CHAPTER 10

Laurel Wilt Spread, Vector Flight Behavior, and Impacts in Sassafras Beyond the Gulf-Atlantic Coastal Plain

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INTRODUCTION

Laurel wilt is a destructive vascular disease of woody plants in the family Lauraceae. The cause of laurel wilt, the fungus *Harringtonia lauricola*, is an ambrosial symbiont of the redbay ambrosia beetle (RAB) (*Xyleborus glabratus*) (de Beer and others 2022, Fraedrich and others 2008). The beetle and the pathogen are native to Asia (Hughes and others 2017, Wuest and others 2017) and were introduced to North America prior to 2002 when RAB was first detected in Georgia (Rabaglia and others 2006). Healthy plants become diseased when RAB bores into host stems and inoculates the xylem with *H. lauricola*. Laurel wilt has killed hundreds of millions of redbay (*Persea borbonia*) and swamp bay (*P. palustris*) and represents a serious threat to the plant family Lauraceae in North America and other parts of the world (Hughes and others 2017, Olatinwo and others 2021).

Sassafras (*Sassafras albidum*) is the most widely distributed member of the Lauraceae in the United States (Griggs 1990) and is susceptible to laurel wilt (Cameron and others 2008, Fraedrich and others 2008). It is intolerant of shade and commonly colonizes old fields, fencerows, burned areas, and other disturbed sites. Stems commonly occur in clusters due to vegetative reproduction via root sprouts (Griggs 1990). Like other members of the Lauraceae, sassafras is rich in essential oils and has numerous medicinal, culinary, cultural, and wildlife uses (Dills 1970, Immel 2016).

In 2018, the known distribution of laurel wilt remained primarily within the Gulf-Atlantic Coastal Plain. It was uncertain how quickly and with what impact laurel wilt would spread into the Piedmont and Mountains of the Eastern United States using sassafras as a host. To examine the spread and impact of laurel wilt in sassafras, we initiated an Evaluation Monitoring project in 2018 to establish sentinel sassafras plots, both within and ahead of the known laurel wilt distribution (Mayfield and others 2022). A comprehensive report on this project has been published previously (Mayfield and others 2022); the present document presents a shorter summary of the methods, results, and implications.

METHODS

Site Selection

We selected monitoring sites containing live sassafras trees ≥5 cm diameter at breast height (d.b.h.) in three regions of the Southeastern United States: (1) Gulf-Atlantic Coastal Plain, (2) Piedmont (including adjacent Sandhills), and (3) Central and Eastern Mountains (including the Southern Appalachian Mountains, Cumberland Plateau, and Highland Rim/Central Basin) (fig. 10.1). In the Coastal Plain, we targeted sites that were not known to be affected by laurel wilt (or only very recently affected), whereas in the Piedmont and Mountain regions, we targeted sites near RAB risk of entry points (mills, campgrounds, RV parks, etc.). We monitored a total of 46 sites, although not every site was monitored in every year due to personnel changes, COVID 19-related travel restrictions, or stand elimination.

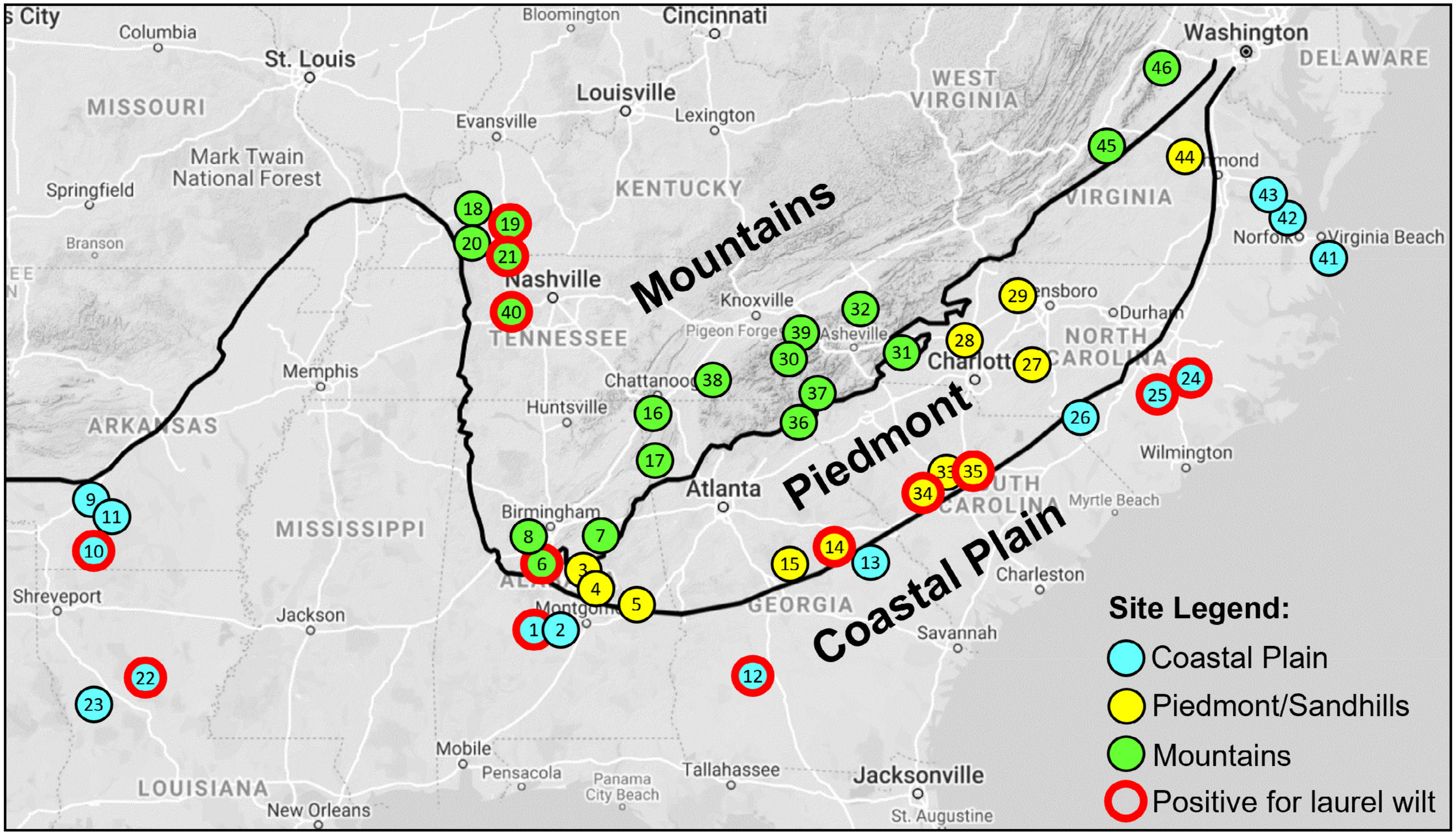

Figure 10.1—Locations of 46 laurel wilt monitoring plots with sassafras in the Southeastern United States, color coded by physiographic region. Red outline indicates laurel wilt pathogen detection in 2018–2020. (Map data © 2022 Google, INEGI [from Mayfield and others 2022])

Vegetation Monitoring and Laurel Wilt Assessment

We tagged a target of 20 live sassafras trees ≥5 cm d.b.h. per site (average n = 19, range 6–32) for annual monitoring of crown health and survival during the leaf-on season. We determined sassafras crown health by visually estimating the percentages of the entire tree crown represented by healthy, wilted/discolored, and missing foliage. Trees with no healthy foliage were considered dead. We sampled xylem from suspected diseased trees with a chisel, and then bagged and shipped the samples overnight to a U.S. Department of Agriculture, Forest Service, Southern Research Station plant pathology lab in Athens, GA, or Pineville, LA, for confirmation of *H. lauricola* (Dreaden and others 2014, Fraedrich and others 2008, Harrington and others 2008).

Redbay Ambrosia Beetle Monitoring

We monitored RAB flight activity at a subset of sites with suspected laurel wilt activity or that were of particular interest. At each trapping site, we baited two traps with a 50-percent α-copaene lure (product #3302, Synergy Semiochemical Corp., Burnaby, BC, Canada). One trap in each pair was a black 8-unit Lindgren funnel trap and the other was a black triple-vane multipanel trap (products #4072 and #4057, respectively, Synergy Semiochemical Corp.). Traps were deployed and checked biweekly for a total of 8 weeks between early June and October. We conducted trapping for an extended duration (3 to 24 months, depending on site) at select sites in each region where laurel wilt was suspected or confirmed.

Data Analysis

We used analysis of variance to evaluate all factorial combinations of Region, Pathogen, and Year as fixed effects and Site(Region*Pathogen) as a random effect, on percentage of sassafras mortality (square-root transformed). We evaluated the effect of trap type (funnel versus panel) on mean RAB per week using a Wilcoxon signed-rank test and by limiting the dataset to the "site x date" combinations on which at least one RAB was collected in a trap. We analyzed RAB flight activity graphically over time, and identified and counted all species of ambrosia beetles at two sites in Kentucky. See Mayfield and others (2022) for full methods and analysis.

RESULTS

Vegetation Monitoring and Laurel Wilt Assessment

Laurel wilt was detected at 28 percent of the monitoring sites during the 3-year project period (2018–2020), including six sites in the Coastal Plain, three in the Piedmont, and four in the Mountains (fig. 10.1). Four of these detections were previously unreported county records for laurel wilt (Chilton County, AL; Bibb County, AL; Columbia County, AR; Worth County, GA), generating new range information for the national Laurel Wilt Distribution Map (https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd669956.pdf). In 2018, mean percentage of mortality of tagged sassafras trees at all disease-free sites did not differ significantly from the mean mortality at sites where laurel wilt would ultimately become detected between 2018 and 2020 (fig. 10.2). In

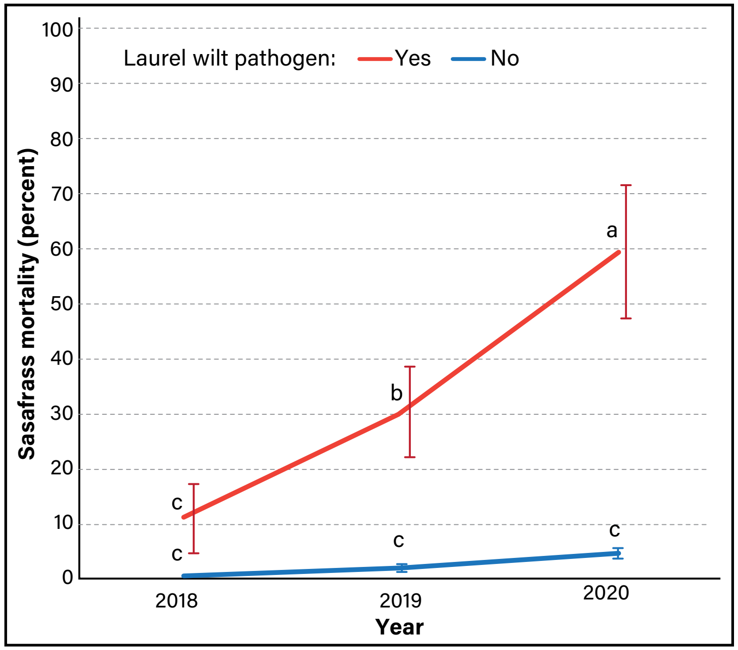

Figure 10.2—Mean percentage of mortality of tagged sassafras monitoring trees from 2018 through 2020 at sites where the laurel wilt pathogen was confirmed versus sites where it was not detected. Vertical bars denote standard error of the mean. Means labeled with the same letter are not significantly different (α = 0.05). (From Mayfield and others 2022)

2019 and 2020, however, mean sassafras mortality at diseased sites increased to 30 percent and 60 percent, respectively, whereas mortality in disease-free stands remained below 5 percent (fig. 10.2). Elevated sassafras mortality in diseased stands was evident in all diameter classes monitored. Sassafras mortality was notably rapid in a number of stands, progressing to 100 percent within 3 years at four sites (Mayfield and others 2022).

Redbay Ambrosia Beetle Monitoring

Redbay ambrosia beetles were captured in traps at a total of 11 sites including 5 sites in the Coastal Plain, 2 in the Piedmont, and 4 in the Mountains. Detection of the laurel wilt pathogen through sampling of host material usually preceded RAB detection or occurred in the same year. There was no significant difference between the mean number of RABs per week captured in panel traps versus paired funnel traps in any year, although statistical significance was marginal in 2019 when slightly more RABs were captured in panel traps. In the Coastal Plain of Louisiana, RAB captures occurred throughout the calendar year (including January) with modest peaks in late August and early December. At two Piedmont/Sandhill sites in South Carolina, RAB flight began as early as February, with two periods of peak capture in April and August through November. A similar pattern occurred in the Mountain region of Alabama where captures began in February with peaks in April and late summer (Mayfield and others 2022).

In western Kentucky, RAB flight activity began in April, peaked in June (with a lesser peak in

August), and persisted at low levels until November. A nearly tenfold decrease in peak RAB captures corresponded with an elimination of fresh sassafras host material from one summer to the next. Trap captures of the two most abundant ambrosia beetle species, the granulate ambrosia beetle (*Xylosandrus crassiusculus*) and the fruit-tree pinhole borer (*Xyleborinus saxesenii*), exhibited strong peak captures in early April or May at much higher abundances than RAB. Redbay ambrosia beetles were present in <9 percent of all the ambrosia beetle specimens captured, and >98 percent of all ambrosia beetle specimens comprised eight species, all of which were nonnative to North America (Mayfield and others 2022).

DISCUSSION

This project demonstrated the movement of laurel wilt beyond the Coastal Plain and into portions of the Piedmont/Sandhills and Mountain regions in Alabama, Georgia, South Carolina, Tennessee, and Kentucky. Four previously unreported county-level infestations were added to the national Laurel Wilt Distribution Map, demonstrating that supplemental Evaluation Monitoring projects can enhance State forestry agencies' baseline laurel wilt monitoring efforts. The impact of laurel wilt in sassafras in Piedmont and Mountain sites was substantial and rapid, with mortality progressions similar to those observed in redbay and sassafras in the Coastal Plain (Cameron and others 2015, Fraedrich and others 2008). Although we did not target sassafras stems <5 cm d.b.h. for monitoring, we documented mortality of stems of this size when they were occasionally tagged or observed informally. The likelihood of attack by RAB increases with stem diameter due to more apparent visual cues (Mayfield and Brownie 2013), which may allow small-diameter stems to escape inoculation by the insect. The clonal growth habit of sassafras, however, provides opportunity for even small sprouts to become infected with laurel wilt via root transmission, leading to the potential for accelerated sassafras mortality even when RAB populations are low.

Our results strongly suggest that deploying α-copaene-baited flight traps in the vicinity of sassafras trees, while useful for monitoring known RAB populations, may not substantially improve early-detection efforts for laurel wilt (compared to visually monitoring for symptoms). Detection and confirmation of the pathogen from symptomatic host material either preceded or coincided with the first trap catch of RAB at 92 percent of our laurel wilt-positive sites. Still, placing α-copaene-baited traps in stands with sassafras could help State surveyors evaluate the potential presence of RAB in certain situations, particularly if laurel wilt has been present and undetected for several years.

Similar to data from Florida reported by Brar and others (2012), we observed two peaks of RAB flight activity in this study in the Piedmont/Sandhills of South Carolina and the southern limit of the Mountain region in Alabama, suggesting two RAB generations annually, which peak in early spring, and then late summer/fall, respectively. However, farther north in Kentucky, RAB captures peaked slightly later (June), seasonal RAB flight activity was only weakly bimodal, and no flight activity was observed from December through March. These differences in RAB flight seasonality may be due to the colder climate of interior Kentucky compared to warmer sites in the Piedmont and Coastal Plain. Furthermore, the notable reduction in beetle abundance in traps between 2020 and 2021 in Kentucky was likely due to the elimination of fresh sassafras host material for brood production.

Although traps in this study were baited with a primary host volatile attractant of the RAB (α-copaene) and thus were intended to mimic lauraceous trees, <9 percent of the all the ambrosia beetle specimens captured in Kentucky comprised RAB. This suggests that numerous other generalist ambrosia beetle species, many of which are nonnative to North America, may be attracted to α-copaene or are at least passively captured in traps deployed in diseased sassafras stands. Thus, the degree to which other ambrosia beetle species compete with the RAB for potential host material, or have a role as potential vectors, is worthy of additional investigation.

CONCLUSIONS

Laurel wilt has spread from the Coastal Plain of the Southeastern United States into the Piedmont and Mountain regions using sassafras as a primary host. Impact to sassafras populations is substantial and rapid, with the disease killing up to 100 percent of the sassafras stems ≥5 cm d.b.h. and the pathogen spreading via root transmission. There was no substantial difference in RAB trapping efficacy between the 8-unit Lindgren funnel trap and the triple-vane multipanel trap. Trapping with α-copaene lures in stands with sassafras was useful for monitoring known RAB populations but did not enhance early detection of latent laurel wilt infections. Seasonal flight activity of the RAB was bimodal in stands with sassafras in the Piedmont, with peak captures in April and a secondary peak between August and November. In western Kentucky, RAB flight was not observed from December through March, peaked in June, and declined markedly as fresh sassafras host material was eliminated from the stand. The georeferenced network of sassafras plots established during this project provides baseline data for future monitoring efforts and could be revisited in the future for possible evidence of trees that display resistance to, or tolerance of, laurel wilt.

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