Invasive Species

Center for Invasive Species Prevention

SOD – Regulations Should Reflect Disease's Complexity

Syringa vulgaris Chmurka 2018-05-06 1352.jpg Wikimedia Commons

As we know, the SOD pathogen *Phytophthora ramorum* infects more than 100 plant species [APHIS host list posted here]. Some are killed, some not. Some support production of spores (=sporulation), and thus promote spread of the disease – either in nurseries and plantings, or in the wild. Conditions under which *P. ramorum* infects specific plant species also varies.

In both the ornamental plant industry and natural environments, transmission is driven mostly by foliar hosts.

Matteo Garbelotto and colleagues have carried out studies aimed at improving our understanding of the differences in host-pathogen interactions, and their meaning *vis a vis* persistence and spread of the disease – especially in wildland situations. The experiments were carried out five or more years ago, funded by the Farm bill Section 7721 funding. See the full reference at the end of this blog.

The team ranked 25 ornamental plant species representing ten families for susceptibility to *P. ramorum* and infectivity (spore production). They also tested potential differences among three of the genetic lineages of the pathogen—NA1 (prevalent in U.S. forests), NA2 (found in some nurseries in Pacific coast states), and EU1 (found in nurseries and – since 2015 – in some wildland forests in Oregon). The team also studied the effect of temperature on infectibility. Their goal was to help focus regulations so they will be more effective.

The studies clearly show that the relationship between *P. ramorum* and various hosts is complex – both susceptibility and infectibility vary depending on the host species, pathogen genetic lineage, and environmental conditions, especially temperature. Results of testing of leaves for the presence of the pathogen were affected by such experimental choices as the concentration of zoospores, temperature, plant host, pathogen genotype, and by the interaction between host and pathogen genotype. Stem results were mostly affected by host and host-pathogen genotype interaction.

Hosts bearing the most severe infections do not always support the highest levels of sporulation, so they are not necessarily the most likely to spread the disease.

Regulators also cannot always generalize re: the pathogen's impact on plant hosts based on the hosts' taxonomic relationship. Results were fairly similar for congeneric species within the genera *Rosa, Prunus*, and *Syringa*, but quite different for species within the genera *Ilex, Gaultheria,* and *Osmanthus*.

It is clear that basing regulatory or best management practices on any one pathogen-host-environment relationship is likely to lead to failure, leaving our forests inadequately protected

The findings that pertain most directly to early detection of infections and those that otherwise promote spread of the pathogen are my focus here.

Hosts that Support Sporulation / Spread of Disease

At least five host species are much more infectious than *Rhododendron catawbiense*. Hosts that support the highest levels of sporulation were *Syringa vulgaris, Hamamelis intermedia,* and *Syringa meyeri*. Hosts that support medium-high levels of sporulation were *Rosa gymnocarpa* and *Syringa pubescens* subsp. *patula.*

Two of the *Syringa* species support high levels of sporulation, but rank low on overall susceptibility. *Rosa gymnocarpa* ranked fourth for levels of sporulation, but only fifteenth for overall susceptibility. At least six other species join this group of taxa that are highly infectious without displaying noticeable symptoms. Note than none of these top disease drivers is included in the so-called "filthy five" genera which are the focus of federal and state detection efforts. These genera are *Rhododendron* spp., *Camellia* spp., *Viburnum* spp., *Pieris* spp., and *Kalmia* spp.

One of the "filthy five" is *Rhododendron catawbiense.* It is often used as a standard against which to compare other species' vulnerability. *R. catawbiense* supports a somewhat lower level of sporulation than do the species listed in the preceding paragraph. Again, disease severity is not a reliable cue to the likelihood of supporting sporulation and disease spread. Thus, the *Hamamelis intermedia* was the only species that scored high for both sporulation and susceptibility.

Temperatures Affect Infection Rates

A temperature of 20°C [68^{o} F] was found to be ideal for maximum sporulation by all three genotypes. However, the NA1 genotype was a relatively good sporulator at 12^{o}C [53^{o}F]. The NA2 genotype sporulates prolifically at 25°C [77^{o}F], but produces fewer sporangia than the other two genotypes at 12^{o}C. These findings suggest which genotype might pose a greater risk in warmer or cooler regions than those supporting the current wildland infestations in California and Oregon. Thus, if NA2 spreads *via* the nursery trade to warmer regions, such as the area of the Southeast identified by various risk maps developed in the past [See maps on pages 14 – 16 in chapter 5 of Fading forests III, available here], it might pose a higher risk. This discovery intensifies concern arising from the fact that many of the *P. ramorum*-infected plants shipped to Indiana – and presumably other eastern states – in 2019 were of the NA2 lineage. States that received infected plants in 2019 included Alabama, Arkansas, Kentucky, Missouri, North Carolina, Tennessee, Virginia, and West Virginia.

Considering individual host species, *Gaultheria shallon, R. catawbiense, Osmathus delayayi* and *Hamamelis intermedia* supported good sporulation at the higher temperatures whereas *Laurus nobilis, Syringa vulgaris,* and *Magnolia stellata* supported better sporulation in cooler climates. Note that *H. intermedia* and *S. vulgaris* support prolific sporulation; the latter is a "symptomless superspreader".

Garbelotto *et al*. note that *Magnolia stellata* is both highly susceptible and highly infectious at 12°C and thus able to spread the infection in colder areas. This advice to limit use of this species in cooler areas runs counter to horticultural experts' guidance to plant this shrub in USDA Hardiness Zones 4–9 – which include virtually all the lower 48 except the most northern parts of Montana, North Dakota, and Minnesota. Clearly, star magnolia is a popular plant in colder regions. At the other end of the spectrum, *Gaultheria shallon, Hamamelis intermedia,* and *Mahonia aquifolia* were both highly susceptible and infectious at 25 °C, thus their use should be limited in warmer areas. All three include warm regions in their native ranges.

Early Detection

There are two ways to carry out early detection surveys.

(1) The first is detection of infection in plants themselves. Garbelotto *et al*. determined that 14 plant species are highly or moderately susceptible to infection even with relatively limited inoculum sources. Intense monitoring of these species would be likely to detect new infestations. Three of the highly susceptiblespecies, namely *Syringa meyeri*, *Syringa pubescens* subsp. *patula* and *Hamamelis intermedia*, are potentially more susceptible than *R. catawbiense*.

Hamamelis x intermedia 'Angelly' 01.JPG Wikimedia Commons

Based on the relative ease of pathogen re-isolation from the following host species after they had been inoculated at low levels, *Syringa meyeri, Syringa pubescens* subsp. *patula, Hamamelis intermedia, Syringa vulgaris, Osmanthus delavayi,* and *Magnolia grandiflora* indicated that a larger number of plants in the production facility had become infected.

(2) A second approach to early detection monitoring would be to focus on those host taxa able to support the most robust sporulation when infected by low levels of inoculum. This approach emphasizes curtailing spread.

As I noted above, Garbelotto *et al*. conclude that five species could spur significantly faster disease spread due to higher transmission rates coupled with higher susceptibility rates. These five species are *Syringa vulgaris, S. meyeri,* and *S. pubescens* subsp. *patula; Hamamelis intermedia;* and *Rosa gymnocarpa.* Note than none of these disease drivers is included in the so-called "filthy five" genera on which regulators focus now detection efforts.

Several species appeared less diseased, but supported more vigorous sporulation (*e.g*., *Syringa vulgaris, S. pubescens subsp. patula and Rosa gymnocarpa*). Others were more diseased but supported less sporulation (*e.g*., *Prunus laurocerasus* and *Prunus lusitanica*). Therefore, nursery managers and regulators should not rely on visual assessment of disease intensity to judge spread risk.

Other Information

Comparing the three genotypes, EU1 was most aggressive in terms of disease incidence at both low and high inoculum loads. At low levels of inoculum, NA1 lineage was comparable in terms of disease severity.

However, at higher inoculum loads NA1 was clearly the most infectious based on the number of sporangia produced on infected hosts. Garbelotto *et al*. conclude that the co-mingling of the EU1 and NA1 lineages in Oregon forests might result in a highly destructive forest disease, as both virulence and transmission potential would be maximized. There is the further risk that the presence of the two genetic lineages, which have different mating types, might enable sexual reproduction/ genetic exchange between the two lineages.

Sources

Matteo Garbelotto, M., D. Schmidt, T. Popenuck. 2020. Pathogenicity and infectivity of *Phytophthora ramorum* vary depending on host species, infected plant part, inoculum potential, pathogen genotype, and temperature. Plant Pathology 2020;00.1

Phytophthora ramorum – a deadly forest pathogen, surviving and spreading as three strains in North America. "Plant Pathology" Highlight. https://www.bspp.org.uk/phytophthora-ramorum-a-deadly-destructive-forest-pathogen-surviving-and-spreading-as-three-strains-in-north-america-on-more-than-100-ornamental-hosts-from-leaf-to-stem-across-a-range-of-t/

Posted by Faith Campbell

We welcome comments that supplement or correct factual information, suggest new approaches, or promote thoughtful consideration. We post comments that disagree with us — but not those we judge to be not civil or inflammatory.

For a detailed discussion of the policies and practices that have allowed these pests to enter and spread – and that do not promote effective restoration strategies – review the Fading Forests report at http://treeimprovement.utk.edu/FadingForests.htm

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