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# Fusiform Rust Trends in East Texas: 1969-1987

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*ABSTRACT. Five surveys of pine plantations in East Texas over an 18-year period (1969–1987) indicated that fusiform rust (*Cronartium quercuum *[Berk.] Miyabe ex Shirai f. sp. fusiforme Birdsall and Snow) infection rates have increased to current levels of about 50% on slash pine (*Pinus elliottii *Engelm.) and are continuing to increase on loblolly pine (*Pinus taeda *L.) to 10–15% levels.*

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In East Texas, as well as elsewhere in the southern United States, the incidence of fusiform rust (*Cranartium quercum [Berk.] Miyabe ex Shurai f. sp. fusiforme Birdsall and Snow*) in planted stands of loblolly and slash pine affects managment decisions. A pine plantation may be established with an initial goal of producing a high-quality product such as sawlogs or plylogs during thinnings or at final harvest. However, if a large proportion of the planted pines develop fusiform rust galls on the tree stem, the plantation manager may not be able to merchandize as many trees as expected for these solid wood products. In addition, rust-associated mortality may severely deplete the plantation.

Information on fusiform rust incidence in East Texas loblolly and slash pine plantations is available from four surveys made over a 15-year period (1969–1984):

1 Mason and Griffin (1970) described a 1969 survey of loblolly and slash pine plantations throughout East Texas. The study considered stem infections only.
2 A 1976 survey sampled natural and planted stands of loblolly pine, and planted stands of slash pine, throughout East Texas (Walterscheidt and Van Arsdale 1976). No differentiation between stem or branch infections was made in this study.
3. Loblolly and slash pine plantations in southeast Texas were surveyed in 1980 by the Texas Forest Service (1982). Stem and branch infections were recorded separately.
4. A subset of the East Texas Plantation Research Project[1] (ETPPRP) permanent plots was analyzed for fusiform rust infection rates as of 1984 (Hunt and Lenhart 1986). Occurrence of fusiform was described in loblolly and slash pine plantations by location on the tree.

This 1987 study extends, analyzes and compares the trends noted in these four surveys with a fifth pine plantation survey, in this case carried out on the ETPPRP permanent plots.

## THE 1987 SURVEY

ETPPRP permanent plots were measured for the second time during the summers of 1985–1987. The 252 ETPPRP plots (173 in loblolly and 79 in slash pine plantations) are located in 24 counties throughout East Texas. Each plot is in a different plantation and consists of two subplots—one for model development and the other for model evaluation. A subplot is 100 × 100 ft in size, and the subplots are separated by a 60-ft buffer zone. ETPPRP field crews were able to reliably tabulate only those fusiform rust galls occurring on trees in plantations 5 years or older. During the second measurement cycle, the occurrence of fusiform rust on each planted pine was recorded following the same format used during the 1982–1984 initial measurement cycle:

1. Infected stem—Gall on a stem or on a live branch within 12 in. of the stem.
2. Infected branch—Gall on a live or dead branch more than 12 in. for the stem.

This rust information represents the 1987 rust survey, which is the fifth and new additional survey. Rust infection amounts from ETPPRP model development subplots were used for both the 1984 and 1987 surveys.

At the time of the 1984 survey, 79 loblolly pine plots and 38 of the slash pine plots were 5 years or older. These were the plots analyzed for the 1984 rust survey. For the second measurement cycle three years later, an additional 72 loblolly pine plots and 29 slash pine plots were 5 years or older and available for 1987 survey analysis. Since the 1984 survey, 15 loblolly pine plots and 1 slash pine plot have been lost as a result of acts of man and nature.

Because of the conditions just described, two different data sets for each species were available for trend comparison and analysis in the 1987 survey:

1. For loblolly, 71 of 79 original plots had not been lost and were measured for a second time. This is considered the original data set. A combined data set was designated to consist of 136 plots (79 − 15 + 72 plots).
2. For slash, 38 of 38 original plots were measured for a second time. This is the original data set, and 66 plots (38 − 1 + 29 plots) were available as a combined data set.

[1] The continuing support from the participating companies—Champion International Corporation, International Paper Company, Louisiana-Pacific Corp., and Temple-Inland, Inc.—is appreciated.

**Table 1. Distribution of combined 1987 survey plots by geographic location, species and age classes for planted loblolly and slash pine trees in East Texas.**

| Species | Plantation age (yr) 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East Texas[a] | | | | | | | | | | | | | | | | |
| Slash | 14 | 12 | 7 | 6 | 9 | 4 | 4 | 3 | 1 | 5 | — | 1 | 3 | — | — | 71 |
| Loblolly | 30 | 20 | 20 | 10 | 3 | 12 | 7 | 3 | 11 | 7 | 5 | 3 | 2 | 2 | 1 | 136 |
| Southeastern Texas | | | | | | | | | | | | | | | | |
| Slash | 12 | 8 | 5 | 3 | 9 | 4 | 3 | 1 | 1 | 2 | — | 1 | 3 | — | — | 54 |
| Loblolly | 16 | 8 | 7 | 6 | — | 6 | 1 | 2 | 3 | 6 | 4 | 2 | 2 | 2 | 1 | 66 |

[a] Includes counties in southeastern Texas.

The combined data sets were analyzed as one-time observations, whereas the original data sets provided an opportunity to track changes in rust occurrence over a 3-year period. The distribution of the new combined data sets by age classes and geographic region is shown in Table 1. The sampled plantations are relatively young with an average age of 8–9 years.

## TRENDS

### *Combined Data*

Based on ETPPRP slash pine sample plot combined data in both East Texas and southeastern Texas[2], average infection observed in 1984 and in 1987 indicate that rust may be stable, with approximately 50% of the trees infected (Table 2). Very few of the slash pines have only branch infections. If a tree is infected, galls are probably on the stem, where the resulting damage may severely reduce the opportunity to use the tree for high-value products. A 50% stem infection is high compared to other southern states, where rust infection in planted slash pine is 10–41% (Phelps 1977). East Texas is 200 miles west of the natural range of slash pine, and tree species planted out of their natural range are highly susceptible to disease (Little 1971).

Since the 1984 survey, average loblolly pine rust infection values from the ETPPRP sample plots indicate increases for East Texas (Table 2). For southeastern Texas, rust infections have been declining for about 8 years. However, the 1987 survey indicated a trend reversal, with increases to 12% for stem infections and 15% for total infections. Southeastern Texas levels are similar to the values (10–14%) for the overall East Texas area. In comparison, Phelps (1977) in his southside study reported percentages of rust-infected planted loblolly pine trees in states along the Gulf Coast, east of Texas, that ranged from 12–19%.

### *Original Data*

Insights into changes in rust occurrence over a 3-year period may be possible by analyzing the original data sets. Average infection percentages for 1984 and 1987 for the same ETPPRP sample plantations (71 loblolly and 38 slash in East Texas and 38 loblolly and 29 slash in southeastern Texas) are presented in Table 3.

During the 3-year period, average infection intensities for the original slash pine plots for both geographic locations increased. The percentage of trees with stem galls changed from just under 50% to 61–66%, while the percentage of trees with stem galls or branch galls on both has increased from 54–57% to 67–71% Average age of the slash pine plots in 1984 was about 8 years and by 1987 the average age was about 11 years. This rust increase is probably a result of the plantations being in the peak period of rust susceptibility based on age (Wells and Dinus 1978). With average rust infection rates approaching 75%, management of East Texas slash pine plantations will probably be affected by increased mortality, and wood quality of surviving infected trees at the time of possible harvest may be degraded

A second measurement of the surviving original loblolly pine sample plots indicated average fusiform rust infection rates increased for each of the four categories measured in this survey (Table 3). Over the 3-year period, average rust percentage for East Texas sample plots almost doubled, to 12% for stem and 17% for stem infections or branch infections or both, while average stem infection rates for sample plots in southeastern Texas grew from 3% to 14%, which is an almost fivefold increase. Stem infection rates or branch infection rates or both types of infection rates for south-

**Table 2. Average fusiform rust incidence in loblolly and slash pine plantations by survey year and geographic location in Texas.**

| Species<br>Location of rust galls | Survey year 1969 | 1976 | 1980 | 1984 | 1987 |
|---|---|---|---|---|---|
| | % | | | | |
| East Texas[a] | | | | | |
| Slash | | | | | |
| Stem[b] | 8 | — | — | 46 | 48 |
| Stem and/or branches | — | 30 | — | 57 | 52 |
| Loblolly | | | | | |
| Stem[b] | 6 | — | — | 7 | 10 |
| Stem and/or branches | — | 9 | — | 11 | 14 |
| Southeastern Texas | | | | | |
| Slash | | | | | |
| Stem[b] | 19 | — | 32 | 47 | 51 |
| Stem and/or branches | — | 43 | 55 | 54 | 54 |
| Loblolly | | | | | |
| Stem[b] | — | — | 8 | 3 | 12 |
| Stem and/or branches | — | 6 | 18 | 9 | 15 |

[a] Includes counties in southeastern Texas.
[b] May or may not also have rust-infected branches.

[2] Southeastern Texas is the area located in the southern half of East Texas.

**Table 3. Average fusiform rust incidence for original loblolly and slash pine plots for each of two survey years.**

| Species<br>Location of rust gall | Survey year<br>1984 | <br>1987 |
|---|---|---|
| | ..... % ..... | |
| ..... East Texas[a] ..... | | |
| Slash (38 obs) | | |
| Stem[b] | 46 | 61 |
| Stem and/or branches | 57 | 67 |
| Loblolly (71 obs) | | |
| Stem[b] | 7 | 12 |
| Stem and/or branches | 11 | 17 |
| ..... Southeastern Texas ..... | | |
| Slash (29 obs) | | |
| Stem[b] | 47 | 66 |
| Stem and/or branches | 54 | 71 |
| Loblolly (38 obs) | | |
| Stem[b] | 3 | 14 |
| Stem and/or branches | 9 | 18 |

[a] Includes counties in southeastern Texas.
[b] May or may not also have rust-infected branches.

eastern Texas have doubled to 18%. During the 3-year period, the loblolly pine sample plantations advanced from an average age of about 9 years to approximately 12 years and thus were also in the peak period of rust susceptibility based on age (Wells and Dinus 1978). Since planted loblolly pines with stem galls are less likely to die than stem-infected slash pines (Powers et al. 1974, Powers 1975), East Texas loblolly pine plantation management may not be as severely affected by rust-associated mortality as are slash pine plantations.

To further understand changes in rust infection rates in the original loblolly and slash pine plots over the 3-year period, rust condition transitions over the 3-year period were considered (Table 4). For slash pine throughout East Texas, the number of trees over a 3-year period that changed from clear or branch-only infection status to stem gall was 72 of 201, or 36%. For the 71 loblolly pine plots in the same area, the transition from clear or branch-only to stem was 32 of 413, or 8%. Similar transition trends were observed from sample plots in the southeast region of East Texas. Mortality was much higher for stem-infected slash pine than for loblolly pine. During the 3-year period, 17 of 145 slash pines in East Texas with stem galls died, while only 1 of 32 stem-infected loblolly pines died. Similar mortality occurred for the southeastern Texas plots. These trends support earlier work by Powers et al. (1974) and Powers (1975).

**Table 4. Average transition of rust status between 1984 and 1987 by number of trees observed in original loblolly and slash pine plots by species and geographic location.**

| Species | Rust status in 1984 | | Tree/rust status in 1987[a] | | | |
|---|---|---|---|---|---|---|
| | | | Clear | Branch[b] | Stem[c] | Dead |
| ..... East Texas[d] ..... | | | | | | |
| | | ..... Trees/ac ..... | | | | |
| Slash (38 obs) | Clear | 160 | 105 | 10 | 42 | 3 |
| | Branch[b] | 41 | | 4 | 30 | 1 |
| | Stem[c] | 145 | | | 117 | 17 |
| | Total | 346 | | | | |
| Loblolly (71 obs) | Clear | 397 | 345 | 18 | 28 | 6 |
| | Branch[b] | 16 | | 4 | 4 | 0 |
| | Stem[c] | 32 | | | 19 | 1 |
| | Total | 445 | | | | |
| ..... Southeastern Texas ..... | | | | | | |
| | | ..... Trees/ac ..... | | | | |
| Slash (29 obs) | Clear | 125 | 83 | 6 | 34 | 2 |
| | Branch[b] | 35 | | 4 | 25 | 1 |
| | Stem[c] | 168 | | | 133 | 24 |
| | Total | 328 | | | | |
| Loblolly (38 obs) | Clear | 411 | 359 | 16 | 29 | 7 |
| | Branch[b] | 19 | | 4 | 3 | 0 |
| | Stem[c] | 42 | | | 29 | 2 |
| | Total | 472 | | | | |

[a] Numbers for transitions from branch and stem infections do not total because of problems such as branches with galls falling off or gall-like stem swellings (on young pines) that were not present at second measurement time.
[b] Rust-infected branches only.
[c] May or may not also have rust-infected branches.
[d] Includes counties in southeastern Texas.

## CONCLUSION

This fifth survey of fusiform rust occurrence in East Texas, in conjunction with four earlier rust surveys, indicates the disease is severely affecting relatively young and susceptible slash pine plantations. During a recent 3-year period (1984–1987), more new stem infections occurred on slash than on loblolly pine, and there was more rapid spread of branch galls into the stem on slash than on loblolly pine. Once a slash pine stem has a gall, there is a higher probability of mortality than is true for a stem-infected loblolly pine. Due to the increasing incidence of fusiform rust in slash pine plantations in East Texas, conversion of slash pine plantations to planted loblolly or longleaf (*Pinus palustris* L.) pine is a possible management recommendation. □

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