

Modeling Elm Growth and Dutch Elm Disease Susceptibility

Alberto Santini¹ and Luisa Ghelardini¹

Abstract

Elm susceptibility to Dutch elm disease (DED) displays strong seasonal variation. The period during which elms can become infected and express DED symptoms is generally restricted to several weeks after growth resumption in spring, although it can vary among species, provenances, and environmental conditions. The reason for this phenomenon is not understood, but the few studies correlating DED susceptibility with the host's rhythm of seasonal morphogenesis suggest that the seasonal variation in disease development depends on the pattern of growth. Susceptibility to DED is correlated to the date of bud burst in the European field elm, suggesting that a differentiation in spring phenology might cause an asynchrony between the period of susceptibility of the host and the phase of disease transmission by the insect vector allowing the tree to escape the disease.

In order to verify which conditions are determinant to express a susceptible response in elm, a thorough study of the time course of longitudinal growth, including reactivation of cambial activity and timing of bud burst, leaf area development, radial growth, wood ring anatomy, and their relations with DED susceptibility, assessed through repeated artificial inoculations from late winter to early summer, was conducted in an intermediately susceptible elm clone. Growth and seasonal variation in the response to DED infection were modeled in 2 consecutive years.

Three different patterns of shoot growth were observed at the same time in elm: predetermined growth, free growth, and growth for successive flushes. Each of the observed types of elongation growth had a specific spatial and temporal distribution, which corresponded to different anatomical patterns in the wood and different responses to DED inoculation.

The period of maximum susceptibility to DED coincided with a phase of initial and slow growth, during which reserves were rapidly exhausted, expanding leaves were behaving as energy sinks, and early wood was formed. The first decrement in DED susceptibility coincided with the transition to a subsequent phase of fast growth, when hefty energy was supplied by an increasing number of mature leaves able to efficiently photosynthesize, and a more compact late wood was formed.

The results fit the "Growth-Differentiation Balance Hypothesis" (Herms, D.A.; Mattson, W.J. 1992. The dilemma of plants - to grow or defend. *Quarterly Review of Biology*. 67 (4): 478.), which provides a framework for predicting possible allocation trade-offs in between differentiation-related and growth-related processes over a range of environmental conditions (Lorio, P.L. 1986. Growth-differentiation balance: a basis for understanding southern pine beetle tree interactions. *Forest Ecology and Management*. 14: 259–273.). Similarly to all other plants, elms are challenged by the highly unpleasant dilemma: to grow or to defend.

¹ Institute of Plant Protection, CNR, Via Madonna del Piano, 10, 50019 Sesto fiorentino, Firenze, Italy.
Corresponding author: a.santini@ipp.cnr.it.