Forest Pathology

WILEY

Forest Pathology

SHORT COMMUNICATION

Estimating Impact of Brown Spot Needle Blight on Loblolly Pine Using 3-PG Growth Model

Tyler J. Dreaden[1] | Rabiu O. Olatinwo[2] | John J. Riggins[3] | Carlos Gonzalez-Benecke[3]

[1]United States Department of Agriculture Forest Service, Southern Research Station, Forest Health Research and Education Center, Lexington, Kentucky, USA | [2]United States Department of Agriculture Forest Service, Southern Research Station, Pineville, Louisiana, USA | [3]Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, Oregon, USA

Correspondence: Tyler J. Dreaden (tyler.j.dreaden@usda.gov)

Received: 24 September 2025 | **Revised:** 2 December 2025 | **Accepted:** 24 December 2025

Keywords: forest pathology | plantation forestry | tree disease

ABSTRACT

Lecanosticta acicola is a fungal pathogen that causes brown spot needle blight (BSNB). It primarily impacts the genus *Pinus* and has been introduced to much of the Northern Hemisphere. Brown spot needle blight causes a reduction of leaf area and photosynthetic capacity that can lead to reduced growth and mortality in extreme cases. In the southeastern USA, the disease has historically primarily impacted grass stage longleaf pine (*Pinus palustris*). Around 2015, large areas of plantation loblolly pine (*Pinus taeda*) were found to be infected with *L. acicola*, which is outside of historic norms for the pathogen. The aims of this research were to get a first estimate of the impact of the disease on loblolly pine plantations and outline methods for managers to model growth with their specific stand characteristics. We used the 3-PG model (Physiological Processes Predicting Growth) to estimate the impact of defoliation caused by the disease. We found the season of defoliation did not have an impact on stem volume and leaf area index recovered to undefoliated levels approximately 5 years following the last defoliation event. Increasing defoliation levels reduced stem volume growth as expected with 1 to 5 consecutive years of defoliation delaying stand development by 0.1 to 1 year. We find that defoliation delays stand development and that this delay is sustained going forward. Lower productivity sites had a larger reduction in stand volume highlighting the need for a measure of stand productivity in estimating the impact of BSNB defoliation and the need to include stand productivity in future models. This framework is primitive but provides managers with the ability to input their stand characteristics and get more specific estimates for growth loss due to BSNB defoliation and provides the ability to model different disease scenarios to better manage losses due to this emerging disease phenomenon.

1 | Introduction

Lecanosticta acicola is an ascomycete fungus that causes a foliar disease of *Pinus* sp. called brown spot needle blight (BSNB). The disease has long been known to cause defoliation and growth loss in grass stage longleaf pine (*Pinus palustris*) in the southeastern USA. The pathogen has been reported on 53 different *Pinus* species and hybrids in the USA, Canada, most European countries, and Asia, as well as Central America and Colombia (van der Nest et al. 2019). Around 2015, in the USA, an increase in foliar disease on loblolly pine (*P. taeda*) was reported, and outbreaks were found in Alabama, Arkansas, Louisiana and Mississippi, with *L. acicola* thought to be a major contributor (Meinecke et al. 2024 and references within). *L. acicola* has now been confirmed from symptomatic loblolly in much of the southeastern USA. The impact of defoliation caused by this disease on loblolly pines growth and health is currently unknown. The aims of this study were to provide a first estimate of growth losses caused by *L. acicola* defoliation and to provide a template for managers to estimate their losses using stand-specific

Published 2026. This article is a U.S. Government work and is in the public domain in the USA.

site characteristics. We used the 3-PG model (Physiological Processes Predicting Growth) to estimate the impact of defoliation and investigated the effect of stand conditions and timing of defoliation on growth loss.

2 | Material and Methods

The 3PGPJS version 2.7 software (Sands 2010; Landsberg and Waring 1997) in Microsoft Excel (Richmond, WA) was used for all loblolly growth calculations with the loblolly stand development parameters from Gonzalez-Benecke et al. (2016, supplemental excel file, 3-PG worksheet with parameters). We modelled BSNB defoliation using the *Silvicultural events* block and a *Defoliation* event table that included the fraction of the foliage remaining at the stand age, where 0.5 represents the removal of all second-year foliage due to disease with the current year foliage remaining in this study (Sands 2010). Initial planting density was 1000 trees/ha, Site Index was 30 m at base age 25 years for all model runs and two-year needle retention, except where noted. Reference the 3-PG user manual for details and a description of *Silvicultural events* and *Defoliation* (Sands 2010).

Season of Defoliation was tested with 3 defoliation events at ages 10, 12 and 14 that left 50% of the foliage remaining by including *Defoliation* (0.5) occurring in *Silvicultural events* of the model (*Age* 10.67, 10.83, 11, for February, April and June, respectively, for year 10).

Percent Defoliation was modelled for a single June defoliation event at age 10 with 100%, 90%, 75%, 60% and 50% of the foliage remaining (*Silvicultural events*, *Defoliation, Age* 10 with 1, 0.9, 0.75, 0.6 and 0.5 foliage remaining respectively).

Consecutive Year Defoliation Events were modelled for 1–5 consecutive years of 50% foliage removed starting at age 10 (*Silvicultural events*, *Defoliation, Age* 10 to 14 with 0.5 foliage remaining).

Every Other Year was modelled with 50% of the foliage remaining that occurred every other June from age 10 to 16 with 0 to 4 defoliation events occurring (*Silvicultural events*, *Defoliation, Age* 10, 12, 14, 16 with 0.5 foliage remaining).

Site Index was tested for high to low productivity sites (30, 28, 22 and 16 m) for a 50% defoliation even at age 10.

Central LA Stand from BSNB monitoring plots (1495 trees/ha at planting, site index 22 m, 50% defoliation at age 6, 6 + 10 and no defoliation).

3 | Results

Season of Defoliation for year 10, 12, 14 and no defoliation events, did not have a large impact on stem volume with 361, 362, 362 and 379 m^3/ha at year 14, respectively. Increased mortality due to self-thinning was observed starting at age 15 and 15.5 in the no defoliation and defoliation stands.

Percent Defoliation for a single age 10 event reduced stand growth with 379, 378, 376, 373 and 369 m^3/ha stem volume at year 14 for the 100%, 90%, 75%, 60% and 50% foliage remaining stands, respectively.

Consecutive Year Defoliation delayed growth with the stands reaching 400 m^3/ha stem volumes at age 14.8, 15, 15.4, 16, 16.4 and 17 for 0 to 5 years of defoliation, respectively.

Every Other Year of 50% defoliation starting at age 10 reduced stand volume with the stands reaching 400 m^3/ha stem volumes at age 14.8, 14.9, 15.3, 15.8 and 15.8 for 0 to 4 years of defoliation, respectively.

Site Index, decreasing, delayed stand development following the single defoliation event at age 10 by 0.2, 0.3, 0.8 and 1.3 years for the defoliated stands to reach the same age 15 nondefoliated

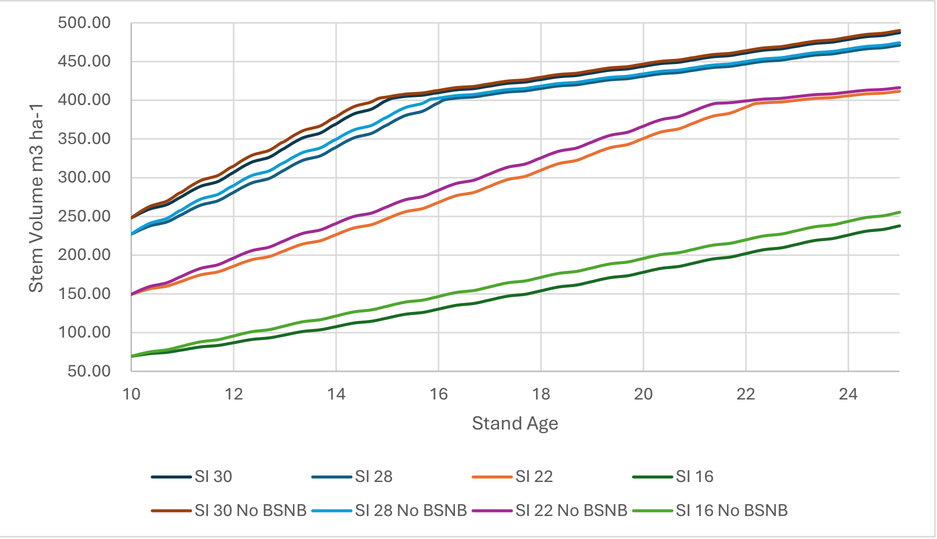

FIGURE 1 | Stem volume following a single 50% brown spot needle blight (BSNB) defoliation event at age 10 for stands with site indexes (SI) of 30, 28, 22 and 16 m at base age 25.

14390329, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/efp.70059 by Readcube (Labtiva Inc.), Wiley Online Library on [05/02/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

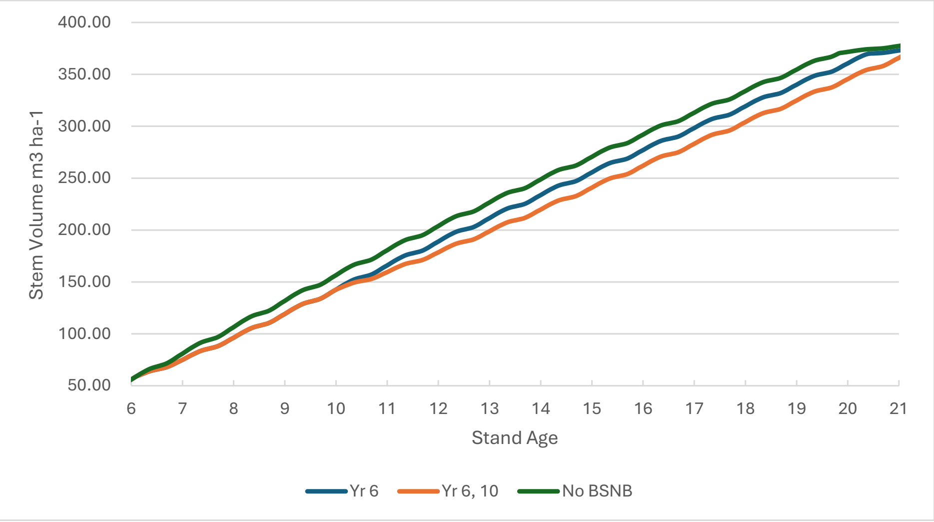

FIGURE 2 | Stem volume for a central LA stand following 50% brown spot needle blight (BSNB) defoliation events at age 6, 6 + 10 and no defoliation for site index 22 m at base age 25 stands.

stem volumes for site index 30, 28, 22 and 16 m, respectively (Figure 1).

Central LA Stand, we find the reduction in stem volume stabilises around 4 years after a defoliation event with 14–15 m^3/ha stem volume reduction for each of the 50% reductions in foliage until self-thinning starts to occur around year 21 for the site index 22 m stand. At age 19 the stands had 355, 340 and 324 m^3/ha stem volume for the no defoliation, age 6, and age 6 + 10 defoliation, respectively (Figure 2).

4 | Discussion

Differences in disease levels have been anecdotally noted in field plantings between loblolly pine families and between portions of stands and nearby stands, indicating disease development and severity are likely affected by both host genetics and environmental components. Currently, we have limited data to estimate the growth losses due to the emerging foliar disease outbreak on loblolly pine plantations in the southeastern USA. Detailed multiyear studies investigating the pathogen, host and environmental conditions are underway to measure losses and collect the data needed to more accurately model the dynamics of this disease (63rd Southern Forest Health Work Conference Greenville, SC USA July 2024). In the meantime, this work provides the first estimates of growth reductions caused by BSNB defoliation in loblolly pine plantations. We find that defoliation delays stand development and that this delay is sustained going forward. Lower productivity sites had a larger reduction in stand volume, highlighting the need for a measure of stand productivity in future models. This framework is primitive but provides managers with the ability to input their stand characteristics and get more specific estimates for growth loss due to BSNB defoliation and provides the ability to model different disease scenarios to better manage losses due to this disease.

Acknowledgements

We thank the 2024 Pine Needle Disease Working Group meeting for the discussion leading to this project, Dr. Chris Maier, with his assistance, and the USDA Forest Service Southern Research Station for providing funds and resources for this project.

Funding

This work was supported by USDA Forest Service Southern Research Station.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

Gonzalez-Benecke, C. A., R. O. Teskey, T. A. Martin, et al. 2016. "Regional Validation and Improved Parameterization of the 3-PG Model for *Pinus taeda* Stands." *Forest Ecology and Management* 361: 237–256.

Landsberg, J. J., and R. H. Waring. 1997. "A Generalized Model of Forest Productivity Using Simplified Concepts of Radiation-Use Efficiency, Carbon Balance and Partitioning." *Forest Ecology and Management* 95: 209–228.

Meinecke, C. D. A., M. M. Niyas, E. McCarty, T. Quesada, J. A. Smith, and C. Villari. 2024. "Searching the *Pinus taeda* Foliar Mycobiome for Emerging Pathogens Among Brown-Spot Needle Blight and Needlecast Outbreaks in the Southeast United State." *Phytobiomes Journal* 8, no. 4: 512–528. https://doi.org/10.1111/mpp.12853.

Sands, P. 2010. "3PGPJS User Manual, Taroona, Australia." https://3pg.forestry.ubc.ca/files/2014/04/3PGpjs_UserManual.pdf.

van der Nest, A., M. J. Wingfield, J. Janoušek, and I. Barnes. 2019. "*Lecanosticta acicola*: A Growing Threat to Expanding Global Pine Forests and Plantations." *Molecular Plant Pathology* 20, no. 10: 1327–1364.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** efp70059-sup-0001-Supinfo1.xlsm.

14390329, 2026, 1, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/efp.70059 by Readcube (Labtiva Inc.), Wiley Online Library on [05/02/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License