhaeuser

ASSOCIATE MEMBERS

Forest Industry
Delaney Development
Molpus Timber Management
Scotch Lumber Company
Westervelt

Federal
United States Forest Service - SRS

Non-Industrial – Private
ArborGen, LLC

Consulting Foresters
F & W Forestry

MAINTAINING MEMBERS

Non-Industrial – Private
Burgin Land

SUSTAINING MEMBERS

Non-Industrial – Private
International Paper
Forestry & Land Resource Consultants

Individual Foresters
Beth Richardson
Ken Clark

State
Alabama Forestry Commission

ADVISORY BOARD CHAIRMAN
Service Rotation

Fiscal Year†	Chairman*
2011	Westervelt
2012	Weyerhaeuser
2013	US Forest Service
2014	Hancock Forestry
2015	Plum Creek
2016	Rayonier
2017	Westervelt
2018	Weyerhaeuser
2019	US Forest Service
2020	Hancock Forestry
2021	Rayonier
2022	Westervelt
2023	Weyerhaeuser
2024	US Forest Service

†Member will conduct the Cooperative business meeting held in that fiscal year.
*First Chairman randomly chosen for FY2011, subsequent Chairman will be alphabetical by company name.

RULES and POLICIES

AUBURN UNIVERSITY
FOREST HEALTH COOPERATIVE

Re-Approved February 1, 2011

MEMBERSHIP

1. Membership in the Forest Health Cooperative (FHC) is open to anyone in the southeastern region of the United States.

2. Members are required to pay annual dues which are as follows:

Full Member	$10,000
Associate Member	$ 5,000
Maintaining Member	$ 2,500
Sustaining Member	$ 500

3. Sustaining Members receive access to FHC Webpage, annual Newsletter, Priority Email and Telephone Consulting, and participation in Members Only Workshops and may participate at the Annual Advisory Meeting, but cannot serve on the Advisory Council. Maintaining Members receive the benefits of Sustaining Members, and Research and Technical Reports. Associate Members receive the benefits of the Maintaining Members, and Field Consulting and Laboratory Diagnostics. Full members receive all the benefits of Associate, Maintaining and Sustaining Members and serve on the Advisory Council and have full voting powers with respect to research program and budgetary decisions.

4. Membership is for one year beginning October 1. Membership may be terminated by either the member organization or by Auburn University by giving 60 days written notice before October 1.

5. Membership will be contingent on signing a memorandum of agreement with Auburn University.

6. After September 30, 2009, all new members at all levels will be required to contribute 1-3 x their annual membership dues in addition to their annual membership dues. The number of annual contributions will depend upon the year of membership beyond 2008.

Year of Joining	Contributions to Forest Health Cooperative
2008	1 Annual Membership
2009	1 Annual Membership + 1 Annual Membership
2010	1 Annual Membership + 2 Annual Membership
2011 and beyond	1 Annual Membership + 3 Annual Membership

ORGANIZATION

1. The Dean, School of Forestry and Wildlife Sciences, Associate Director Agricultural Experiment Station of Auburn University in consultation with the Forest Health Cooperative Executive Committee, will appoint the Forest Health Cooperative's Director.

   The Director will be responsible for:
   A. Directing the activities of the Forest Health Cooperative;
   B. Employing a competent staff;
   C. Developing the Forest Health Cooperative's direction in conjunction with the Advisory

Council;
D. Ensuring each member participates to a threshold level; and
E. Reporting research accomplishments to the Advisory Council

2. The Advisory Council will have an annual meeting in the first quarter of each fiscal year.

3. An Advisory Council consisting of one representative from each full member shall be established to:
   A. Act as a liaison between the organization and the Director;
   B. Develop Forest Health Cooperative policies;
   C. Advise the Director on the Forest Health Cooperative's direction;
   D. Approve the annual budget and membership fee.

4. An Executive Committee consisting of three Advisory Council members and the Director shall have the authority to meet and conduct routine business in the name of the Advisory Council. One Executive Committee member will be appointed annually according to a rotating schedule and will serve for 3 years. The Advisory Council chairman will be the senior member of the Executive Committee and will preside at the Executive Committee and Advisory meetings.

5. Contact representatives will be designated by each cooperating member/organization. This individual may or may not be the same person serving on the Advisory Council. Contact Representatives will be directly involved in research established with each member organization.

6. All information will be available to all members in the Forest Health Cooperative.

7. All members agree to keep confidential the data and information given to them for future publications and limit the spread of information to non-members that would benefit without paying annual FHC dues.

<u>DUES and BUDGET</u>

1. Membership dues will be set by the Advisory Council at its annual meeting.

2. The Cooperative will operate on the fiscal year October 1 to September 30. Invoices for membership fees will be sent to all member organizations on October 1 of each year, or by special arrangement with the individual organization.

<u>RULES CHANGES</u>

1. Changes in, deletions from, and additions to the membership rules may be adopted by a two-thirds vote of advisory members in attendance at regularly scheduled or special sessions of the Advisory Council.

<u>DIVISION OF RESPONSIBILITIES BETWEEN AUBURN UNIVERSITY AND MEMBER ORGANIZATIONS IN THE AUBURN UNIVERSITY FOREST HEALTH DYNAMICS LABORATORY COOPERATIVE</u>

1. Study plans will be developed by Auburn University in conjunction with the Cooperative's Advisory Council. Responsibilities for cooperative research will be delineated in individual study plans.

2. Auburn will do data analysis and processing, as well as manuscript preparation, and will insure timely distribution of results to cooperators.

3. Auburn University graduate students will be utilized to work on specific forest health problems.

4. All cooperators will be responsible for adhering to the study plans.

5. Information will be disseminated at annual Advisory meeting and in an annual Newsletter and Research

Reports to members. A web site dedicated to Forest Health with the Cooperative's research will be maintained by School of Forestry & Wildlife Sciences.

6. Results will also be disseminated at local, regional and national forest related meetings.

7. Site visits for risk assessment and diagnostic evaluations will be conducted by Auburn University staff. Full members get 2 days/yr, Associate Members get 1 day/ yr. Additional days are $1000 per day for all membership classes.

8. Laboratory diagnostic evaluations will be conducted by Auburn University staff. Full members get 10 sent in samples per year, Associate Members get 5 sent in samples per year. Additional samples are $100 per sample for all membership classes.

RESEARCH

MOLECULAR ANALYSIS OF *DELADENUS* SPP. NEMATODE
Andrea Cole Wahl

Nematodes are microscopic round worms that are often found parasitizing various species of plants and animals. While some species of nematodes are known to cause economic damage in crops or diseases in humans and pets, other species can be utilized by industry as biological control agents to control pest populations. *Deladenus* spp. nematodes are an example of a species of nematode that are reared and sold commercially in some countries to control invasive *Sirex* wasp populations. *Deladenus* nematodes are naturally parasitic to *Sirex* wasps in the native range of Northern Africa and Eurasia, but parasitize at much lower rates than when commercially applied to *Sirex* infested stands. A complex and interesting relationship exists between *Sirex* and *Deladenus* species (Fig.1).

The nematodes can also live freely feeding on *Amylostereum*, the fungi associated with *Sirex* wasps. Until recently, it was assumed that certain species of nematodes only parasitized certain species of *Sirex* wasps. After the detection of *Sirex noctilio* in New England, a greater understanding of how introduced species of nematodes would interact with our native wasps was needed.

As a part of the *Sirex* woodwasp project being conducted, several samples of nematodes were collected after analyzing wasp specimens brought back to the lab. These nematode samples, as well as tissue from wasps and fungal cells were all sent to a lab at the University of Pretoria's Forestry and Biotechnology Institute (FABI) for molecular analysis. DNA was extracted from nematode, wasp, and fungal samples, and was sequenced to gain better insight into the relationships between these three species. Andrea was able to spend three months in the lab at FABI conducting these analyses, and making relationships with scientists and students from around the world.

After using the molecular data to draw phylogenetic trees to determine how closely related organisms are to each other, we found that the story of nematodes in the United States is very interesting, and needs to be explored further. We have already seen that native species of wasps are capable of picking up and utilizing *Amylostereum areolatum*, the species of fungi historically associated with *S. noctilio*. The next question that our work addresses is whether or not our native *S. nigricornis* will be affected by the commercially available biological control agent *D. siricidicola* (Figure 2). More work needs to be conducted to see if the *D. siricidicola* samples isolated from *S. nigricornis* in Alabama are those of the commercially available strain, or if these species unknowingly cohabitate in a natural environment.

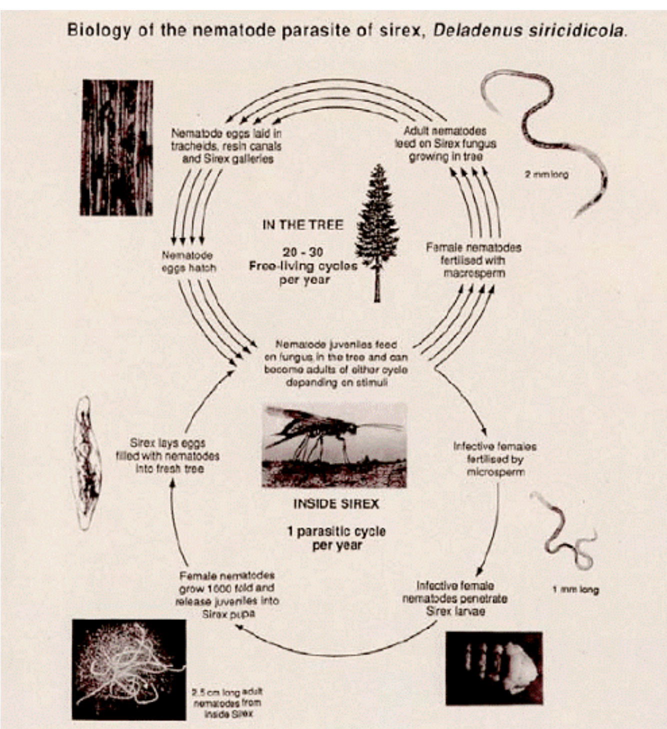


Figure 1. *Deladenus siricidicola* lifecycle. Found at http://csiropedia.csiro.au

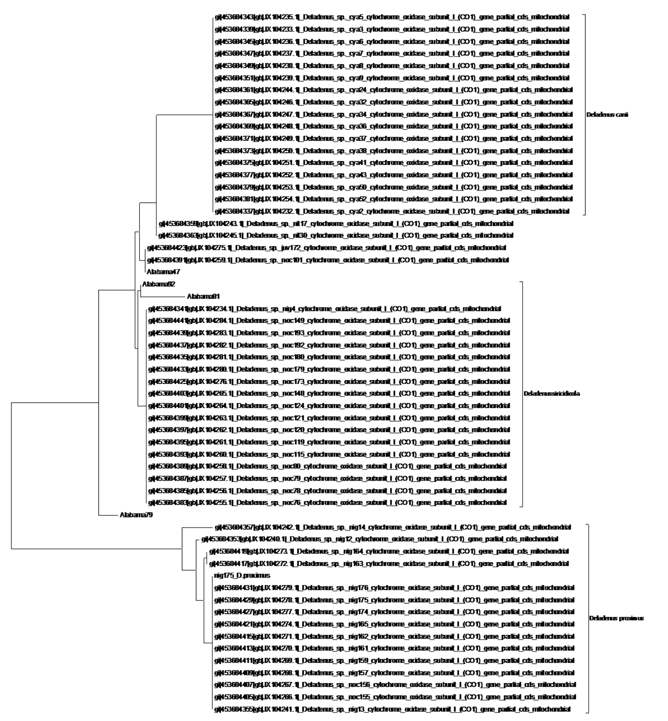


Figure 2. Phylogenetic relationships between Alabama isolates and perviously identified species

RW-19 UPDATE
Andrea Cole Wahl

The RW-19 insect study was conducted by the Forest Health Dynamics Lab and assessed the impact that different thinning and fertilization regimes would have on pest insect populations. The objectives of this study were to quantify the population dynamics of root and lower stem colonizing beetles (Hylastes spp.) and other pine bark beetles over a 3 year period. Insect populations on plots under ten various treatments (Thinning to 100 TPA, 200 TPA, 300 TPA, 500 TPA and with or without fertilization: 200 lbs N + 25 lbs P) were monitored, taking seasonal variation into consideration. Tree vigor following thinning and fertilization treatments were determined, with management and site characteristics to changes in insect populations monitored for changes in forest health condition so as to relate back to treatment.

The larger scope of this project includes eight industrial study sites which were established across different physiographic regions across the southeastern United States. This project focused on the insect data collected at one of these sites established near Hilliard, Florida. Insects were collected and monitored from November 2012 until February 2015 (Fig. 3), which encompassed pre thinning monitoring November 2012 to May 2013 and post thinning monitoring from February 2014 until February 2015 (Fig. 4).

The results of the Florida study show that thinning has a significant effect on Ips spp. post treatment (Fig. 2). The thinning treatments differed significantly in some cases. Black turpentine beetle populations were significantly lower in the 100 TPA treatment than other thinning regimes (Fig. 4). When reading the insect data on root feeding beetles (Figs. 3,4) it is important to remember that these are the mean insects captured at the sites over the whole span of the study. Hylastes pales populations were higher post-treatment overall (Fig. 4).

Over the summer, more work was undertaken at the RW-19 site in Hilliard, Florida. Root samples from three trees on each plot were excavated and stored in order to be brought back to the Forest Health Dynamics Laboratory. There the root samples were processed in which the root sample is cut into pieces, surface sterilized, and plated onto two different types of media in order to isolate certain fungi associated with bark beetles. In addition to plating the root samples, all roots were examined for specific signs and symptoms and any external observations were recorded. The plates were then grown out on the plates; then analyzed to see if any of the specific fungi observed. Native and non-native fungi associated with decline were both recovered from different trees on different plots.

Florida Pre Treatment						
	df	*Dendroctonus terebrans*	*Hylastes*	Hylobiini	*Ips* spp.	Ambrosia
Fertilizer	1	*p* = 0.2493	***p* = 0.0337**	*p* = 0.2489	*p* = 0.6693	*p* = 0.2489
Thinning	4	*p* = 0.1554	*p* = 0.6141	*p* = .04893	*p* = 0.5881	*p* = 0.5446
Fertilizer x Thinning	4	*p* = 0.4598	*p* = 0.3247	*p* = 0.8202	*p* = 0.4267	*p* = 0.2551

Figure 1. Least Squares Fit Model, Florida sites, Pre-Treatment.

Florida Post Treatment						
	df	*Dendroctonus terebrans*	*Hylastes*	Hylobiini	*Ips* spp.	Ambrosia
Fertilizer	1	*p* = 0.1647	***p* = 0.0727**	*p* = 0.2568	*p* = 0.7878	*p* = 0.7263
Thinning	4	*p* = 0.1806	*p* = 0.0867	*p* = 0.6458	***p* = 0.0002**	*p* = 0.4124
Fertilizer x Thinning	4	*p* = 0.8918	*p* = 0.0279	*p* = 0.2195	*p* = 0.1590	*p* = 0.3081

Figure 2. Least Squares Fit Model, Florida sites, Post-Treatment.

Root-feeding Species						
	Btb	**Hpo**	**Hs**	**Ht**	**Pp**	**Hp**
Fertilization						
Fertilizer	0.0050 a	0.0235 a	0.0578 a	0.0675 a	0.0067 a	0.0813 b
No Fertilizer	0.0117 a	0.0183 a	0.6667 a	0.09479 a	0.0049 a	0.1331 a
Thinning						
100 tpa	0.0125 a	0.0044 a	0.0476 a	0.0870 a	0.0083 a	0.0940 a
200 tpa	0.0208 a	0.0250 a	0.0917 b	0.0792 a	0.0083 a	0.1000 a
300 tpa	0.0125 a	0.0335 a	0.0840 b	0.0916 a	0.0083 a	0.1294 a
500 tpa	0.0042 a	0.0292 a	0.7917 b	0.0875 a	0.0042 a	0.0875 a
No thin	0.0042 a	0.0125 a	0.0625 b	0.0667 a	0.0042 a	0.1250 a

Figure 3. Least Squares Fit Mean, Florida sites, Pre-treatment.

Root-feeding Species						
	Btb	Hpo	Hs	Ht	Pp	Hp
Fertilization						
Fertilizer	0.0713 a	0.0042 a	0.6349 a	0.5910 a	0.2918 a	1.036 a
No Fertilizer	0.1032 a	0.0058 a	0.8517 a	0.3303 a	0.1954 a	1.2279 a
Thinning						
100 tpa	0.0475 a	7.8063e-18 a	0.3101 a	0.2966 a	0.2089 a	1.0093 a
200 tpa	0.1071 b	0.0107 a	0.8536 a	0.6500 a	0.3339 a	1.1321 a
300 tpa	0.1076 b	0.0072 a	0.9592 a	0.5582 a	0.2868 a	1.1788 a
500 tpa	0.1167 b	0.0070 a	0.9929 a	0.4492 a	0.2084 a	1.279 a
No thin	0.0570 b	4.7705e-18 a	0.6007 a	0.2966 a	0.1748 a	1.1862 a

Figure 4. Least Squares Fit Mean, Florida sites, Post-treatment.

Crown rating was also performed on all trees that root samples were taken. Trained staff and graduate students rated multiple aspects of crown health and overall vitality of each individual tree per plot. Along with crown rating additional measurements were recorded. DBH and height were done in the field and increment borers were utilized in order to obtain a core from each tree. The cores were taken back to the lab where 5 and 10 year incremental growth rates recorded. These observations and measurements influence overall tree health and vigor to compare with the different treatments as well as the influence of insects and fungi recovered.

SIREX UPDATE
Andrea Cole Wahl

Sirex woodwasps are a group of insects that are being monitored throughout the country to determine population sizes, and the potential of invasion by non-native species. In their native areas, Siricids are attracted to dead and dying trees, but in non-native areas, they have been documented colonizing healthy tree stands. Female wasps deposit eggs, venom, and fungal spores into host trees, where previously healthy trees may begin to show signs of stress, and may eventually succumb to heavy infestations. Once a tree has been attacked by an invasive *Sirex* wasp, the tree begins to exhibit defensive behavior. This defense is made up of chemicals given off, some of which have been shown to serve as attractants to secondary pests and some of which are hypothesized to affect the growth rates of *Sirex* associated fungal species (Figure 1).

A trapping survey was conducted throughout the state of Alabama to gain a clearer understanding as to which native or non-native woodwasp populations exist. Insect panel traps were checked every other week for the duration of the year in Talladega National Forest (Oakmulgee District), Tuskegee National Forest, and Auburn University's Solon Dixon Center (Figure 1.). No *Sirex noctilio* was detected throughout the duration of the study; all wasps collected were native to the area.

All wasps collected and the fungi isolated from those wasps were taken to the Forestry and Agricultural Biotechnology Institute (FABI) at the University of Pretoria, South Africa for molecular analyses. This work shows us that relationships between wasp and fungal species are not as strictly linked as previously thought. Our work proves that native wasp species are either able to pick up and utilize non-native species of fungi, or that multiple species of fungi may be linked to our endemic wasp populations.

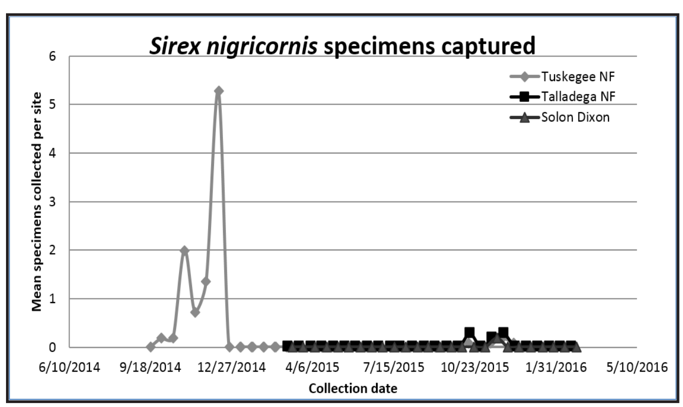


Figure 1. Mean trap capture of *S. nigricornis* females per collection date (every two weeks) from all three collection sites.

This past fall, more research was conducted to determine how *Sirex* associated fungi would interact when placed in direct competition with other species of fungi that are commonly found in pines in the Southeast. Growth

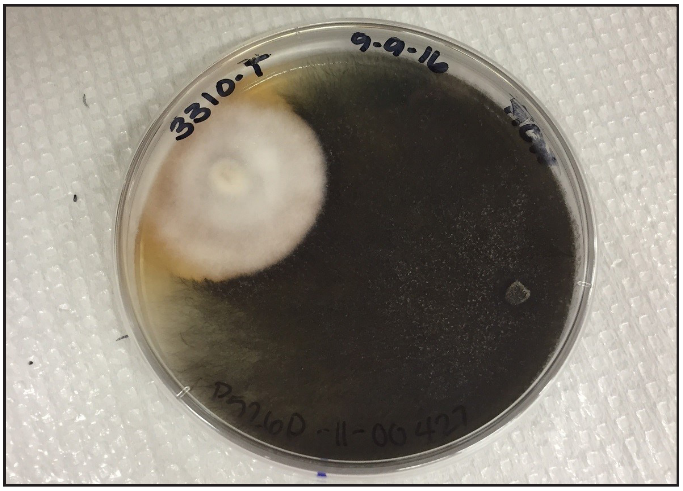


Figure 2. *Amylostereum areolatum* (white hyphae) plated in competition with *Leptographium terebrantis* (green hyphae) after two weeks of growth

and interaction between *Amylostereum* spp. (*Sirex* associated) and *Leptographium terebrantis* and *L. procerum*. Analyses are still being conducted on this data, but preliminary results show that *Leptographium* spp. clearly outcompete *Amylostereum* spp. in most cases (Figure 2). *Leptographium* spp. isolates grew faster, and in some cases over grew the *Amylostereum* spp. isolates completely.

Another aspect of this study, to answer questions on the behavior of *Amylostereum* fungi, is currently being carried out. A Vegetative Compatibility Group (VCG) study is being run to assess how closely related different isolates of *A. areolatum* are that were collected from various sites around the world. This study can give us better insight as to where certain isolates in introduced areas originally came from.

PLANT GROWTH-PROMOTING RHIZOBACTERIAL STUDY
Pratima Devkota

Plant growth-promoting rhizobacteria (PGPR) have been shown to induce the systemic resistance of plant to pathogen infection along with growth promotion. The aim of this study was to understand whether PGPR strains can induce systemic resistance of *P. taeda* L. to *Leptographium terebrantis* and *Grosmannia huntii*.

Plant growth-promoting rhizobacteria; *Bacillus pumilus* strains (INR7 and SE-34) and *Serratia marcescens* (90-166) and a control with no PGPR were included in study. About 100 mL of sterile distilled water with 108 colony forming units per milliliter of these bacteria were inoculated to *P. taeda* seedlings by soil drenching. Two weeks following application of rhizobacteria, *L. terebrantis* and *G. huntii* were artificially inoculated. Then dark necrotic tissue around fungal inoculation and seedling biomass were measured eight weeks after the inoculation of fungi (Figure 1).

The first replicate of the study showed that the necrotic tissue was significantly shorter and plant biomass was higher in the seedlings that received *Bacillus pumilus* INR7 (Figure 2). Similarly, other PGPR also caused significantly shorter lesion and had higher biomass as compared to control seedlings with no PGPR treatments. Results suggest that the studied PGPR strains have ability to promote *P. taeda* growth and induce systemic resistance to ophiostomatoid fungi.

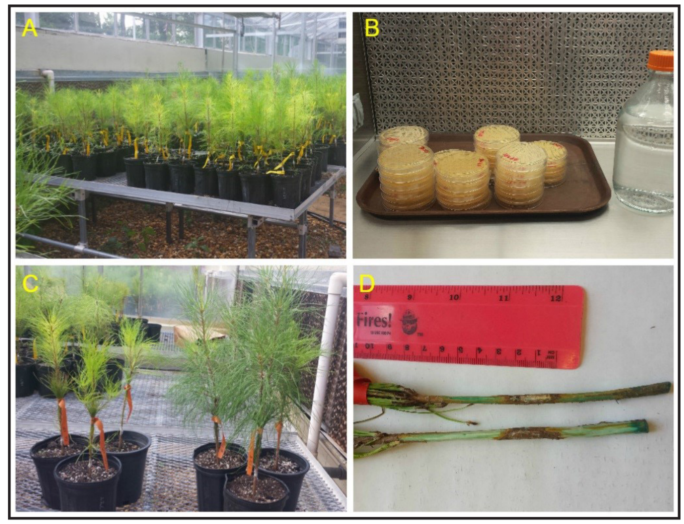


Figure 1. (A) Loblolly pine seedlings planted inside greenhouse; (B) Rhizobacterial inoculum preparation; (C) Appearance of the *Leptographium* inoculated seedling with and without PGPR treatment from left to right; (D) The dark necrotic lesions observed in the seedlings

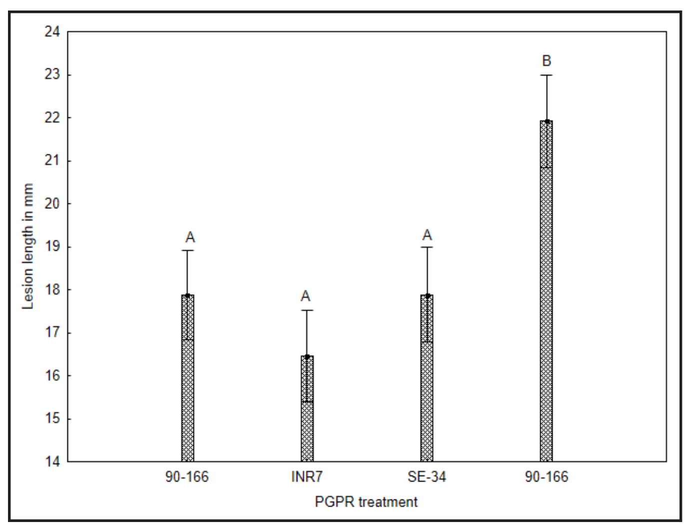


Figure 2. The mean length of the lesion produced in the seedlings inoculated with ophiostomatoid fungi and the various PGPR treatment and control treatment. Letters indicate 95% confidence interval.

SEEDLING SCREENING STUDY, YEAR 5 UPDATE
Pratima Devkota

Infection of roots of *Pinus* spp. by ophiostomatoid fungi is a serious threat to forest production sustainability in the southern United States. Ophiostomatoid fungi *Leptographium* and *Grosmannia* species, vectored by the root-feeding bark beetles are the major fungi causing root-infection of *Pinus taeda* L. and further lead to tree decline. The symptoms associated with the decline are thinning crowns, sparse and chlorotic needles, deterioration of fine and lateral roots, premature decline and mortality of pine trees.

The objective of this study was to determine the variability in tolerance of different *P. taeda* families to two root-infecting ophiostomatoid fungi. In 2016, the study was conducted in 23 containerized *P. taeda* families. The study was designed as randomized control block design with 6 blocks. In the study, one year old seedlings were artificially inoculated with fungi; *Leptographium terebrantis*, *Grosmannia huntii* and controls; wound and wound + media as shown in Figure 1. Eight weeks following inoculations, seedling responses (seedling survival, lesion presence, lesion length and occlusion of vascular tissues) were measured.

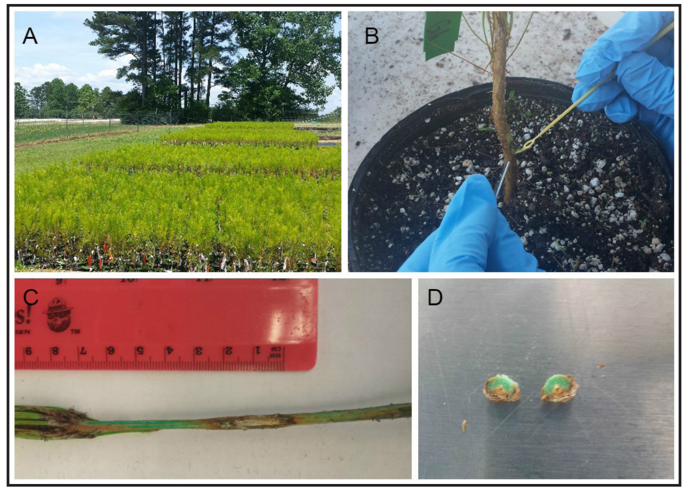


Figure 1. **(A)** Seedlings of 23 loblolly pine families in Randomized Complete Block Design; **(B)** Artificial inoculation of fungi; **(C)** Dead necrotic lesion in seedling stem eight week following inoculation; **(D)** Cross section of the stem showing blocked vascular tissue

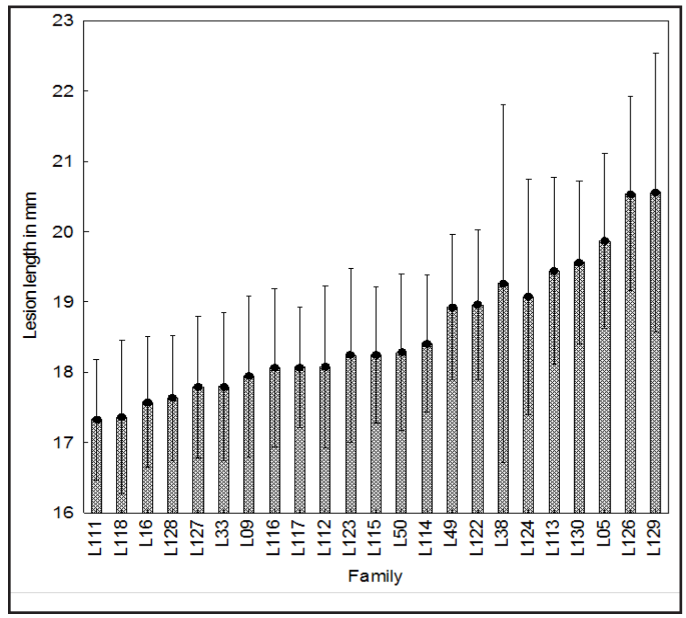


Figure 2. Average lesion length in 23 *P. taeda* families after inoculation with *Leptographium terebrantis* and *Grosmannia huntii.*

Both the fungal treatments caused dark brown lesions in all the families tested. The length of the lesion caused by both the fungal treatments was significantly longer than those caused by the control treatments in all the families tested. There was no interaction between the family and the fungal treatment (F=1.16, p = 0.27). The average legion length caused by overall fungi was significantly different among the families (F= 2.21, p = 0.00096). The family L111 had the lowest average lesion length (i.e. 17.32 mm) and is considered the most tolerant family. Family L129 have the highest average lesion length (i.e. 20.55 mm) and is considered the most susceptible family.

There was variation in susceptibility or tolerance of *P. taeda* families to ophiostomatoid fungi associated with pine decline in 2016 seedling screening study. The results are consistent with the results of previous seedling screening studies. *Pinus taeda* families can be ranked based on their tolerance and susceptibility to infection by these two fungi. Thus, family differences exist and tolerant families can perform better when planted in pine decline risk sites.

MOISTURE STRESS STUDY
Pratima Devkota

The susceptibility of host conifers to attack by pathogens and insects is influenced by stress factors like adverse climatic conditions. The interactions of biotic and abiotic factors on the health of *Pinus* spp. can be complex. The aim of this study was to determine the combined effect of soil moisture and pathogenic stress on the growth and survival of *Pinus taeda* L.

We studied two *P. taeda* families (one susceptible and another tolerant to *Leptographium terebrantis* and *Grosmannia huntii*). There were three watering treatments: a) normal moisture b) medium moisture stress and c) low moisture. One month following the establishment of the watering two treatments: *L. terebrantis*, *G. huntii*, and three controls: wound, wound + media, and no wound were applied. Predawn water potential, stomatal conductance, and number of buds that developed were measured at the end of the experiment. Plant-biomass, lesion and occlusion (blocked vascular tissue) were measured six months following inoculation (Figure 1).

Our results showed that the length of the dark necrotic lesion and vascular occlusion was longer in the susceptible family. However, it was not statistically significant (Table 1). The depth of the occluded tissue, dry mass of the coarse root and fine root were significantly higher in the susceptible family. The needle biomass was higher in the control inoculated seedlings than the fungal inoculated seedlings (Figure2). Also, we observed that the needle water potential decreases in seedlings from the susceptible family under low moisture conditions compared to seedlings in the tolerant family. Our results suggest that the *Leptographium terebrantis* is more virulent in low moisture conditions. Tolerant families can perform better than the susceptible families in varying moisture conditions.

Table 1. P-values showing the significance of each of the dependent variables

Source	Lesion length	Occlusion length	Occlusion Depth	Coarse Root	Fine Root
Fam	0.8059	0.2145	0.0018	<0.0001	0.0030
Trt	<.0001	<0.0001	<0.0001	0.4293	0.7878
Moisture	<0.0001	<0.0001	<0.0001	<0.0001	0.0003
Farm*Mos	0.2499	0.2996	0.1775	0.1769	0.9511
Fam*Trt	0.8804	0.7630	0.0139	0.2710	0.7030
Mos*Trt	0.0286	0.1176	0.8120	0.5185	0.3051
Fam*Trt*Mos	0.9201	0.7920	0.6182	0.2587	0.4138

Figure 1. (A) Loblolly pine seedlings planted in moisture stress boxes; **(B)** Seedlings inoculated with fungi and control; **(C)** Monitoring of the moisture treatment; **(D)** Cross-section of the vascular tissue being blocked; **(E)** Necrosis of the stem after the inoculation in seedling of susceptible family

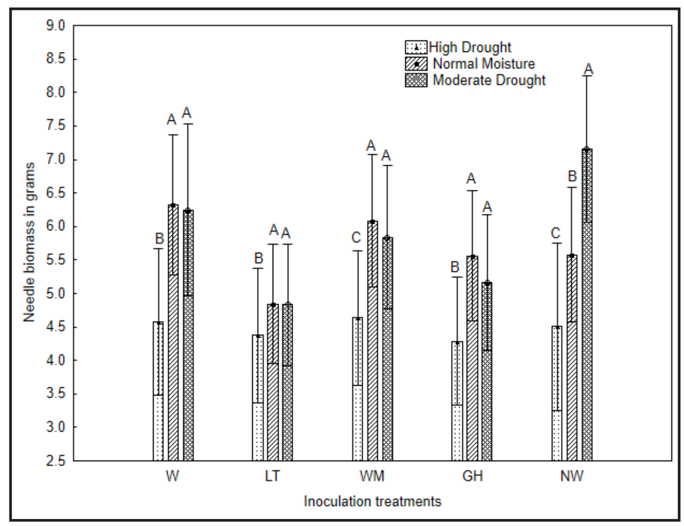


Figure 2. Dry needle biomass on the seedling inoculated with different fungal and control treatment under different soil moisture levels (Note:W=wound, LT=*Leptographium terebrantis*, WM:Wound+media, GH=*Grosmannia huntii*, NW=No wound)

BOLT INOCULATION STUDY
Pratima Devkota and John Mensah

The inoculum density, the number of the fungal inoculum per certain area, plays a major role in determining the level of impact of the blue-stain fungi on loblolly pine host. Therefore we designed a study in which we can mimic the natural process of the fungal inoculation by bark beetle. This designed study seeks to determine 1) the most pathogenic isolate of *L. terebrantis* to *P. taeda* seedlings and 2) its growth ability in *P. taeda* bolts and trees to it at different inoculum loads and develop the relationship between the inoculum density and tissue occlusion.

An artificial seedling inoculation study was performed and the most pathogenic fungi was determined and used in the further inoculations during the experiment. Subsequently, loblolly pine bolts were inoculated with toothpicks cultured with the most pathogenic *L. terebrantis* by making 0.15 mm diameter and 5 mm deep holes. The inoculation points were a) 1.27 cm apart sideways and parallel, b) 1.27 cm apart in a single line, c) 2.54 cm in a single line and d) 2.54 cm apart in parallel line. The growth of the fungi was determined by accessing the blue-stain at cross section of the bolts. Following the laboratory study, a field inoculation test was conducted in regenerating pine forest in Andalusia, Alabama. Four fungal treatments and their respective controls; two, four, eight and sixteen inoculation points were applied to the trees. Then eight weeks following inoculation, proportion of the occluded tissues was determined.

In the lab inoculation study, the bolts inoculated 1.27 cm apart in double line stained 44.89 cm^3 more volume of the wood than that of those inoculated in single line 2.54 cm apart, $p = 0.0383$. The bolts with inoculations 1.27 cm apart in double line stained 35.46 cm3 more volume than that by 1.27 cm apart in single line, P = 0.0128. Similarly, 1.27 cm apart in double line produced significantly higher volume of the inoculation than that caused by 2.54 cm in double line.

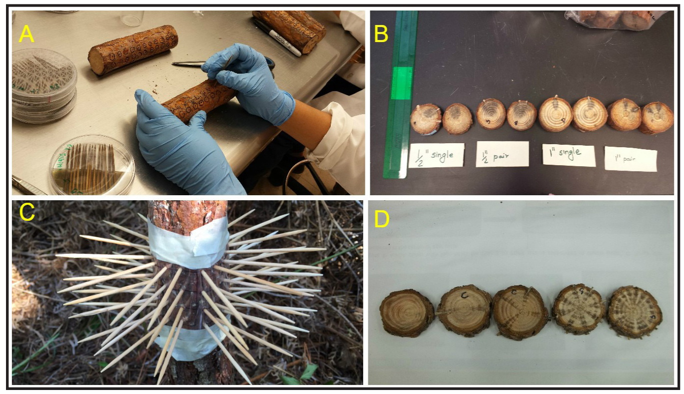


Figure 1. **(A)** Inoculation of loblolly pine bolts in FHDL; **(B)** The stain observed in the cross-section as a result of fungal growth; **(C)** Inoculation of *L. terebtantis* in field; **(D)** Occluded tissue as a result of fungal inoculation.

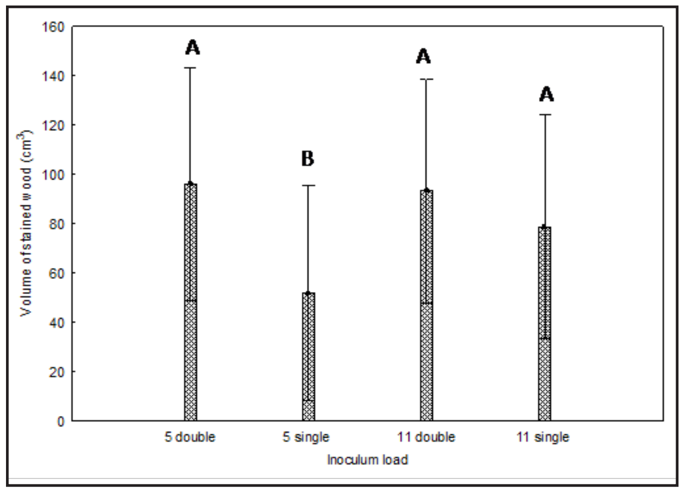


Figure 2. Mean volume of wood stained by different inoculum load of *L. terebrantis*.

Table 1. Mean occlusion length and volume associated with treatments (n=72)

Treatment	Occlusion length (± S.E)cm	Volume (± S.E)cm^3
2IP	87.30 ± 5.03	12.47 ± 1.31
4IP	112.63 ± 7.87	29.91 ± 3.19
8IP	116.44 ± 6.64	52.20 ± 5.11
16IP	144.36 ± 7.88	106.20 ± 10.43

Note: IP=inoculation point

In the field inoculation study, statistically significant differences were observed in percentage of tissue occlusion (F=18.95, $p = <0.0001$) caused by four inoculation densities of *Leptographium terebrantis* as indicated in Table 1. Treatments 16IP and 2IP recorded the highest (45.6%) and lowest (9.0%) tissue occlusion respectively.

Leptographium terebrantis caused occlusion of vascular tissue and blue-staining of loblolly pine stem segments in the field and laboratory study respectively. Higher inoculum density produced staining and occlusion extending over a larger area. Inoculated loblolly pine trees should be monitored over an extended period of time to understand how certain aspects of plant physiology are impacted by *L. terebrantis* at different inoculum densities.

LOBLOLLY PINE RESPONSE TO *L. TEREBRANTIS* IN NATURALLY REGENERATING STAND – A PRELIMINARY STUDY IN ANDALUSIA

John Mensah

L. terebrantis has been identified as one of the most pathogenic ophiostomatoid fungi associated with roots of loblolly pines undergoing decline. Studies conducted by FHDL has confirmed its pathogenicity in loblolly pine seedlings. As part of a broader study to quantify the impact of *L. terebrantis* on loblolly pine growth and productivity, a preliminary study was installed in naturally regenerating pine forest to determine pathogenicity and the influence of *L. terebrantis* infection on loblolly pine physiological processes. *L. terebrantis* was used as a single factor in a completely randomized design and inoculations were done using sterilized and toothpicks colonized with the fungi to mimic the feeding habits of the bark beetles.

The results from the study clearly show infectivity and colonization of healthy tissues by *L. terebrantis* as shown by the presence of dark brown areas in Figure 1. Percentage of tissue occlusion was significantly different among treatments ($F(4,79)=90.64$ $P=<.0001$) and the interaction (time and treatments) but time had no significant effect on percentage of tissue occlusion ($F(3,79)=0.85$ $P=0.4521$). The lowest percent of occlusion (3.7%) was observed in treatment 1 whereas treatment 4 recorded the highest (65.8%) as shown in Figure 2. No occlusion was observed in the control treatment.

The occlusion length was significantly influenced by treatment and time but their interaction had no significant effect ($F(12,79)=0.96$ $P=0.4890$). The trend in the occlusion length followed a similar pattern as observed in percent occlusion. Results from the study clearly show that *L. terebrantis* successfully infected and caused occlusions in healthy xylem tissue of loblolly pine trees following destructive sampling. Despite infection and colonization by the fungus, neither symptoms of decline nor signs of dieback were observed in the infected trees which may be partly attributed to short study period.

Figure 1. Radial sections of loblolly pine stem showing infection by *Leptographium terebrantis*

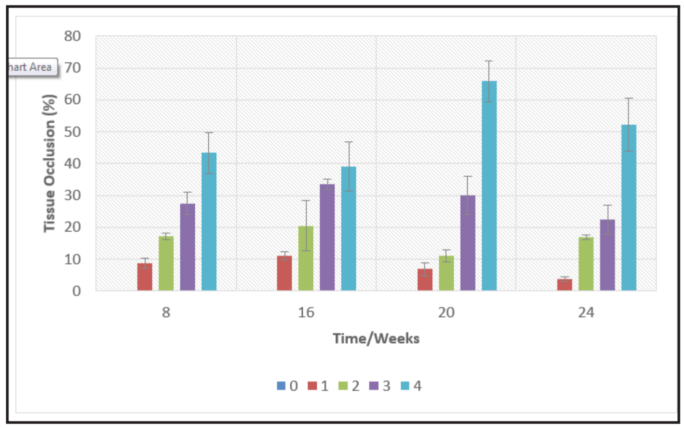


Figure 2. Percent tissue occlusion associated with different treatments. 0– Control; 1-Very low inoculum density (ID); 2- low ID; 3 – Medium ID; 4 –High ID

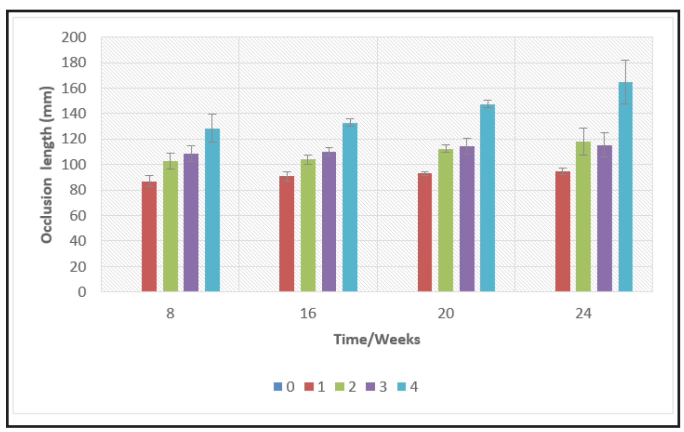


Figure 3. Mean occlusion length caused by L. terebrantis. 0– Control; 1-Very low inoculum density; 2- low; 3 – Medium; 4 –High inoculum density

STUDY OF SOIL MICROBIAL BIOMASS AND SOIL MOISTURE IN A LOBLOLLY PINE STAND
Shrijana Duwadi

Soil microbial biomass (MB) is the total population of active microbes in the soil at the time of sampling which includes bacteria, fungi, actinomycetes, etc. It is measured by the amount of C, N and P present in the microbes. In the forest soils, MB takes part in Carbon (C) decomposition and Nitrogen (N) cycling and is taken as the early indicator of changes in total soil carbon and soil properties. Seasonal variations like temperature and rainfall are taken as some of the limiting factors affecting microbial activity in the soil; however different studies have suggested that microbial community respond inconsistently to seasonal variation.

This study is based on the hypothesis that loss of tree vigor and stand production by pine decline is aggravated by a carbon (C) deficit. Although several studies have focused on soil conditions associated with the declining trees, soil related factors are still poorly understood. Through this research, I seek to understand how carbon availability affects root disease progression in loblolly pine. The study was carried out for four consecutive seasons to inspect the seasonal variations of MB and soil moisture content (SMC) at the study site located in Eufaula, Alabama, USA. We collected the soil samples in the winter, spring, summer and the fall from fifteen different plots, starting from January 2016. Microbial biomass was collected by taking 5 soil samples from the top 10 cm at each plot ; 4 from cardinal points and 1 from the middle of the plot. After sieving the collected soil samples with 2 mm mesh size sieve, soil microbial biomass C (MB-C) and soil microbial biomass N (MB-N) at the depth of 0-10 cm were determined by soil fumigation with alcohol-free chloroform ($CHCl_3$) and expressed in mg/L.

The data was used to calculate MB- C:N ratio (figure 3). C:N ratio in the microbes is usually 8:1. Also after sieving the soil, 10 g of field soil was weighed in an aluminum tin and kept in oven at 105°C for 3 days to calculate the SMC of each plot. In every season, soil moisture in each plot was observed to be lower than the previous season (figure 2). A maximum soil moisture content of 0.536 w/w and a minimum of 0.008 w/w were recorded in the winter and the fall respectively. Decreasing soil moisture might be due to low rainfall intensity; however, microbial biomass didn't necessarily decrease with decreasing soil moisture.

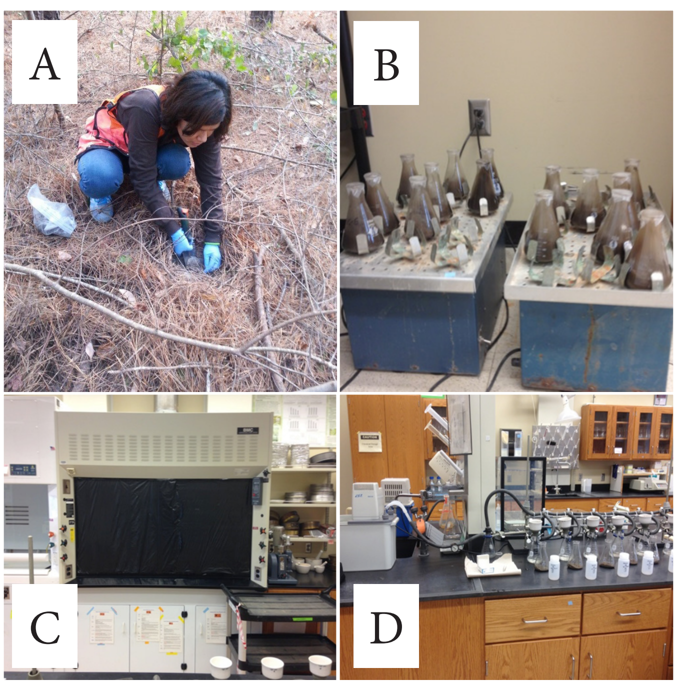


Figure 1. (A) Soil collection from the field; **(B)** Samples (18.5 g in each flask) kept in shaker to blend soil and K_2So_4 solution (0.5 M); **(C)** Samples form each plot fumigated with ethanol free chloroform and kept in dark for a day in vacuum hood (this step skepped for unfumigated samples) ; **(D)** both fumigated and unfumigated samples vacuum distilled to get soil solution.

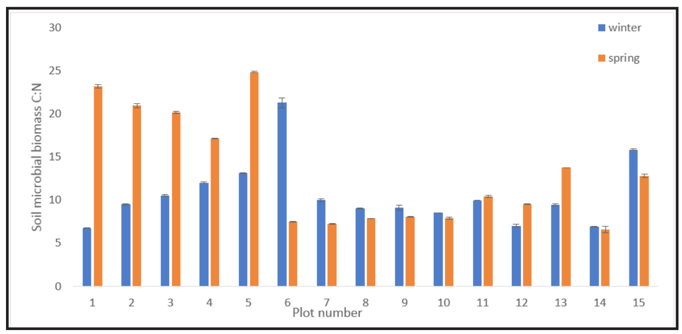


Figure 2. Mean value of Microbial biomass C:N ratio measured during the winter and spring. Comparisons were made between same plot in different collection periods as well as different plots in same collection period as well as ($p<0.0001$). Error bars represent standard error of the mean.

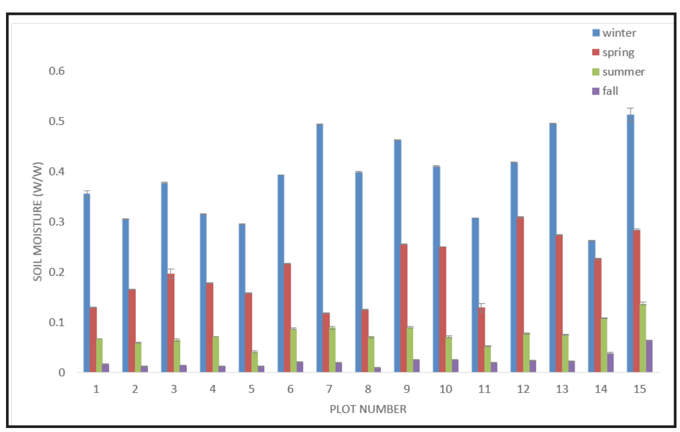


Figure 3. Mean value of soil moisture content (SMC) measured during four collection periods. Comparisons were made between same plot in different collection periods as well as between different plots in same collection period ($p<0.0001$). Error bars represent standard error of the mean.

Future studies include measurement of bulk density, soil pH, soil nutrients, fine root turnover and foliar nutrients, along with soil MB. This study aims to improve our understanding as to how soil physical properties, chemical compositions, and biological makeup interact with root disease progression. In so doing, this study shall aid land managers in soil management decisions to reduce the impact of pine decline on the growth of loblolly pine.

ESTIMATING THE STRENGTH PROPERTIES OF FAMILIES USING NEAR INFRARED SPECTROSCOPY

Gifty E. Acquah

Density is considered to be the most important physical property of wood due to its effect on other wood attributes such as the strength properties, the yield of pulp per unit volume and the shrinkage and swelling behavior of wood. Just like density, the strength properties of MOE and MOR dictate the quality of wood for structural applications. In addition, MOE and MOR are valuable traits in standing trees since they impact the failure of stems and uprooting of trees during inclement weather. Currently, test methods used to determine the density, MOE and MOR of wood require extensive sample preparation and destructive testing. With the large number of trees that have to be sampled in tree breeding programs, these conventional methods will not be practical and feasible. The aim of this study was to employ near infrared spectroscopy coupled with chemometric modeling as a high throughput tool to rapidly predict the density, MOE and MOR of select elite loblolly pine families.

Materials used in this study included thirty trees representing fifteen elite loblolly pine families obtained from two sites in Brantley County, GA and Nassau County, FL. In addition, nominal 2 x 4 southern pine commercial lumber acquired from West Fraser Inc. Opelika, AL were used. Samples were processed for three-point static bending tests as specified in ASTM D143. Clear wood test specimens were cut to final dimensions of 2.5 x 2.5 x 41 cm and conditioned to an average moisture content (MC) of 9% in a control chamber (temp: 22°C; relative humidity: 55%). Prior to destructive testing, the mass of a sample was measured and the dimensions obtained with calipers for basic density computations. Test samples were then loaded into a Zwick-Roell load frame (Ulm, Germany) and tested until failure. After destructive testing, each specimen was further processed to pass an 80-mesh screen. NIR spectra was collected from this material with a PerkinElmer Spectrum Model 400 NIR spectrometer (Waltham, MA, USA). The wavenumber range of the instrument was from 10000 cm^{-1} to 4000 cm^{-1}. Partial Least Squares regression (PLS) models were developed using the first derivatives of spectra as x-variables and the conventionally obtained results as the y-variables. Models that had the lowest error values were chosen and used to predict the basic density, MOE and MOR of three hundred and fifty-five increment cores representing fourteen elite loblolly pine families.

Descriptive statistics for the density and MOR of the elite families on the two forest sites are presented in Table 1.

The mean predicted densities of the families ranged from a low of 0.37 g/cm^3 to a high of 0.50 g/cm^3; whereas MOR was from 70 MPa to 116 MPa. A Two-way ANOVA ($\alpha = 0.05$) showed that the families differed significantly in their densities and MORs, Table 2. It was also determined that the density and MOR of the juvenile elite loblolly pine families were comparable to what have been reported in the literature for older trees. In addition, the interaction term was significant for these two traits; indicating that the density and MOR of a family could vary dependng on the environment. Further studies with more sites would however be helpful in estimating the extent of the family by site interaction. Such knowledge would be valuable for tree breeders in decisions to plant families with desired traits in certain environments.

With respect to the MOE, only family had a significant effect. The predicted mean MOE ranged from 10946 MPa (SD = 2703 MPa) for A9 to 7782 MPa (SD = 2237 MPa) for A33, Figure 2.

In spite of the significant interactions term, families A9 and A1, as well as A26 and A2 consistently had higher density, MOR and MOE irrespective of site.

Figure 1. **(A)** Loblolly pine trees and bolts; **(B)** Test specimen for bending test; **(C)** Testing machine loaded with sample; **(D)** Test samples for NIR spectra collection

Conversely, the strength related properties of A21 and A33 remained relatively low on the two studied. Apart from the structural implications, the survival of these families might also be impeded on site due to inclement weather.

Table 1. NIR-estimated properties of loblolly pine families

	Density (g/cm³)		MOR (MPa)	
Family	**Florida**	**Georgia**	**Florida**	**Georgia**
A1	0.49 (0.06)	0.46 (0.06)	116 (28)	103 (21)
A2	0.46 (0.04)	0.46 (0.05)	109 (17)	99 (11)
A5	0.43 (0.02)	0.40 (0.05)	87 (10)	92 (32)
A9	0.47 (0.03)	0.50 (0.07)	106 (10)	109 (28)
A10	0.46 (0.04)	0.44 (0.07)	103 (19)	96 (30)
A13	0.37 (0.03)	0.39 (0.05)	77 (17)	92 (19)
A15	0.42 (0.02)	0.45 (0.07)	93 (27)	96 (16)
A21	0.39 (0.03)	0.44 (0.06)	77 (10)	88 (21)
A26	0.45 (0.03)	0.49 (0.07)	101 (21)	98 (19)
A33	0.40 (0.03)	0.38 (0.02)	80 (14)	70 (13)
A34	0.44 (0.04)	0.44 (0.08)	104 (21)	84 (22)
A37	0.41 (0.01)	0.41 (0.05)	111 (12)	83 (20)
F17	0.40 (0.04)	0.43 (0.05)	92 (18)	95 (17)
F23	0.39 (0.03)	0.45 (0.05)	79 (16)	101 (15)

Table 2. ANOVA P-values per treatment for strength properties

Property	Family	Site	Family x Site
Basic density	< 0.0001	0.0294	0.0055
Modulus of rupture	< 0.0001	0.3747	0.0005
Modulus of elasticity	<0.0001	0.5625	0.5198

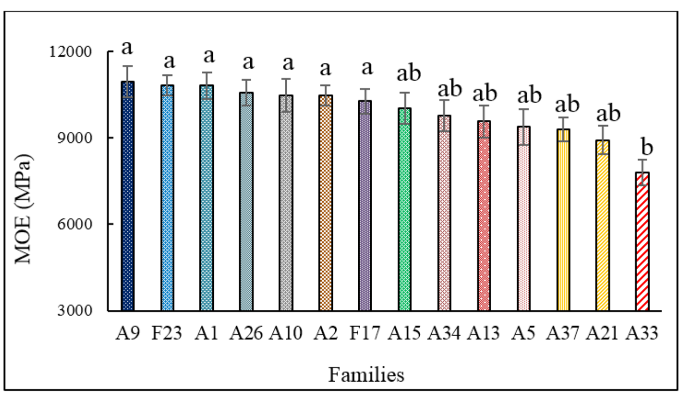


Figure 2. Rank of loblolly pine families for MOE. *Bars with different letters are significantly different at 95% confidence level (Tukey's HSD Test).

DOES TREE SUSCEPTIBILITY TO ROOT-FEEDING FUNGI AFFECT WOOD QUALITY?

Charles Essien, Pratima Devkota, Brian K. Via, Lori G. Eckhardt

Loblolly pine is one of the most important tree species in the southeastern USA contributing substantially to the economy. Recently, loblolly pine decline has become one of the major challenges confronting plantation development in the southern USA. This decline has been linked to a complex interaction among fungi, insect, environment and host. There are several studies exploring the underlay causal and the nature of relationships among the factors causing this decline. However, little information exists on the use of rapid nondestructive wood quality assessment techniques to help differentiate between trees susceptible and tolerant to root-feeding fungi. The objective of this study is to explore the possibility of using acoustic techniques to differentiate trees susceptible and tolerant to root feeding fungi.

Four families of mature loblolly pine identified as tolerant and susceptible to root-feeding fungi by FHDL were used for this study. Two of the families, L5 and L8 were tolerant while L56 and L37 were susceptible (Table 1). The trees were about 17 years at the time of sampling and the stands had received one row thinning since establishment. Some morphological properties such as crown ratio, crown transparency, crown light, crown density, tree height and DBH (diameter at breast height) were measured. Slenderness or tapering was estimated as the ratio of total height to DBH of the tree. Wood anatomical parameters such as microfibril angle (MFA), fiber length, lumen diameter, fiber wall thickness, and wood quality indicators such as basic density, green density, velocity and moisture content were also determined.

The results indicated significant variations among the properties studied. The average live crown characteristic parameters indicated significant difference among the families studied (Figure 1). Generally, the susceptible families (L37 & L56) had similar crown characteristics as compared to the tolerant ones (L5 & L8). From Figure 2, the total height of the L5 was significantly shorter than the rest of the families (p-value < 0.05). The anatomical parameters followed similar trend where the susceptible families (L37 &L56) were statistically similar while the tolerant ones were statistically different (Figure 3). From Figure 4, the velocity which is a measure of stiffness of the wood was statistically lower in L5 as compared to the susceptible ones (L37 & L56). Generally, the results presented indicated greater similarities within the susceptible families in all the properties studied as compared to the tolerant ones. The wood anatomical and quality parameters studied show that families

L37, L56 and L8 seem to produce stiffer and stronger wood as compared to L5 indicating that the quality of wood produced is independent of the susceptibility status of the trees. It is important to note that since the families were not planted on the same site, the edaphic and environmental factors can influence the above results.

Table1. Description, site location and sample size of the four mature loblolly pine families used for the study.

Site	Family and susceptibility status	Sample size
Eufaula, AL	L5 – tolerant to root-feeding fungi	25 trees
Eufaula, AL	L8 – tolerant to root-feeding fungi	25 trees
Cordele, GA	L37 – susceptible to root-feeding fungi	25 trees
Cordele, GA	L56 – susceptible to root-feeding fungi	25 trees

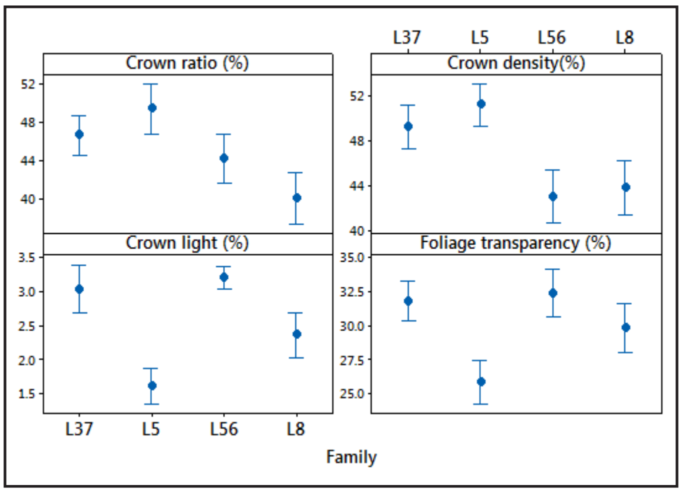


Figure 1. Live crown characteristics indices of the four mature loblolly pine families. L5 & L8 are tolerant while L37 & L56 are susceptible. Different letters indicate significant difference at 95% confidence level.

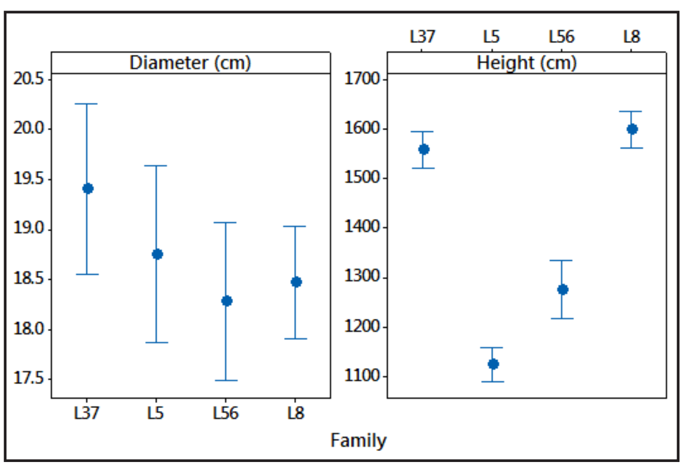


Figure 2. Tree morphological parameters of the four mature loblolly pine families. L5 & L8 are tolerant while L37 & L56 are susceptible. Different letters indicate significant difference at 95% confidence level.

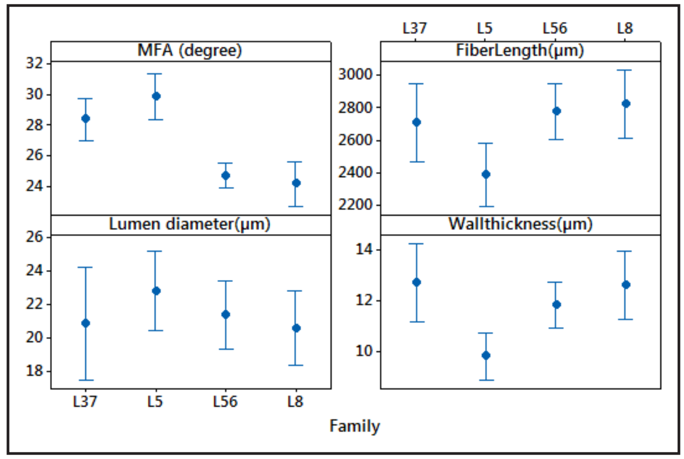


Figure 3. Wood anatomical parameter of the four mature loblolly pine families. L5 & L8 are tolerant while L37 & L56 are susceptible. Different letters indicate significant difference at 95% confidence level.

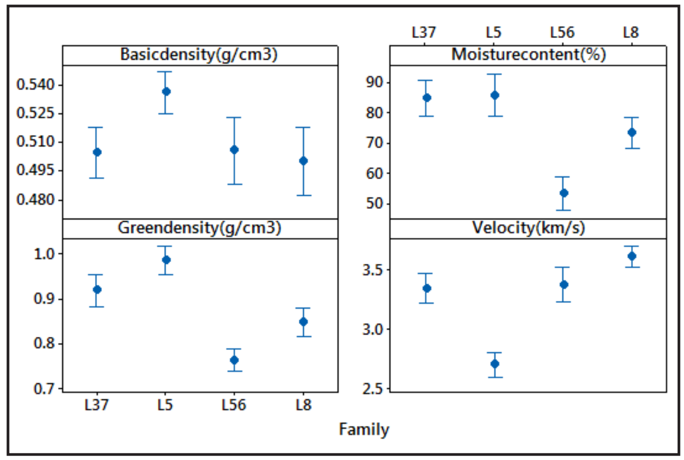


Figure 4. Wood quality indicators of the four mature loblolly pine families. L5 & L8 are tolerant while L37 & L56 are susceptible. Different letters indicate significant difference at 95% confidence level.

GRANTS

NEW GRANTS

Eckhardt, Nadel, Fan, Sword, and Carter. 2016 Quantifying the impact of root disease on the function of a tree. NIFA-AFRI $497,691 (*Pending discussion*)

CONTINUING GRANTS

Via and Eckhardt. 2015. Novel analytical tools for the selection of superior loblolly pine genotypes for improved plant health, fuels, and chemicals – SFWS, Forest Products Development Center and AU-IGP (Good to Great Grant). $150,000. *Year 2 of 2

Enebak and Eckhardt. 2014. Seedling production and forest health in the Southeastern United States – NSF-CAFS - $300,000 ($150,000 to FHC). *Year 3 of 5

Enebak and Eckhardt. 2014. Testing of a rapid PCR Screening test for the presence of *Fusarium circinatum*, the causal agent of pitch canker on pine planting material – FHM - $150,000. *Year 3 of 3

Eckhardt and Enebak. 2015. Sudden Oak Death – *Phytophpora ramorum* surveys - $210,000. *Year 6. Funding for 2017 expected.

Via and Eckhardt. 2014. Wood chemistry and disease resistance. SFWS - $25,000. *Year 4 of 5

Hoeksema and Eckhardt. 2014. Mycorrhizal fungal colonization and disease resistance – SFWS and University of Mississippi - $25,000. *Year 4 of 4

Eckhardt and Wingfield. 2015 *Pinus* related diseases and molecular aspects. SFWS and FABI – University of Pretoria South Africa for travel and supplies and a graduate student stipend at UP - $30,000. *Year 4. Extended until 2019.

ASSOCIATED ACTIVITIES

(Meeting, Workshops, Short Courses, Disease Clinic)

ADVISORY MEETING

The Advisory meeting was held July 29-30, 2016 in Auburn at the School of Forestry and Wildlife Sciences. The meeting was attended by 20 Forest Health Cooperative members. Forest Health Cooperative staff presented information of the virulence of the fungi associated with Pine Decline, the emerging threats of non-native invasive weeds and the potential effects of Sirex Wood Wasp. To review any of the presentations again, I encourage you to access them on the member page.

They FY18 meeting is set for June 13-15, 2017. It will begin after lunch on Tuesday and adjourn around noon on Thursday and will consist of a field trip. Place those days on your calendar and more information will be available soon.

BUSINESS MEETING

The Business meeting was held on July 30, 2016 at the School of Forestry and Wildlife Building at 602 Duncan Drive. The Forest Health Cooperative Staff presented the Accomplishments, Budget and next year's Work Plan. The work plan and budget were approved.

CENTER FOR ADVANCED FORESTRY SYSTEMS (CAFS)

Staff from both Auburn Cooperatives attended the CAFS Annual meeting in Pensacola Florida April 26-28, 2016. John Mensah, a PhD student, won a graduate student travel scholarship to the meeting. The Forest Health Dynamics Laboratory at Auburn's School of Forestry and Wildlife Sciences was awarded the third year of the 5-yr grant as part of the research center of the National Science Foundation, as part of the Center for Advanced Forestry Systems (CAFS). The Auburn site that addresses forest health in the region via the two research Cooperatives. This $60,000 grant will be used to fund research in the Nursery and Forest Health Cooperative.

WORKSHOPS, TRAINING AND FIELD VISITS

We conducted a Forest Health Short Course in Auburn Alabama at the School of Forestry and Wildlife Sciences. There were 60 participants in attendance and the workshop and lab exercises got good reviews. We also completed various forest health trainings and field visits for members. In addition we worked with the 4-H Forestry county teams in Alabama with insect and disease identification and were involved in several FFA (Future Farmers of America) teacher workshops on forest insect and disease as well as the student competitions. Training the youth of Alabama about forestry is important to the industry.

DISEASE CLINIC

We are still conducting the new procedures for the Disease Clinic. There is a link on the webpage explaining sampling procedures and a form to send in with your samples. This will make the process and information received more uniform and easier for us to track, process and report. Dalton Smith is the new contact for diagnostics for the Cooperative. His contact information is at the beginning of this report and on the website. Please feel free to contact him with any questions.

The Forest Health Cooperative staff saw a variety of issues this past year in the laboratory. The most frequent repeat occurrence was blue-stain fungi and root-feeding insect damage in loblolly pine roots. If you have any questions about the identification and management of these issues, be sure to check the Forest Health Cooperative web page or just give us a call.

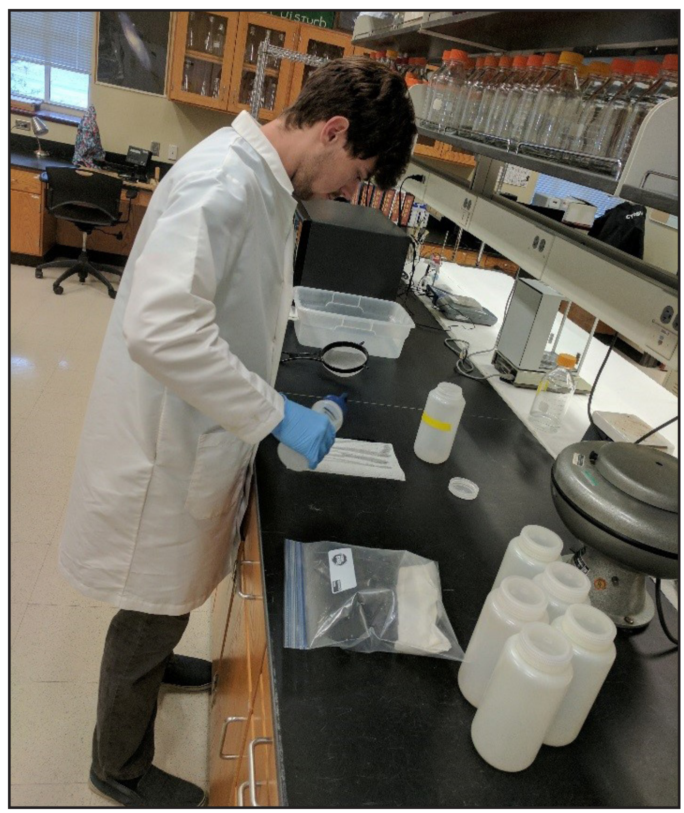
Here is a list of the problems we were involved in during 2016:

1. Pine decline – blue-stain fungi and *Hylastes* feeding in loblolly pine roots
2. Pine decline – blue-stain fungi and *Hylastes* feeding in longleaf pine roots
3. Annosus Root Disease
4. Tip Moth
5. Pine Sawfly
6. Pine Shoot Borer
7. Southern Pine Beetle
8. Ips
9. Slim flux
10. Hickory Borer
11. Horned Oak Gall
12. Coleosporium

SUDDEN OAK DEATH (SOD) STATE LABORATORY

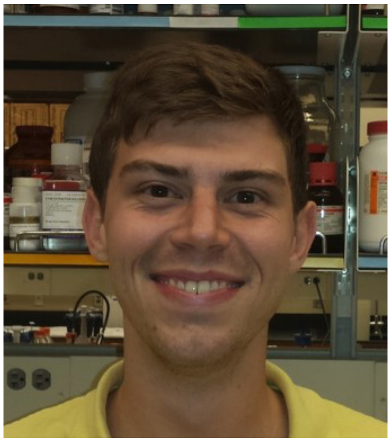
The Forest Health Cooperative (FHC) continued to be involved in the national 2015/2016 Sudden Oak Death (SOD) surveys and responsible for Alabama and Mississippi monitoring. During both fall and spring the Forest Health Cooperative conducted its survey using the "bottle of bait" protocol to monitor for the presence of *Phytophthora ramorum*, the pathogen responsible for Sudden Oak Death. Surveys were conducted at a total of 9 sites in Alabama and 5 sites in Mississippi. Early detection of this pathogen is essential to prevent an infection from becoming fully established. Water supplies at specific locations were monitored for the presence of the pathogen, with site selection based on stream drainage from nurseries considered at risk or known to have received plant material contaminated with the pathogen.

Sampling occurs only in fall and spring as water temperatures are then optimal for *Phytophthora ramorum* detection. Detection of the pathogen is determined using both morphologically and molecular identification techniques and carried out by the Department of Agriculture, Plant Disease Diagnostic lab. The 2016 sampling is scheduled to commence in March – April.



Dalton Smith processing the "Bottle of Bait"

STAFF



Dalton Smith – Research Assistant (Fall 2015)
Dalton Smith joined the Forest Health Dynamics Laboratory this past September as a Research Assistant, replacing Tessa Bauman. He is from St. Petersburg, Florida and a graduate from the University of Florida where he studied Natural Resource and Forest Conservation. He is interested in the field of forest health and mycology as well as the economic side of forestry. He wishes to continue his learning, gain valuable experience and possibly attend graduate school in the future. In the Forest Health Dynamics Laboratory he assists Dr. Lori Eckhardt with the work being done in the laboratory on Southern Pine Decline as well as works with the graduate students offering them any assistance they require. He works on the Sudden Oak Death (*Phytophthora ramorum*) survey, where they take water samples in Alabama and Mississippi. They test different nurseries for the presence of the pathogen *Phytophthora ramorum* and, in conjunction with APHIS, monitor the pathogen in the southeast. He is excited to work in the Forest Health Dynamics Laboratory, meet individuals involved in industry and contribute to the research in the laboratory.

Dr. Ryan Nadel – Research Fellow (Spring 2014)
Dr. Ryan Nadel joined the Forest Health Dynamics Laboratory as a Post-Doctoral Fellow. His current research focus is on tree health. His current research project focusses on testing pine seed for the presence of *Fusarium circinatum* using a newly developed rapid molecular screening technique compared to the blotter paper method currently used by the International Seed Testing Association (ISTA). Ryan is from South Africa where he was employed as a Senior Research Scientist and Project Leader for Integrated Pest Management (IPM) Research at the Institute for Commercial Forestry Research (ICFR). Ryan has worked on numerous pests and pathogens (including *Fusarium circinatum*) that impacted the growth and survival of non-native Eucalypt, Pine and Wattle tree species grown in commercial forestry plantations. He is a graduate of the University of the Witwatersrand where he was awarded a BSc, BSc (Hons) in Ecology, Environment and Conservation and an MSc in the School of Animal, Plant and Environmental Sciences. In 2010, he was awarded a PhD degree from the University of Pretoria in the Department of Genetics after conducting research at the Forestry and Agricultural Biotechnology Institute (FABI). He has published several articles in international scientific journals and presented at several National and International conferences.

TEACHING

Each year the faculty associated with the Cooperative teach various courses at both the graduate and undergraduate level. Lori Eckhardt and Scott Enebak co-teach FORY 5150/6150 (Forest Health) and FORY 5151/6151 (Forest Health Lab). Scott Enebak teaches FORY 3020 (Introduction to Forest Biology) at Summer Practicum at the Solon Dixon Center in Andalusia Alabama. Lori Eckhardt teaches FOWS 7950 (Graduate Seminar) which teaches students to how to give a research presentation. Nancy Loewenstein teaches FORY 3100 (Dendrology) and Ryan Nadel teaches FORY 5140/6140 (Forest Regeneration and Seedling Production). Brian Via teaches FORY 3390 (Introduction to Wood Science), FORY 5250/6250 (Biocomposites), FOEN 3000 (Introduction to Forest Operations), and FORY 7950 (Chemometrics).

GRADUATE STUDENTS

Graduate students' contributions to the program continue to be critical. Forest Health students have had a great year winning over 10 awards which include Best Presentation, Outstanding MS Student, Travel Scholarships, Research Scholarships, and 3 Minute Thesis Presentation Award. A big congratulations to them for their hard work and efforts on their projects!

We additionally welcomed a Master's student, Jessica Ahl, this year to work on the Quantifying Pine Decline project. Listed below are the current students and a little bit about them and their project.

Andrea Cole –Masters Student (Fall 2014)
Andrea Cole joined the Forest Health Dynamics laboratory as an MS student. From Tucker, Georgia, Andrea undertook her undergraduate degree in Environmental Science at Berry College in Rome, Georgia. At Auburn her MSc will focus on *Sirex*

woodwasps. This experiment is to assess what pest insects were found in the area, specifically targeting native and invasive *Sirex* wood wasp species. Of particular interest is *Sirex noctilio*, a species of wood wasp native to Europe that has been identified as an invasive species in Australia, South Africa, and a few states in the Northeastern United States. This study will discern major forest pest population and abundance in eastern Alabama, and what needs to be done in order to control pests found in Alabama forests. After specimens are collected, the wasps will be keyed to species, then will be dissected in order to sample symbiotic fungal arthrospores and nematodes carried in their abdomens. This survey to determine if *S. noctilio* has reached Alabama is necessary because southern Alabama is at risk of invasion via the port of Mobile, where species have the potential to do economic damage to natural and commercial forests.

Shrijana Duwadi –Masters Student (Spring 2016)

My name is Shrijana Duwadi. I joined the Forest Health Dynamics Laboratory, Auburn University in January 2016 for MS program. I earned my undergraduate degree from Tribhuwan University, Nepal. As an undergraduate, I had involvement in a project that focused on evaluating the drought resistance property of wheat genotypes in different soil and climatic conditions. Soil Science, Pathology and Genetics being my areas of interest; my MS at Auburn University will focus on quantifying the impact of root disease, associated with root-feeding bark beetles and ophiosomatoid fungi in pine tree function. For this, experiments will be carried out on the soil portion looking at physical and chemical composition, soil nutrients, microbial biomass function, mycorrhizae and how all these relate to disease progression. I am hopeful that my study will contribute to the economic well-being of forests in the southeastern U.S. to some extent. Reading is what I love and travelling is my greatest passion; these are the reasons why I am here in the U.S. to pursue my higher education. I am more than happy to be a part of the Auburn family.

Pratima Devkota –PhD Student (Fall 2014)

My name is Pratima Devkota. I am a PhD student at Forest Health Dynamics Laboratory, Auburn University. I started my program in August, 2014. I completed my B.S and M.S in Microbiology from Tribhuvan University in Nepal. My research interests include the mechanisms of host- fungal interactions and disease resistance, as well as genetics. Currently, I am studying the variance and resistance of different loblolly and slash pine families towards different ophistomatoid fungi like *Leptographium terebrantis* and *Grosmannia huntii*. My study will help land managers make informed decisions regarding planting tolerant pine families. I am happy to be a part of this lab and Auburn University. Some of my hobbies are traveling and playing sports.

John Mensah –PhD Student (Spring 2016)

My name is John Mensah and I joined Forest Health Dynamics Laboratory, Auburn University as a PhD student from the Forestry Research Institute of Ghana. I started my program in January, 2016. I obtained my BSc and MPhil degrees in Botany from the University of Ghana, Legon. My research interests include fungal host interactions, biological control of pest and diseases and cultivation of edible mushrooms and molecular biology. Currently I am working on "The impact of *Leptographium terebrantis* on *Pinus taeda* growth in southeastern United States". This study seeks to quantify the impact of fungal root infection on tree and plantation productivity and investigate the early detection potential of tree variables. Ultimately, it will enable forest managers and practitioners to take appropriate decisions concerning commercial stands that are affected by certain pests and pathogens. I am glad to be part of the Forest Health Dynamics Lab at Auburn University and I like watching soccer.

Jessica Ahl – Masters Student (Fall 2016)

My name is Jessica Ahl. I joined the Forest Health Dynamics Laboratory as a MS student in the fall of 2016. Originally from Brunswick, Georgia, I received my BS degree in Coastal Ecology at the College of Coastal Georgia in Brunswick, Georgia in 2015. My research interests involve entomology, insect-plant interactions, and conservation of wildlife and our natural resources. My project at Auburn University will focus on insect populations involved with one of the fungi that cause Southern Pine Decline – *Leptographium terebrantis* – as well as trying to validate a method to identify such decline-causing fungal spores on the bodies of beetles with hyperspectral imaging. My work will attempt to find a better way to predict Southern Pine Decline and the effect *L. terebrantis* has on local insect populations. This will be important to combat the rising incidences of decline in the Southeast. I am excited to have joined this lab at Auburn University and look forward to learning many new things. My hobbies include pollinator gardening, Lepidoptera rearing, reading, and caring for my pets.

PUBLICATIONS
OF SPECIAL INTEREST TO MEMBERS (2013-2016)

From our inception in 2008, there have been over 24 publications written by Cooperative Scientists, Students, and Associates. Below is a list of publications from the last 3 years. The entire list is available on our website. (*indicates student)

2016

*Trautwig, A. Eckhardt, L.G., Hoeksema, J., Carter, E.A., and Loewenstein, N. (*Accepted*) Mycorrhizal communities in Imperata cylindrical invaded and non-invaded commercial *Pinus taeda* stands. Printed online first: http://www.ingentaconnect.com/content/saf/fs/pre-prints/content-forsci16016. For. Sci. 62:000-000.

*Acquah, G., Via, B.K., Fasina, O., and Eckhardt L. 2016. Raped quantitative analysis of forest biomass using Fourier transformation spectroscopy (FTIR) and partial least squares (PLS) regression. J. Anal. Meth. Chem. 00:000-000. Published online first doi:10.1155/2016/1839598.

*Acquah, G., Via, B., Billor, N., Fasina, O., and Eckhardt, L. 2016. Identifying plant part composition of forest logging residue using infrared spectral data and linear discriminant analysis. Sensors. Published first online: DOI: 10.3390/s16091375.

Matusick, G., *Walker, D., *Hossain, M., Nadel, R.L., and Eckhardt, L.G. 2016. Comparative behavior of root disease pathogens in stems and roots of *Pinus* species. Fungal Biology. Published first online: DOI: 10.1016/j.funbio.2015.12.007.

2015

*Chieppa, J.J., Chappelka, A.H., and Eckhardt, L.G. 2015. Effects of tropospheric ozone on loblolly pine seedlings inoculated with root infecting ophiostomatoid fungi. Environ. Poll. 207: 130-137.

Beach, J., Uertz, J., and Eckhardt, L. 2015. Hyperspectral interferometry: sizing micro-scale surface features in the pine bark beetle. Microscopy Research and Techniques Published online first: DOI: 10.1002/jemt22550.

*Acquah, G.E., Via, B.K., Fasina, O. and Eckhardt, L.G. 2015. Nondestructive estimation of forest biomass properties for bioenergy, fuels and chemical applications using near infrared spectroscopy (NIRS). J. Near Infr. Spec. Published online first: doi: 10.1255/jnirs.1153.

*Sells, S.M., Held, D., Enloe, S., Loewenstein, N., and Eckhardt, L. 2015. Impact of cogongrass management strategies on generalist predators in longleaf pine stands. Pest Mgmt. Sci. 71:478-484.

2014

Via, B.K., Zhou, C., Acquah, G., Jiang, W., and Eckhardt, L. 2014. Near infrared spectroscopy calibration for wood chemistry: which chemometric technique is best for prediction and interpretation? Sensors. 14:13532-13547.

Riggins, J.J., Little, N.S., and Eckhardt, L.G. 2014. Correlation between infection by ophiostomatoid fungi and the presence of eastern subterranean termite (*Reticulitermes* spp.) in loblolly pine (*Pinus taeda*) roots. Agric For Entol. 16:260-264.

*Duong, T.A., de Beer, Z.W., Wingfield, B.D., Eckhardt, L.G., and Wingfield, M.J. 2014. Microsatellite and mating-type markers reveal unexpected patterns of genetic diversity in the pine root-infecting fungus *Grosmannia alacris*. Phytopathology 64:235-242.

*Singh, A., Anderson, D, and Eckhardt, L.G. 2014. Variation in resistance of loblolly pine (*Pinus taeda* L.) families against *Leptographium* and *Grosmannia* root fungi. For. Path.44:293-298.

Enloe, S.F., Loewenstein, N.J., Held, D.W., Eckhardt, L.G., and Lauer, D.K. 2014. Impacts of prescribed fire, glyphosate, and seeding on cogongrass, species richness and species diversity in longleaf pine. Invasive Plant Science and Management. 6:536-544.

RESEARCH PRESENTATIONS
OF SPECIAL INTEREST TO MEMBERS (2015-2016)

From our inception in 2008, there have been over 200 presentations, seminars and trainings by Cooperative Scientists, Students, and Associates. Below is a list of presentations from the last year. The entire list is available on our website.

2016

Talks:
Eckhardt, L.G. 2016. Forest health of southern pines. Pine Mountain and War Eagle Chapters of the Society of American Foresters, Oxbow Meadows, Columbus, GA

*Devkota, P., and Eckhardt, L.G. 2016. Variation in Tolerance of Mature *Pinus taeda* Families to Root Infesting Fungi *Grosmannia huntii* And *Leptographium terebrantis*. This is Research: Student Symposium 2016, Auburn University, Auburn, AL

Eckhardt, L.G. 2016. Forest health of southern pines. Southeastern Society of American Foresters Annual Meeting, Auburn, AL

*Devkota, P., and Eckhardt, L.G. 2016. Virulence of Ophiostomatoid Fungi on Loblolly Pine Families under Drought Stress. Society of American Foresters Annual Convention. Madison, WI.

*Cole A.B., Eckhardt, L.G., Liebold, A., and Slippers, B. 2016. A survey for *Sirex noctillio* and native woodwasps in Alabama. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Duwadii, S., Carter, E.A., Nadel, R.L., and Eckhardt, L.G. 2016. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Mensah, J., Nadel, R.L., Matusick, G., Sword, M.A. and Eckhardt, L.G. 2016. How does *Leptographium terebrantis* inoculum density on loblolly pine physiology? Forest Health Cooperative Advisory Meeting, Auburn, AL

Nadel, R.L. and Eckhardt, L.G. 2016. Quantifying the impact of pine decline in the southeastern United States. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Devkota, P., and Eckhardt, L.G. 2016. Variation in Tolerance of Several Loblolly Pine (*Pinus taeda*) Families to *Grosmannia huntii* and *Leptographium terebrantis*. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Mensah, J., *Devkota, P., Nadel, R. and Eckhardt, L.G., 2016. Impact of *Leptographium terebrantis* Inoculum Density on Loblolly Pine Physiology. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Devkota, P., and Eckhardt, L.G. 2016. Virulence of *Leptographium terebrantis* and *Grosmannia huntii* on Loblolly Pine Families under Drought Stress. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Devkota, P., and Eckhardt, L.G. 2016. Response of Different Mature Loblolly Pine (*Pinus taeda* L.) Families to *Leptographium terebrantis* and *Grosmannia huntii*. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Devkota, P., and Eckhardt, L.G., and Kloepper, J.W. 2016. Antibiosis of Blue-Stain Fungi by Plant Growth-Promoting Rhizobacteria. Forest Health Cooperative Advisory Meeting, Auburn, AL

*Cole A.B., Eckhardt, L.G., Liebold, A., and Slippers, B. 2016. Effect of growth rate on *Amylostereum* spp. fungus by terpenes. This Is Research: Student Symposium, Auburn, AL

*Devkota, P., and Eckhardt, L.G. 2016. Variation in tolerance of mature *Pinus taeda* families to root infesting fungi *Grosmannia huntii* and *Leptographium terebrantis*. This is Research: Student Symposium 2016, Auburn University, Auburn, AL
Posters:

*Cole A.B., Nadel R.L., Slippers B., Eckhardt, L.G. 2016. Effect of Growth Rate on *Amylostereum* spp. Fungus by Terpenes. Sigma Xi Annual Meeting. Atlanta, GA

*Devkota, P., and Eckhardt, L.G. 2016. Variation in Tolerance of *Pinus taeda* Families to Ophiostomatoid Fungi *Grosmannia huntii* and *Leptographium terebrantis*. Sigma Xi Annual Meeting and Student Research Conference, Atlanta, GA.

*Devkota, P., and Eckhardt, L.G. 2016. Susceptibility of Various Mature Loblolly Pine (*Pinus Taeda* L.) Families to Root Infecting Fungi. Society of American Foresters Annual Convention. Madison, WI.

*Devkota, P., Eckhardt, L. and Via, B. 2016. Response of different mature loblolly pine (*Pinus taeda* L.) families to *Leptographium terebrantis* and *Grosmannia huntii*. Auburn University This is Research, Auburn. AL

*Essien, C., Via, B. and Eckhardt, L. 2016. Acoustic stiffness characterization of loblolly pine (*Pinus taeda* L.) families used for improved forest health. Auburn University This is Research, Auburn. AL

*Cole, A.B., Slippers, B., Liebold, A., and Eckhardt, L.G. 2016. Effect of growth rate on *Amylostereum* spp. fungus by terpenes. Advisory Council Meeting, SFWS, Auburn University Auburn, AL

*Devkota, P., and Eckhardt, L.G. 2016. Variation in Tolerance of *Pinus taeda* Families to Ophiostomatoid Fungi *Grosmannia huntii* and *Leptographium terebrantis*. Advisory Council Meeting, SFWS, Auburn University Auburn, AL

*Essien, C., Via, B.K., Cheng, G., Gallagher, T., McDonald, T. and Eckhardt, L. 2016. Assessing the Sensitivity of Acoustic Tools to the effect of Moisture Content in Estimating Acoustic Velocity and Modulus of Elasticity of Loblolly Pine (*Pinus taeda*) families. This is Research: Student Symposium 2016. Auburn University, Auburn, AL

*Acquah, G.E., Via, B.K., Eckhardt L.G., Fasina, O.O., and Billor, N. 2016. Near infrared based partial least squares regression models for predicting the strength and basic density of disease tolerant *Pinus taeda* families. Forest Products Advisory Board Meeting, Auburn, AL

*Essien, C., Via, B.K., Cheng, G., Gallagher, T., McDonald, T., Wang, X. and Eckhardt, L. 2016. Acouto-mechanical response of fourteen year old suppressed loblolly pine (*Pinus taeda*) to variation in wood chemistry, microfibril angle and density. Forest Products Advisory Board Meeting, Auburn, AL

*Essien C, Via BK, Cheng G, Gallagher T, McDonald T and Eckhardt L. 2016. Are acoustic tools sensitive to moisture variations in juvenile wood of loblolly pine families? Forest Products Advisory Board Meeting, Auburn, AL

*Essien, C., Via, B.K., Cheng, G., and Eckhardt, L. 2016. Effect of tracheid length and chemistry on acoustic velocity in determining the strength properties of juvenile wood of loblolly pine families. Forest Products Advisory Board Meeting, Auburn, AL

*Devkota, P., and Eckhardt, L.G. 2016. Variation in tolerance of *Pinus taeda* families to ophiostomatoid fungi *Grosmannia huntii* and *Leptographium terebrantis*. Advisory Council Meeting, School of Forestry and Wildlife Sciences, Auburn University, Auburn, AL

*Acquah G. E., Via B.K., Eckhardt L.G., Fasina O. O. and Billor N. 2016. Rapid assessment of disease tolerant *Pinus taeda* families for strength, chemical and bioenergy applications using near infrared spectroscopy. Southeastern Society of American Foresters Annual Meeting, Auburn, AL

*Essien, C., Via, B.K., Eckhardt, L., Cheng, Q., Gallagher, T., McDonald, T., and Wang, X. 2016. Acouto-mechanical response of fourteen year old suppressed loblolly pine (*Pinus taeda*) to variation in cellulose, hemicelluloses, lignin, microfibril angel and density. Southeastern Society of American Foresters Annual Meeting, Auburn, AL

*Cole, A.B., and Eckhardt, L.G. 2016. Effect of growth rate on *Amylostereum* spp. fungus by terpenes. Southeastern Society of American Foresters Annual Meeting, Auburn, AL

*Devkota, P. and Eckhardt, L. 2016. Susceptibility of various mature loblolly pine (*Pinus taeda* L.) families to root infecting fungi. Southeastern Society of American Foresters Annual Meeting, Auburn, AL

2015

Talks:

*Acquah G. E., Via B.K., Eckhardt L.G., Fasina O. O. and Billor N. 2015. Application of near infrared spectroscopy in the screening of disease tolerant *Pinus taeda* (Loblolly Pine) families for chemistry, strength and bioenergy. 19th International Nondestructive Testing and Evaluation of Wood Symposium, Rio de Janeiro, Brazil.

Eckhardt, L.G. 2015. *Leptographium* species: Tree pathogens and agents of blue stain, and their bark beetle associates [Pine Decline: Is it real? If so, what are its effects?] Clemson Cooperative Extension Landowners Workshop and Field Trip, T & S Farms, Leesville, SC

Eckhardt, L.G. 2015. An overview of forest health research at the forest health cooperative Auburn University. Entomology and Plant Pathology Departmental Seminar, Auburn University, Auburn, AL

Eckhardt, L.G., Ditchkoff, S.S. , Duong, T.A. , De Beer, Z.W. , and Wingfield, M.J. 2014. Two new ophiostomatoid species isolated from soil on snouts of feral hogs damaging pine roots in Georgia, USA. International Wild Pig Conference Science & Management, Montgomery, AL

Clay, N.A., Little, N., Eckhardt, L.G. and Riggins, J.J. 2015. Widespread and complex interactions among bark beetle vectored blue stain (ophiostomatoid) fungi and subterranean termites. Ecological Society of America Annual Meeting, Baltimore, MD

*Piculell, B.J. Nelson, C.D., Roberds, J., Eckhardt, L.G., and Hoeksema, J.D. 2015. Examining the evolutionary interactions of loblolly pine with both beneficial and pathogenic fungi. Ecological Society of America Annual Meeting, Baltimore, MD

*Trautwig, A., Eckhardt, L., Hoeksema, J., and Carter, E. 2015. Cogongrass (*Imperata cylindrica*) reduces colonization of mycorrhizal fungi on loblolly pine (*Pinus taeda*) in commercial stands. Ecological Society of America Annual Meeting, Baltimore, MD

Via, B.K. and Eckhardt, L.G. 2015. Near infrared reflectance (NIR) spectroscopy: dialing stem chemistry for optimal root disease resistance and forest products. Joint Auburn University Southern Forest Nursery Management & Forest Health Cooperatives 2015 Contact Meeting. St, Simons, GA

Nadel, R.L., Matusick, G., and Eckhardt, L.G. 2015. Quantifying the impact of pine decline in the southeastern United States. Joint Auburn University Southern Forest Nursery Management & Forest Health Cooperatives 2015 Contact Meeting. St, Simons, GA

*Trautwig, A., Eckhardt, L., Hoeksema, J., and Carter, E. 2015. Mycorrhizal communities in *Imperata cylindrica* invaded and non-invated commercial Pinus taeda stands. Joint Auburn University Southern Forest Nursery Management & Forest Health Cooperatives 2015 Contact Meeting. St, Simons, GA

*Chieppa, J.J., Chappelka, A.H., and Eckhardt, L.G. 2015. Effects of elevated tropospheric ozone and altered irrigation regimes on loblolly pine seedlings inoculated with ophiostomatoid fungi. Joint Auburn University Southern Forest Nursery Management & Forest Health Cooperatives 2015 Contact Meeting. St, Simons, GA

*Devkota, P. and Eckhardt, L.G. 2015. Variation In tolerance of *Pinus taeda* Families to root infesting fungi *Grosmannia huntii* and *Leptographium terebrantis*. Joint Auburn University Southern Forest Nursery Management & Forest Health Cooperatives 2015 Contact Meeting. St, Simons, GA

*Cole, A., Eckhardt, L., Liebold, A., and Slippers, B. 2015. A survey for *Sirex noctilio* and native woodwasps in Alabama. Joint Auburn University Southern Forest Nursery Management & Forest Health Cooperatives 2015 Contact Meeting. St, Simons, GA

Via, B.K. and Eckhardt, L.G. 2015. Near infrared reflectance (NIR) spectroscopy: dialing stem chemistry for optimal root disease resistance and forest products. Center for Advanced Forestry Systems 2015 Industrial Advisory Board

Meeting, Asheville, NC

Nadel, R.L., Matusick, G., and Eckhardt, L.G. 2015. Quantifying the impact of pine decline in the southeastern United States. Center for Advanced Forestry Systems 2015 Industrial Advisory Board Meeting, Asheville, NC

*Acquah, G., Via, B.K., and Eckhardt, L.G. 2015. Nondestructive estimation of the chemical and thermal properties of forest biomass using vibrational spectroscopy and thermogravimetric analysis. This is Research: Student Symposium 2015. Auburn University, Auburn, AL

*Chieppa, J.J., Chappelka, A.H., and Eckhardt, L.G. 2015. Effects of elevated tropospheric ozone and altered irrigation regimes on loblolly pine seedlings inoculated with ophiostomatoid fungi. This is Research: Student Symposium 2015. Auburn University, Auburn, AL

*Trautwig, A., Eckhardt, L., Hoeksema, J., and Carter, E. 2015. Mycorrhizal communities in *Imperata cylindrica* invaded and non-invated commercial *Pinus taeda* stands. This is Research: Student Symposium 2015. Auburn University, Auburn, AL

*Devkota, P. and Eckhardt, L.G. 2015. Variation In tolerance of *Pinus taeda* families to root infesting fungi *Grosmannia huntii* and *Leptographium terebrantis*. This is Research: Student Symposium 2015. Auburn University, Auburn, AL

*Trautwig, A., Eckhardt, L., Hoeksema, J., and Carter, E. 2015. Mycorrhizal communities in *Imperata cylindrica* invaded and non-invated commercial Pinus taeda stands. Southeastern Ecology and Evolution Conference, Athens, GA

Eckhardt, L.G., Ditchkoff, S.S., Duong, T.A., DeBeer, Z.W, and Wingfield, M.J. 2015. Two new ophiostomatoid species isolated from soil on snouts of wild pigs damaging pine roots in Georgia. 18th Annual Biennial Southern Silvicultural Research Conference, Knoxville, TN

*Chieppa, J.J., Chappelka, A.H., and Eckhardt, L.G. 2015. Effects of elevated tropospheric ozone and altered irrigation regimes on loblolly pine seedlings inoculated with ophiostomatoid fungi. 18th Annual Biennial Southern Silvicultural Research Conference, Knoxville, TN

*Trautwig, A., Eckhardt, L., Hoeksema, J., and Carter, E. 2015. Mycorrhizal communities in *Imperata cylindrica* invaded and non-invated commercial Pinus taeda stands. 18th Annual Biennial Southern Silvicultural Research Conference, Knoxville, TN

Carter, E.A., Brunson, B.A., and Eckhardt, L.G. 2015. Soil properties associated with cogongrass infested and non-infested loblolly pine stands in Mississippi. 18th Annual Biennial Southern Silvicultural Research Conference, Knoxville, TN

Posters:

Nadel, R.L., Eckhardt, L.G., and Enebak, S.A. 2015. A rapid PCR screening test for the presence of *Fusarium circinatum* on pine seed and planting material. Society of American Foresters National Convention, Baton Rouge, LA

*Acquah G. E., Via B.K., Eckhardt L.G., Fasina O. O. and Billor N. 2015. Rapid assessment of disease tolerant Pinus taeda families for strength, chemical and bioenergy applications using near infrared spectroscopy. Sigma Xi's Annual Meeting and Student Research Conference, Kansas City, MO

*Cole, A.B., and Eckhardt, L.G. 2015. Effect of Growth Rate on *Amylostereum* spp. Fungus by Terpenes. Society of American Foresters National Convention, Baton Rouge, LA

*Essien, C., Via, B.K., Eckhardt, L., Cheng, Q., Gallagher, T., McDonald, T., and Wang, X. 2015. Acouto-mechanical response of fourteen year old suppressed loblolly pine (*Pinus taeda*) to variation in cellulose, hemicelluloses, lignin, microfibril angel and density. Society of American Foresters National Convention, Baton Rouge, LA

*Cole, A.B., Eckhardt, L.G., Liebhold, A., Slippers, B. 2015. Prevalence of *Sirex noctilio* F. in Alabama Forests.

Society of American Foresters National Convention, Baton Rouge, LA

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