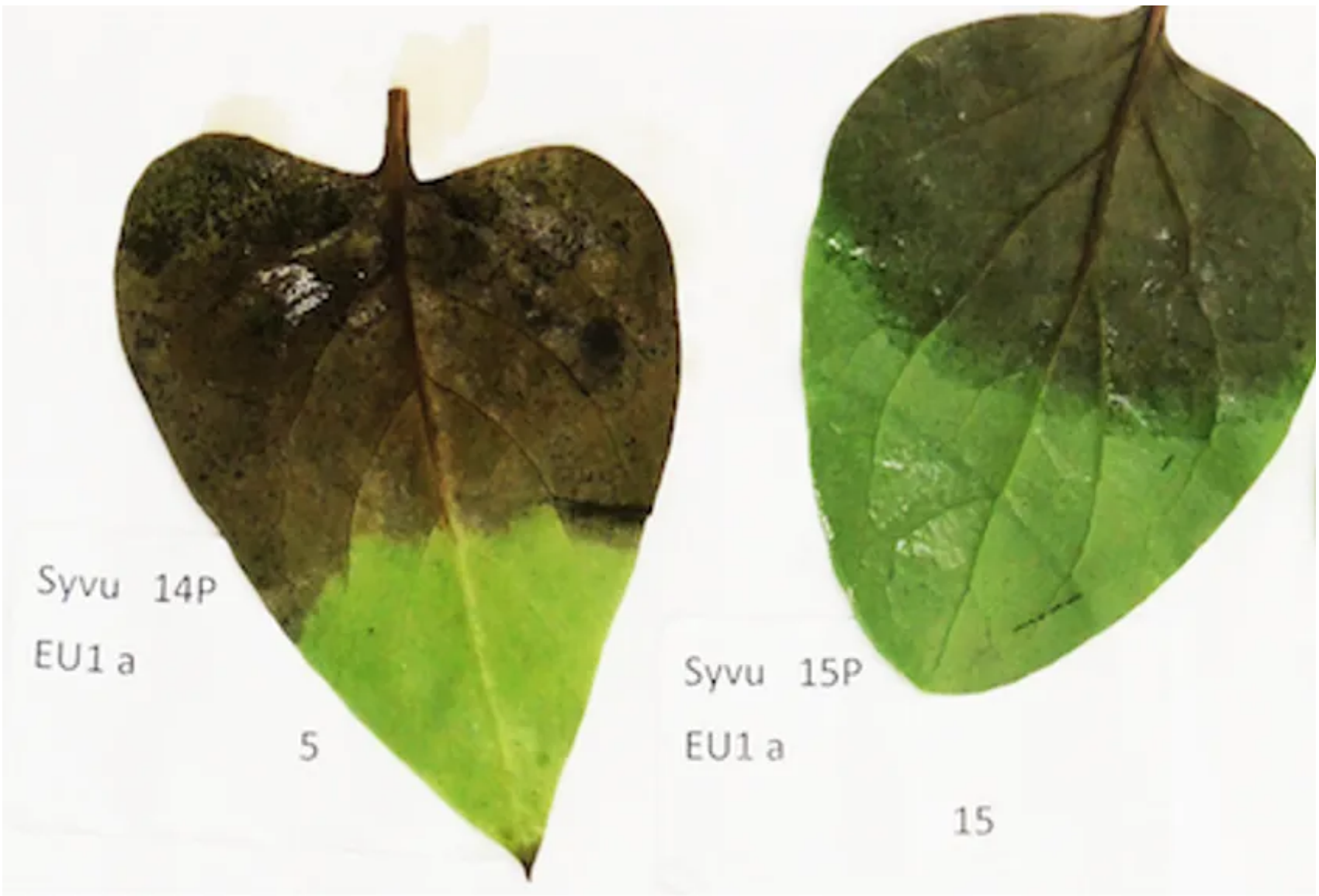

Phytophthora ramorum – a deadly forest pathogen, surviving and spreading as three strains in North America – 'Plant Pathology' Highlight

27th November 2020

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***Phytophthora ramorum* (Pram) is an extremely destructive Forest Pathogen responsible for Sudden Oak Death (SOD), a disease that has killed over 150 million trees in California and Oregon. This oomycete generalist is also responsible for Sudden Larch Death (SLD) in the UK and Ireland, and Ramorum Blight in the ornamental plant industry worldwide.**

The ornamental plant industry was responsible for introductions of the pathogen both in North America and European wildlands with at least four separate lineages of the disease. The pathogen is strictly regulated to prevent its further spread, with a significant and justified regulatory pressure on the ornamental plant industry. However, knowledge of susceptibility and infectiousness of over 100 ornamental hosts is patchy at best, with most information focused on the five "main" ornamental hosts (*Rhododendron* spp., *Camellia* spp., *Viburnum* spp. *Pieris* spp., *Kalmia* spp.).

A group of researchers from the Forest Pathology and Mycology Lab at the University of California, Berkeley (arguably one of the oldest plant pathology departments in the USA), studied Pram in North America from May 2013- November 2017. Lead author and Forest Pathology Expert, Matteo Garbelotto:

"This provides **one of the most complete analyses to date of the susceptibility and infectiousness of 25 ornamental plant species from 10 plant families**. There are at least four genetically and phenotypically distinct pathogen lineages of Pram in infected ornamental plant stock. **Three such lineages are present in North America (NA1, NA2 and EU1).**

The study had excellent replication (20-40 replicates per treatment) and included **three pathogen genotypes**, each being a representative of one of the North American lineages. Model testing showed that pathogen inoculum level, pathogen genotype (e.g. lineage), host, plant part infected (leaves vs. stems), and temperature (15 vs. 20 vs. 25 ^{0}C) all had a significant effect on disease development and on pathogen sporulation.

Unexpectedly, at least **five hosts were found to be two to ten times more infectious than the well-known host *Rhododendron catawbiense***. These hosts are*: Syringa vulgaris, Hamamelis intermedia, Syringa meyeri, Rosa gymnocarpa* and *Syringa pubescens subsp. patula*."

Clockwise from top-left: The well-known host *Rhododendron catawbiense* versus five more infectious hosts for *Phytophthora ramorum* (Pram): *Syringa vulgaris, Hamamelis intermedia, Syringa pubescens subsp. patula, Rosa gymnocarpa* and *Syringa meyeri*. (Click the image to enlarge)

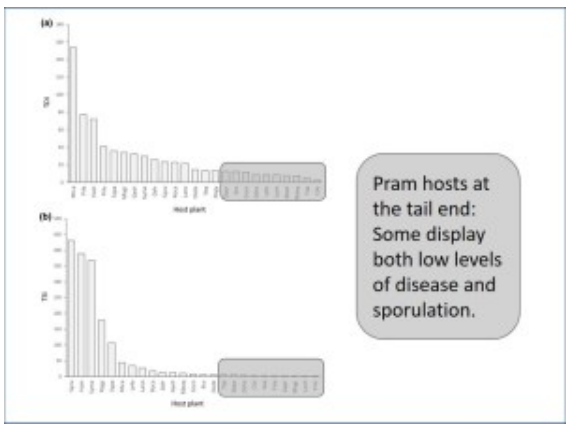
Symptomless 'Super-Spreaders'

"A second unexpected result was the presence of plant hosts supporting abundant sporulation of the pathogen but displaying rather limited visible symptoms. This phenomenon was most striking in ***Rosa gymnocarpa, Syringa pubescens subsp. patula* and *Syringa vulgaris*, but at least other six species could be added to this list.**

There is a **huge variability in response to Pram** across the 25 plant species we analyzed. Some plants developed relatively small lesions but produced a large number of sporangia…The good news is that the tails on the graphs for disease severity and sporulation are long so there are ornamental species that are not very affected by the disease and are unlikely to cause much spread of the disease."

A Pathogen with 3 Identities

The study provided additional information in support of significant differences among the three lineages of the pathogen, suggesting they should be dealt with differently: the **EU1 genotype caused the highest disease incidence and high disease severity**; the NA1 genotype had the highest sporulation levels and caused a high severity disease; finally, the **NA2** genotype caused the greatest stem disease incidence and was **the only genotype to sporulate prolifically at the warmer 25 ^{0}C**.



For the 25 Pram host plants tested, some displayed both low TSI (Total Sporulation Index) and TDI (Total Disease Index) so provide less 'risky' ornamentals (Click the image to enlarge).

Pram is a pathogen that thrives at mild temperatures around 20 ^{0}C, however our study identified plant species that will develop significant disease or will be rather infectious at warmer temperatures around 25 ^{0}C. These species are *Gaultheria shallon, Rhododendron catawbiense, Osmanthus delavayi and Hamamelis intermedia*. Conversely, the following hosts developed significant disease or supported abundant pathogen sporulation at cooler temperatures (15 ^{0}C): *Syringa vulgaris* and *Laurus nobilis*. The paper also provides info on what type of disease will develop on each species upon infection by Pram: stem only, leaf only or a disease of both stems and leaves.

Three genotypes of Pram representative of three lineages in North America (from left): NA1, NA2 and EU1. (Shown from experiments on different ornamental host species: Holly, Rhododendron and Salal respectively.) Experiments were conducted for all hosts from both leaf tip and petiole.

Guidance for risk limitation for *Phytophthora ramorum*

This study fills in many of the gaps of knowledge about Ramorum Blight in the ornamental plant industry by identifying:

1. plant species that can be highly infectious,
2. plants that are infectious when symptomless and
3. plants that may facilitate disease spread in warmer or cooler climates.

The study also allows to identify or predict:

1. the type of disease (stem vs. foliar vs. both) that may develop on 25 important plant species and

2. highlights possible different "behavior" among the three lineages of the pathogen present in North American plant production facilities.

"This information will be invaluable in perfecting regulations and best management practices aimed at curtailing the spread of Pram both within plant nurseries and from plant nurseries to natural habitats."

Matteo Garbelotto, Doug Schmidt and Tina Popenuck recently published their study in Plant Pathology Journal:

"Pathogenicity and infectivity of *Phytophthora ramorum* vary depending on host species, infected plant part, inoculum potential, pathogen genotype and temperature."

TITLE IMAGE: Experimental lesions from *Phytophthora ramorum* strain EU1 on Lilac (*Syringa vulgaris*)

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