Final Technical Report

FCEB Project #52

Final Report 2023 - 2024 Florida Cattle Enhancement Fund

Title: Endophyte and mycotoxin laboratory start-up to address forage-related evaluations from Florida pastures

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Project end date: July 31, 2024; % Completed: 100%

Project Aims and results

Aim 1: Creation of a UF-NFREC Endophyte and Mycotoxin Research and Service Laboratory network for the preliminary identification of endophyte and mycotoxins in Florida pastures.

Progress and results: Team of Endophyte and Mycotoxin Diagnostic Laboratory, continuously contributes efforts in enhancing the capabilities of our in-house diagnostic lab services. The service includes delivering the skill set to Extension professionals on grass and hay sample collection (**Fig 1**). The in-house analysis has been performed by Endophyte and Mycotoxin Diagnostic Lab (at NFREC, Quincy FL) and generates the report to determine the quantity of fungal endophytes, the genes, and products of mycotoxins (**Table 1**). PI (Liao) and team Endophyte and Mycotoxin Diagnostic Lab also delivered the data updated to the Extension agents, the producers, and other stakeholders through several Extension activities. Part of the report/research update has been delivered to the agents and reported at the American Forage and Grassland Council (AFGC), FCA quarter meeting, FCA Convention and Allied Trade Show, The Florida Cattleman and Livestock Journal, and other Extension publications (EDIS):

1. Zhang K, **Liao H-L**, Wang H, Reimer B, Verma V, Justesen B, Walter J, Tomlinson P, Jones R, Mendez V, Blount A, Mackowiak C, Wallau M, Chen, K-H, Buringer J, Love J, Yarborough JK, Mayo D. Endophyte and Mycotoxin Advancement Laboratory: Research and Service Updates. (Poster) June 2024. Florida Cattlemen's Association Convention and Allied Trade Show. Marco Island, FL
2. **Liao H-L**, Zhang K, Mendez V, Wang H, Chen K-H, Reimer B, Verma V, Justesen B, Walter J, Blount A, Mackowiak C, Wallau M, Jones R, Mayo D. Grass endophytes and

mycotoxins in Florida pastures (Oral presentation). January 2024. American forage and grassland council (AFGC), Mobile Alabama

3. **Liao H-L**. Highlights of Forage soil health, Grass Endophyte and Mycotoxin projects conducted in Endophyte and Mycotoxin diagnostic lab (5 min short talk). Nov 30 2023 FCA quarter meeting, Marianna FL
4. **Liao H-L**, Chen K-H, Marcon F, Jones R, Justesen B, Walter J, Blount A, Mackowiak C, Mayo D, Wallau M. Could fungi living in our on bahiagrass leaves produce Mycotoxin? (Poster) Nov 30 2023 FCA quarter meeting, Marianna FL
5. **Liao H-L**, Zhang K, Verma V, Wang H, Justesen B, Walter J, Mendez V, Blount A, Mackowiak C, Wallau M, Jones R, Chen K-H, Jennings Ed, Yarborough JK, Mayo D, Bodrey R, Stam A, Cooper C, Eubanks S, Halbritter A. (Poster) Nov 30 2023 FCA quarter meeting, Marianna FL
6. Verma VC, Reimer B, Wang H, Zhang K, Erhunmwunse AS, **Liao H-L**. Introduction: Endophytes and Mycotoxin Advancement Laboratory (EMAL). (Poster) Nov 30 2023 FCA quarter meeting, Marianna FL
7. Erhunmwunse A, Sena P, **Liao H-L**. Grass-Endophyte interactions. (Poster) Nov 30 2023 FCA quarter meeting, Marianna FL
8. **Liao H-L**, Chen K-C, Marcon F, Jones R, Justesen B, Walter J, Blount A, Mackowiak C, Mayo D, Wallau M. 2023. Black fungal structures (black stroma) grown on the leaves of bahiagrass, limpograss and smutgrass: What are they? The Florida Cattleman and Livestock Journal. 2023. September issue.
9. **Liao H-L**, Chen K-H, Marcon F, Jones R, Justesen B, Walter J, Blount A, Mackowiak M, Mayo D, Wallau M. 2023. A preliminary survey of mycotoxins identified from Florida bahiagrass pastures. EDIS SL505/SS718. (Peer-Reviewed) doi.org/10.32473/edis-SS718-2023
10. Wallau M, Justesen B, Blount A, Mackowiak C, **Liao H-L**, Vyas D. 2024. Mycotoxins in Florida Pastures. EDIS SS-AGR-422 (2024, renewal of the article after sunset)

From July until now, the Endophyte and Mycotoxin Diagnostic Lab has been in communication with Extension agents to document pasture, forage, and hay management, environmental conditions, and abnormal livestock behavior. This has been followed by receiving several cases of submitted or collected samples in collaboration with Extension agents. for Extension (*Aim 1 and 3*) and research (*Aim 1 and 2, next section*) projects. The representative Cases (June 2023-current) led by Endophyte and Mycotoxin Diagnostic Lab are listed below (**Table 1**):

The representative Cases (September 2023- current):

Case 1: September 2023: We have received and analyzed the bermudagrass and fed hay samples provided by the Extension agent and Extension specialist from Clemson University, Georgia, as part of a collaborative effort involving multiple states within the Extension network. A portion of the pathogenetic report was delivered by Liao in late September. This collaboration aims to address concerns raised by producers regarding head smut and mycotoxin issues. The team working on this project also includes Silva, an Extension specialist affiliated with the Forage Livestock System Program at Clemson University, and Robbie Jones, an Extension agent from the University of Florida.

Case 2: September 2023: We have received and analyzed the sorghum sudangrass samples that were sent to us by Extension agent Tomlinson. These samples were submitted due to concerns raised by producers in Hamilton County regarding their chemical toxicity (Animals were impacted but not death). The Endophyte and Mycotoxin Diagnostic Lab conducted examinations for nitrate and prussic acid levels, and the resulting report was shared to agent Tomlinson for Vet's reference. In brief, the samples exhibited a high concentration of NO3- at ~1,750 ppm per kilogram of fresh grass, but it may not have surpassed the toxicity threshold. No prussic acid were detected from these samples.

Case 3: November 2023: We performed the on-site sample collections from two producers' grass/peanut hay storage in Jefferson County. We conducted the analysis for 7 targeted mycotoxins and delivered the report to Extension agents in Dec 2023. Upon mycotoxin analysis using LC-MS/MS, none of those 7 target mycotoxins were detected from any of the haylage samples in this case.

Case 4: November 2023: We received a rhizoma peanut silage sample from a producer which has "white" mold and other fungi on it. We conducted DNA extraction and fungal community analysis for this sample form Gadsden County. The DNA extraction and two-step PCR processes have been finished for this sample. DNA sequencing will be carried out to identify the fungi and predict their mode of action on the silage.

Case 5: December 2023: We received 11 haylage samples from Extension agent Tomlinson and conducted the analysis of 7 targeted mycotoxins (Aflatoxin, Ochratoxin, Vomitoxin, DON, T-2, Zearalenone, Fumonisin) and delivered the report in Dec 2023 rule out the concerns of mycotoxin on these haylage from the producers in Columbia County. We conducted HPLC detection of 7 targeted mycotoxins for the received samples, and none mycotoxin was detected from those samples. The report has been delivered to Extension agents.

Case 6 and 7: March 2024: We collaborated with Extension agents Walter and Justesen to conduct on-site forage sampling and analysis for two ranchers who have reported animal sickness in recent years related to mycotoxins. We performed a comprehensive survey of bahiagrass, bermudagrass, and limpograss for key toxins identified in the past few years, including Zearalenone produced by Fusarium and emodin associated with Myrogenospora. We also examined the fungal diseases present in these pastures. One of the leaf fungi (rust) was found to produce a significant amount of spores this season (apparently affecting over 30% of the leaves examined from the collected grasses), which could be concerning for animal allergens and forage health. We delivered these observation reports to the Extension agents and provided on-site reports to the ranchers in the same month.

Case 8: April 2024: We received and analyzed a feed sample (millet seeds) from Agent Tomlinson in Columbia County. The seeds, provided by the producer Mr. Moore, raised concerns about nitrate levels and mycotoxins. We delivered a report to Tomlinson indicating the nitrate/nitrite levels and the presence of seven targeted mycotoxins a week after receiving the samples.

Case 9: May 2024: We received and analyzed an oat feed sample from State Specialist DiLorenzo in Jackson County. The feed, submitted by the producer Mr. Williams, raised concerns about nitrate levels. Two days later, we delivered a report to DiLorenzo indicating that nitrate/nitrite levels were detectable but within the safe range for feed.

Case 10: June 2024: We received and analyzed sorghum and sudangrass samples from Agent Tomlinson in Columbia County, focusing on potential prussic acid and nitrate toxicity to livestock. The producers were particularly concerned about prussic acid due to a lack of rain in the field during that season. There were also concerns about nitrates because the field had been fertilized without significant rainfall. The examination results indicated that both nitrate and prussic acid levels were below detectable levels. The report was delivered to the Agent.

Case 11: July 2024: We received bahiagrass samples from Gadsden County producers who observed mold symptoms on the seedheads. We conducted in-house mycoscope and sequence examinations and identified at least two fungal groups responsible for these symptoms: Ergot (*Claviceps* sp.) and seedhead black mold (*Curvularia* sp.). The reports detailing the potential concerns associated with these fungi, including mycotoxin production and allergenic spores, were delivered to the County Agent (Jones). The Gadsden County Agent also informed other forage and livestock agents in North Florida to be vigilant about these fungal symptoms appearing in pastures

Case 12: July 2024: Recently, we received hay samples from Agent Justesen in Osceola County. According to Justesen, there have been 20 animals exhibiting neurological symptoms, including head pressing and ataxia. Most of the affected animals are goats, with a few sheep and a couple of cattle. One goat has died, and the necropsy results were normal according to the vet. These animals are from six different locations in Osceola County, with the only common factor being the hay. At one location, the goats live in a concrete barn and are not out on pastures. We are currently performing examinations to detect mycotoxins that could cause neurotoxicity, including T-2, fumonisin, and ochratoxins. The report will be delivered within a week. In the meantime, the vet has advised all locations to stop feeding the hay, and some animals have shown improvement or no change in symptoms.

Table 1. The representative cases received by the Endophyte and Mycotoxin Research and Service Laboratory from producers (Year 2023 – 2024)

Date (case #)	Sample type(s)[1]	FL County (States)	Issues: concerns
Sept 2023 (1)	bermudagrass and fed hay	(Georgia)	Livestock illness: “black” seed head (suspect smut fungal infection), mycotoxins
Sept 2023 (2)	annual blend (sorghum sudangrass)	Hamilton	Livestock illness: Chemical toxicity (Prussic acid, Nitrate)
Nov 2023 (3)	haylage (annual peanut; bermuda)	Jefferson	Regular check: Mycotoxins
Nov 2023 (4)	rhizoma peanut haylage	Gadsden	Forage disease: Massive mold grown on the samples
Dec 2023 (5)	haylage	Columbia	Cattle illness: Mycotoxins
Mar 2024 (6)	bahiagrass; bermudagrass; limpograss	Brevard, Osceola	Forage disease: Leaf spots (suspect fungal infection or allergy)
Mar 2024 (7)	bahiagrass; bermudagrass; limpograss	Osceola	Cattle illness: Myrogenospora fungal endophytes, mycotoxins
Apr 2024 (8)	millet seed feed	Columbia	Livestock illness: Mycotoxins, nitrate
May 2024 (9)	oat feed	Jackson	Livestock illness: Nitrate
Jun 2024 (10)	sorghum; sudangrass	Columbia	Livestock illness: Prussic acid and Nitrate
Jul 2024 (11)	bahiagrass	Gadsden	Livestock allergy: seedhead mold, ergot (mycotoxins)
Jul 2024 (12)	hey	Osceola	Livestock neurotoxicity: suspect hay for mycotoxin causing neurotoxicity

[1.] The samples were received from county agents and processed by the Endophyte and Mycotoxin Research and Service Laboratory. Analysis reports were delivered within a month after receiving the samples

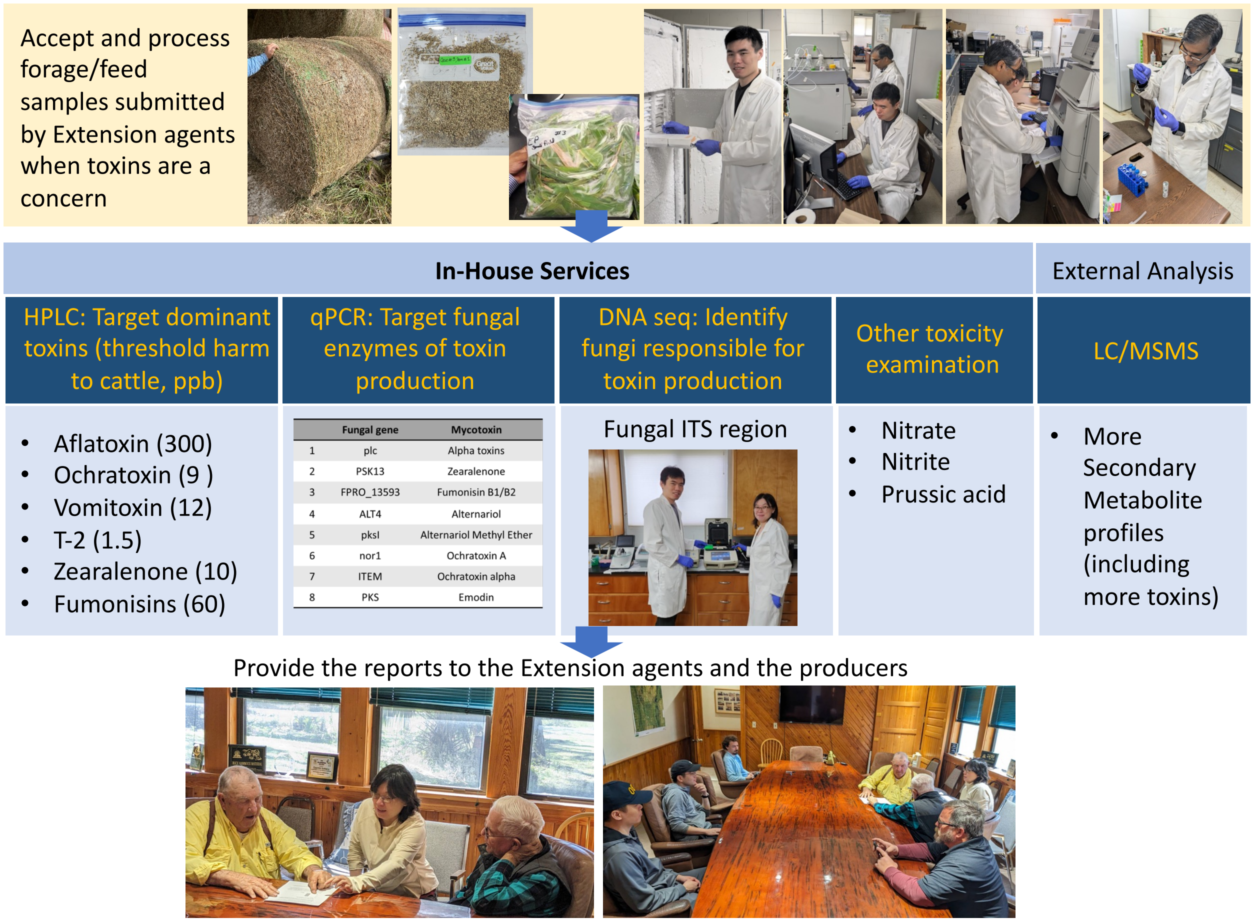

Figure 1. Service workflow provided by the Endophyte & Mycotoxin Research and Service Laboratory, Quincy FL

Aim 2: Identify and quantify plant-related toxins present in forage samples (fresh plant, hay, or other forms of conserved forage): Specific forages of interest include, but are not limited to, the major Florida pasture grass species: bahiagrass, bermudagrass, limpograss, and smutgrass

Overview (September 2023-current): Long-term monitoring of pastures with high concentrations of mycotoxins to understand the effect of soil types, seasons, and annual variations on mycotoxin accumulation.

As part of our ongoing mycotoxin survey efforts that we have done in recent years, we continue to perform surveillance of mycotoxin accumulation in two ranchers previously identified with high concentrations of mycotoxins (particularly Zearalenone) (Map in **Fig. 2A**). This extended monitoring aims to assess the persistence and fluctuations of mycotoxin accumulation over a prolonged duration. We conducted the sample collection from Osceola County in October 2023 and March 2024. In each season, we collected around 80 samples, comprising ~20 representative soil samples, along with 20 samples each from bahiagrass, bermudagrass, and limpograss across the two locations. Notably, we collected bahiagrass samples both with and without the presence of black fungal stromata and rust symptoms.

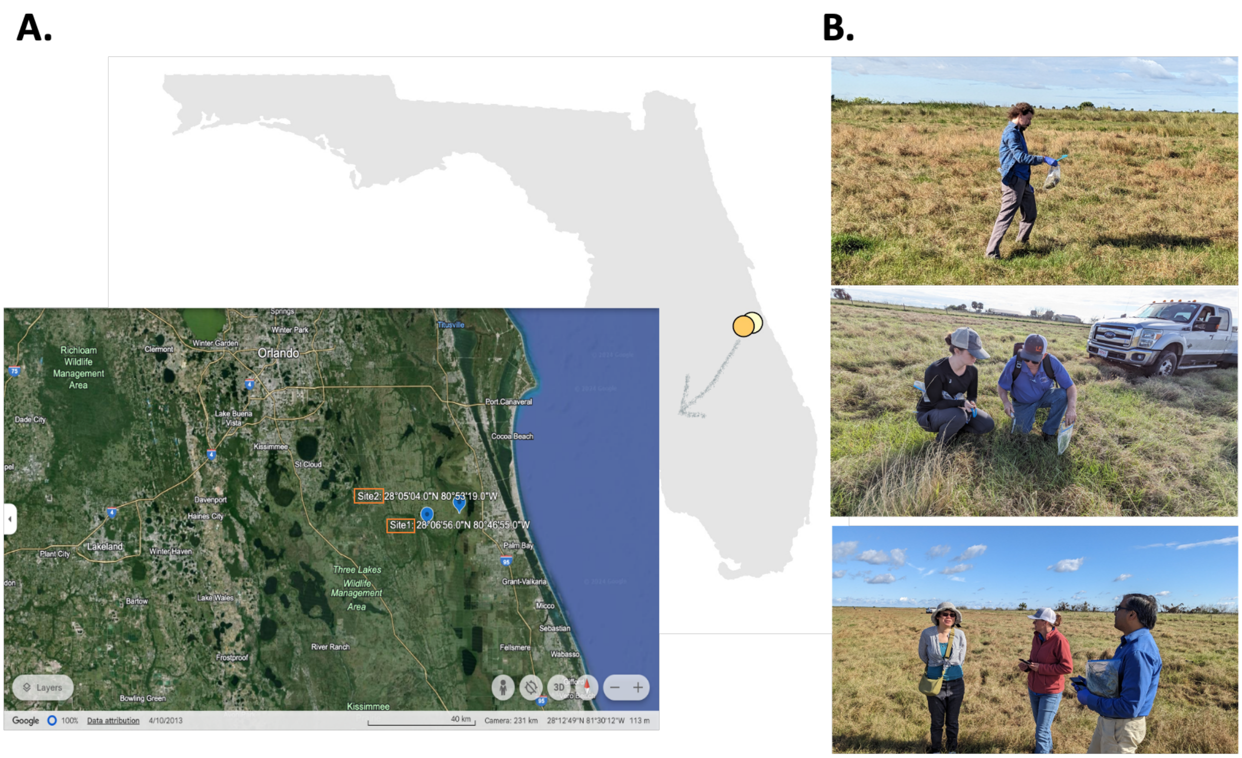

Figure 2 (A) The geographic location of two ranchers where we have been collecting the samples. We are combining these newly collected samples with our previous collections from years 2017, 2018, 2019, 2022, 2023, and spring 2024 to identify the endophyte community, mycotoxins, and soil chemistry. (B) Team Endophyte and Mycotoxin Diagnostic lab (Liao, Verma, and Reimer) and Extension Professions (Walter, Justesen) conducted the on-site sample collection in October 2023. We plan to collect more samples in the upcoming Fall and the subsequent years, with the objective of understanding if mycotoxins can be consistently present in the pastures in response to Florida's changing climate.

The current updated data report includes:

<u>Experiment 1</u>: We analyzed the bahiagrass, bermudagrass, and limpograss samples, specifically comparing those with visible black fungal structures (symptomatic) against those without (asymptomatic) from these two specific locations (**Fig. 2A**), and integrated this analysis with the data from our collections in previous years to provide a comprehensive overview.

Result: In our earlier investigation, we discovered black fungal structures, identified as black stroma, on bahiagrass and smutgrass in four of the five surveyed areas throughout Florida. During visits to two specific ranches (see **Fig. 2A**), we consistently observed these black fungal structures on bahiagrass during the summer season (July 2023) and on limpograss during the fall seasons (October 2023). Similar to our previous report, around one of every 1,000 leaf blades for both grass species harbored these black stroma structures. The molecular analysis identified that the black stomata present on bahiagrass and limpograss leaves were *Myriogenospora atramentosa*. *M. atramentosa* builds its reproduction structures on the leaf blades of grasses, functioning as epiphytes. The seed heads of bahiagrass were occasionally found to be covered by *M. atramentosa* tissues. In our previous survey, we found that the leaves of bahiagrass that harbor these black fungal structures of *M. atramentosa* accumulated more dihydrolysergol and emodin. Dihydrolysergol, an ergot alkaloid precursor and identified as mycotoxin, was detected in 30% of the bahiagrass samples containing these black stromata, although the concentrations were generally low. The levels of dihydrolysergol did not show a significant difference between leaf tissues with and without black stromata. This indicates that the black stroma (*M. atramentosa*) is not the main producer of dihydrolysergol. Emodin has also been reported as a mycotoxin in some literature (Gross et al 1984; Wehner et al 1975; Wells 1975). Our results showed that the accumulation of emodin was significantly higher in bahiagrass samples with fungal stroma structures of *M. atramentosa*. Since emodin can be produced by both fungi and plants, it remains uncertain whether the leaf fungi (*M. atramentosa*) can produce emodin or just trigger emodin synthesis in the leaf cells of bahiagrass. While we also consistently observe the presence of black fungal stromata on limpograss (across years 2017, 2018, 2019, 2022, 2023 and 2024), often referred to as the tangletop symptom (**Fig. 3**), it remains unknown whether *M. atramentosa* residing in limpograss can produce similar mycotoxins compared to those in bahiagrass. We plan to further investigate this question using our samples collected from the coming seasons.

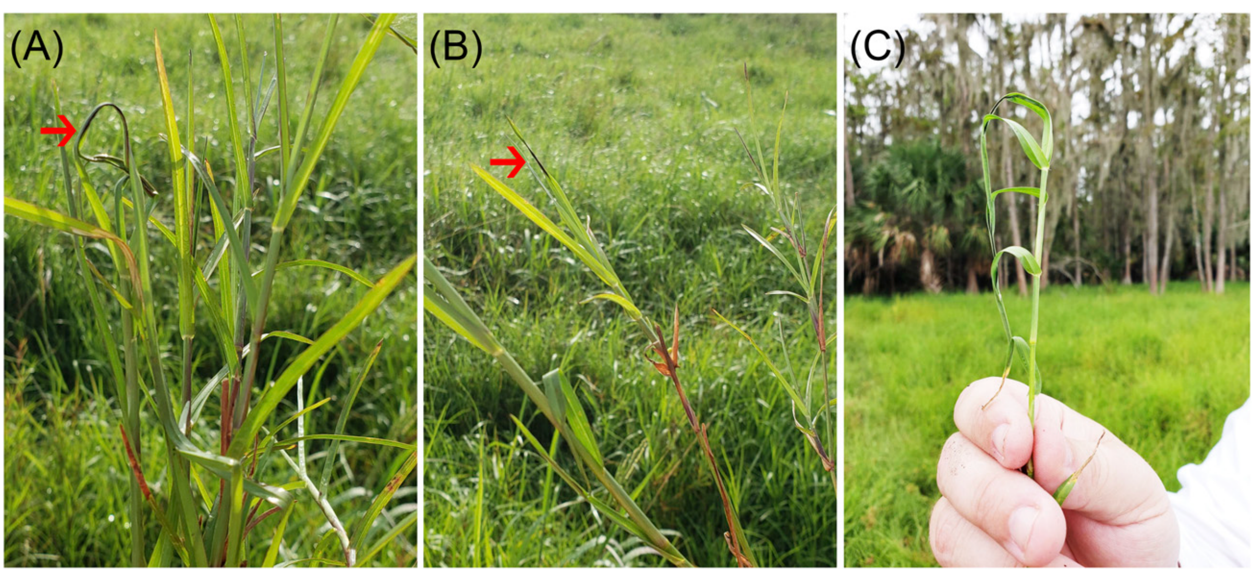

Figure 3. *Myriogenospora atramentosa* produces black fungal stroma on Limpograss *(Hemarthria altissima),* resulting in the tangletop symptom (highlighted by the red arrow). (Discovered by our team - Chen et al 2019). We have consistently observed tangletop symptoms throughout our collection years from 2017 to 2023 during the fall season.

Additionally, during the March 2024 collection, we identified rust fungi that produced a significant number of spores this season. Over 30% of the leaves examined from the collected grasses, including bahiagrass, bermudagrass, and limpograss, were affected (**Fig. 4**). Monitoring the population of these fungal pathogens and spore allergens may provide valuable preliminary information for producers about the impact on forage health and nutrient levels. It can also help veterinarians in identifying potential allergy sources from fungal spores for animals.

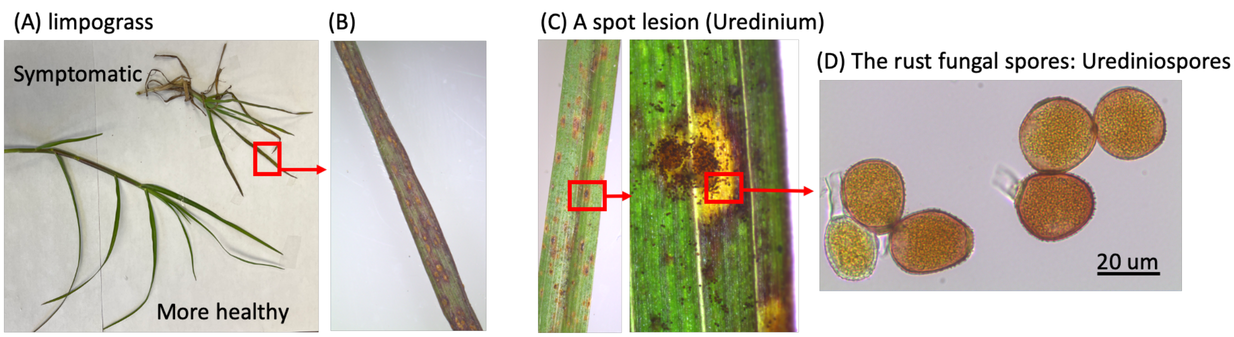

Figure 4. Rust fungal lesions were identified in more than 30% of the grass samples collected from the two ranches in Central Florida in March 2024 (Figure 2). (A) The symptomatic leaf of limpograss shows rust lesions, which can adversely affect growth. (B) Numerous rust lesions were observed on the limpograss leaf blade. (C) Myoscope observation revealed rust fungal structures (uredinia) and spores (urediniospores) present in each mature lesion. Each lesion contains hundreds of spores, which can also adhere to nearby leaf blades. (Liao and Endophyte and Mycotoxin lab team et al, preliminary data)

In addition to identifying fungal groups with distinctive structures (such as *Myriogenospora* and rust fungi as described above) , we also conducted research to identify grass leaf fungi that do not form large reproductive structures and to quantify the mycotoxins they produce.
Our data showed that bahiagrass, bermudagrass, and limpograss hosted different dominant fungal groups. In bahiagrass, the dominant leaf fungal genera were *Ramichloridium, Myriogenospora,* and *Saitozyma*, while *Saitozyma*, *Curvularia*, and *Hannaella* were the most abundant fungal genera in both bermudagrass and limpograss. By analyzing the accumulation of mycotoxins in leaf samples of bahiagrass, bermudagrass, limpograss, and smutgrass, we found that bahiagrass generally accumulated a lower amount of total mycotoxins compared to the other collected grass species (**Fig. 5**). Specifically, we identified zear-4-sulphate, alternariol methyl ether, ochratoxin α, alternariol, and emodin as the five most prevalent mycotoxins in bahiagrass

samples, with concentrations ranging from 86 to 34 ppb (**Fig. 5A**). In contrast, zear-4-sulphate (1782 ppb) and emodin (994 ppb) were the predominant mycotoxins in bermudagrass samples (**Fig. 5B**); ochratoxin α (2080 ppb) and zear-4-sulphate (1008 ppb) emerged as the most abundant mycotoxins in limpograss samples (**Fig. 5C**); the dominant mycotoxins identified in smutgrass samples were sterigmatocystin (1500 ppb) and fumonisin B1 (1178 ppb) (**Fig. 5D**). Although the mycotoxin-producing fungal taxa may or may not be among the top three dominant taxa identified within these grass species, they frequently appear within the top 10 taxa in our samples. These include genera such as *Alternaria* (known for producing alternariol methyl ether), *Fusarium* (for zearalenol-associated toxins and Fumonisin B1), *Penicillium* (for ochratoxin α), and *Aspergillus* (for ochratoxin α and sterigmatocystin).

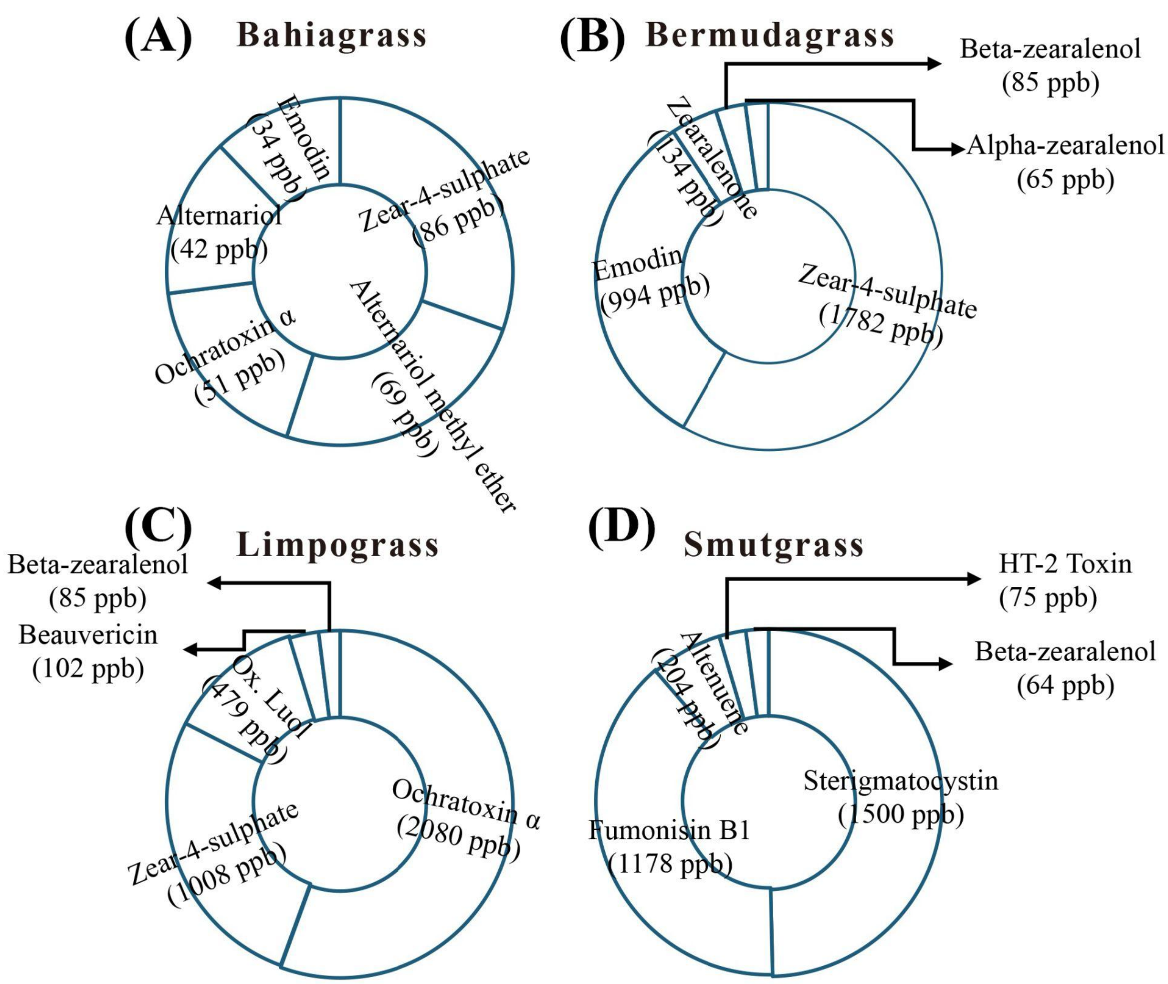

Figure 5. The dominant mycotoxins (top 5) in leaf samples of bahiagrass (A), bermudagrass (B), limpograss (C), and smutgrass (D) identified across Florida ranches.

<u>Experiment 2</u>: Explore the phyllosphere fungal communities (endophytes) of four grass species (bahiagrass, bermudagrass, limpograss, and smutgrass) across different locations in Florida

From 2017 to 2019, we collected leaf samples from four grass species (bahiagrass, bermudagrass, limpograss, and smutgrass) across 13 ranches in Florida (**Fig. 6A**). Our preliminary molecular analyses revealed that the phyllosphere fungal alpha diversity, measured by the Shannon index that assesses both richness and evenness of fungal communities, was predominantly influenced by geographic locations (**Fig. 6A**). We observed a gradual decline in fungal alpha diversity in grass leaves from the South to the North.The type of grass species also significantly impacted leaf fungal alpha diversity. Particularly, sumtgrass had significantly greater fungal alpha diversity than bahiagrass and bermudagrass. We also found that geographic location and grass species had a significant interactive effect on leaf fungal communities (Fig. 6C) as determined by permutational multivariate analysis of variance ($P < 0.001$). Compared to grass species ($R^2 = 0.059$, $P < 0.001$), geographic location ($R^2 = 0.139$, $P < 0.001$) had a greater effect on the changes in leaf fungal communities. To further explore the impact of geography and climate variables induced by gerography and sampling time, we performed generalized additive models to identify the most important predictors of leaf fungal diversity. We found that geographic distance ($F = 20.1$, $P < 0.001$), annual temperature (MAT, $F = 21.0$, $P < 0.001$), annual relative humidity (MARH, $F = 3.8$, $P < 0.001$), and annual solar radiation (MASR, $F = 3.8$, $P < 0.01$) were significant predictors of fungal diversity (Fig. 6D). Specifically, leaf fungal diversity is reduced with increasing geographic distance and decreasing temperature and solar radiation.

To further explore the relationship between leaf fungi and the mycotoxin production, we performed fungi-mycotoxin interaction analyses. We observed a great number of fungal and mycotoxin nodes as well as fungi-mycotoxin links in the southern regions, which decreased with increasing altitude. This suggests that geographic location significantly influences fungi-mycotoxin interactions, with mycotoxins being preferentially produced in climates characterized by higher temperature, precipitation, humidity and solar radiation.

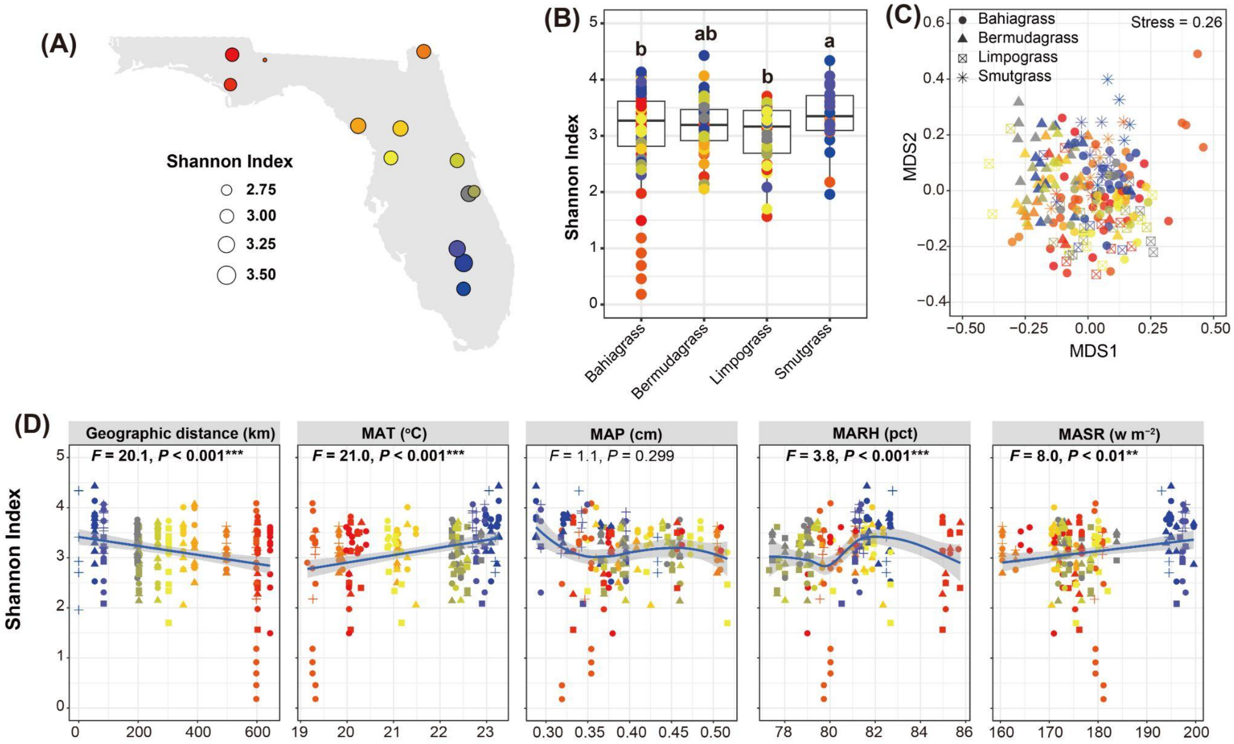

Figure 6. (A) The geographic distribution of phyllosphere fungal diversity across Florida. (B) Comparison of phyllosphere fungal alpha diversity (represented by the Shannon Index) among different warm-season pasture grass species across Florida. Lowercase letters denote the significant differences in the fungal Shannon index among different species using a one-way ANOVA followed by an HSD test. (C) Phyllosphere fungal community composition of warm-season pasture grasses across Florida, shown in a non-metric multidimensional scaling (NMDS) plot. Symbols indicate different grass species. (D) GAM results show phyllosphere fungal alpha diversity trends across geographic and climatic gradients. Geographic distance is defined as the distance of each site from the southernmost site studied. "*", "**", "***" indicate significance at $P < 0.05$, 0.01, and 0.001, respectively. MAT: mean annual temperature; MAP: mean annual precipitation; MARH: mean annual relative humidity; MASR: mean annual solar radiation.

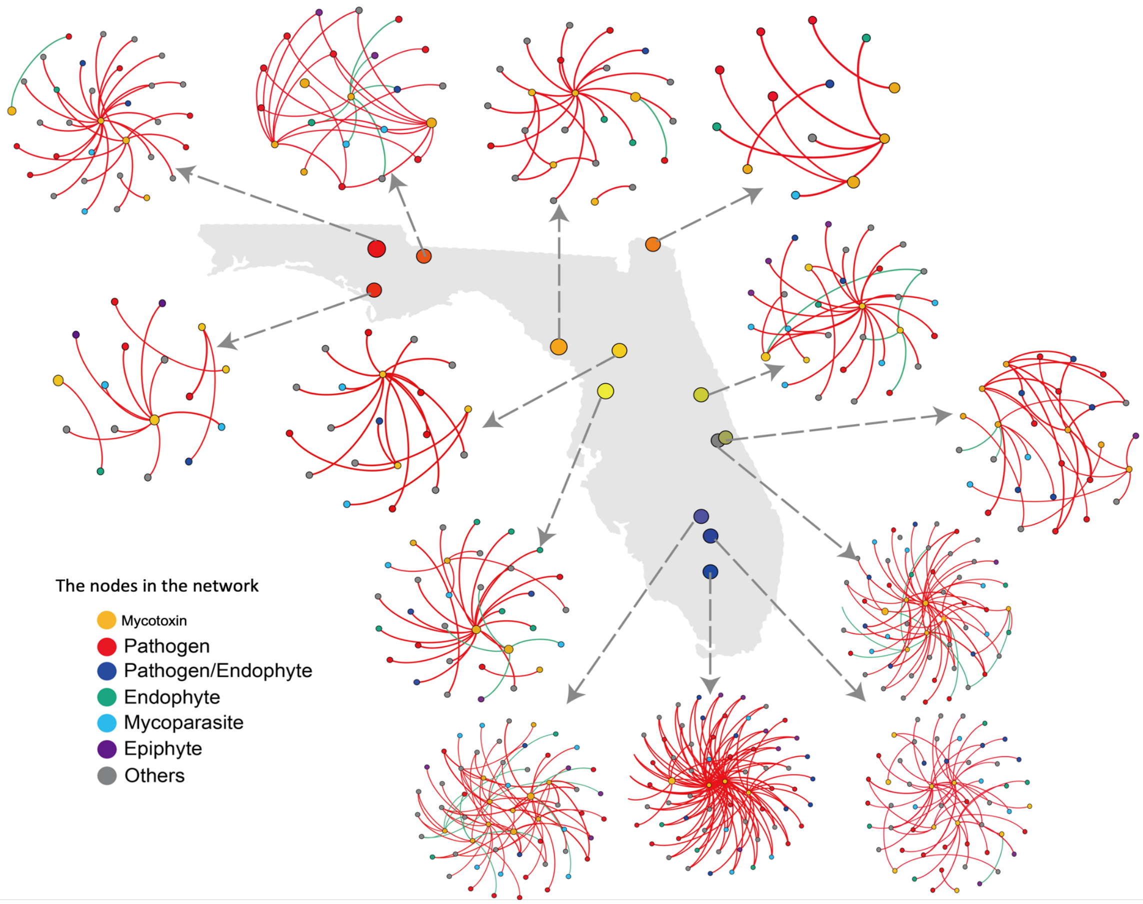

Figure 7. Grass leaf fungi-secondary metabolite interactions. Nodes in different colors represent mycotoxin and functional fungal groups. Red and green links represent positive and negative relationships between mycotoxin and fungal groups.

Experiment 3: Characterize the seasonal effect on fungal communities and mycotoxin production in bermudagrass hay

(**Table 2**): We collected a total of 84 samples of commercial bermudagrass hay from Nassau County (FL) at various points throughout a few years. Our analysis identified the most dominant mycotoxins (top 5) and their potential causal agents (fungal genus) in our hay samples. These included zearalenone (352 ppb) primarily associated with Fusarium, emodin (320 ppb) linked to Myriogenospora, zear-4-sulphate (260 ppb) related to Fusarium, moniliformin (112 ppb) found with Fusarium, Alternaria, and *Penicillium*, and alternariol methyl ether (32 ppb) associated with Alternaria.

Table 2. The dominant mycotoxins and fungi identified from the bermudagrass hay samples in Nassau County

Hay (top 5 mycotoxins)	Ave. ppb	Potential causal agents (Fungal genus)
Zearalenone	352 ppb	*Fusarium*
Emodin	320 ppb	Myriogenospora
Zear 4 sulphate	260 ppb	*Fusarium*
Moniliformin	112 ppb	*Fusarium*, *Alternaria*, *Penicillium*
Alternariol methyl ether	32 ppb	*Alternaria*

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Award Amount:	$58,241.00

Invoice #	I000130471
UF Award #	AWD15830
Primary Project #	P0325270
Primary Department:	60770000
Current Invoice Amount:	$51,132.19

Description	Current	Cumulative
Personnel - Salary	$21,082.81	$21,907.31
Personnel - Fringe Benefits	$2,989.89	$3,024.51
Materials and Supplies	$5,025.18	$7,172.40
Consultant Services	$0.00	$350.00
Contractual Services	$14,071.00	$15,229.55
Publication Costs	$191.00	$191.00
Other Expenses	$45.50	$45.50
Domestic Travel	$2,708.73	$4,541.00
Direct Cost	$46,114.11	$52,461.27
Facilities and Administrative Costs	$5,018.08	$5,779.73
Total	$51,132.19	$58,241.00

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Peterson,Nathan Kyle npeterson82@ufl.edu
Please reference the UF Award Number and Invoice Number in all correspondence

By signing this report, I certify to the best of my knowledge and belief that the report is true, complete, and accurate, and the expenditures, disbursements and cash receipts are for the purposes and objectives set forth in the terms and conditions of the federal award. I am aware that any false, fictitious, or fraudulent information, or the omission of any material fact, may subject me to criminal, civil, or administrative penalties for fraud, false statements, false claims or otherwise. (U.S Code Title 18, Section 1001 and Title 31, Sections 3729-3730 and 3801-3812).

Payment History	
Cumulative Invoices:	$58,241.00
Payments Received:	$7,108.81
Outstanding Balance:	$51,132.19
Note: Outstanding balance includes current invoice amount	

Nathan Peterson

Certifying Official

FOR UF USE ONLY Additional Projects: N

Project ID	Deptid	Department Name	Current	Cumulative