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Rose Rosette Disease – Where From? What Now?

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Summary

Rose rosette disease (RRD) is a destructive viral disease of roses that was first observed in North America in 1940s. The disease has since spread across the United States. RRD is caused by rose rosette virus (RRV), that is transmitted by the microscopic eriophyid mite, *Phyllocoptes fructiphilus.* RRD can results in one or more of the following symptoms: deformed, excessive growth known as "witches' brooms," reddening of leaves, excessive thorniness, malformed leaves, and death of plant. There are current research efforts to seek knowledge and better understanding to help in the development of resistant rose varieties, better RRV detection methods and improved management strategies and practices against the disease. Despite it devastating effects, RRD has remained relatively obscure until the last 20-25 years when it became more widespread and significantly impacted cultivated rose varieties. Since there are no known rose disease resistance, nor effective miticidal control – diseased plants must be rogued and destroyed to limit disease spread.

INTRODUCTION

Historical origins. Initial observations describing rose rosette disease (RRD) can be traced back to 1940 in a Canadian plant disease survey. More details were later provided on additional findings in Wyoming and California of this disease occurring on native rose species (Thomas and Scott, 1953). There were not much reported about this plant disease issue for the next decades, until the 1970s and 80s it began to spread to various parts of the United States (Soto et al., 2020) (**Fig. 1**). This was when it became more of a problem on cultivated rose varieties.

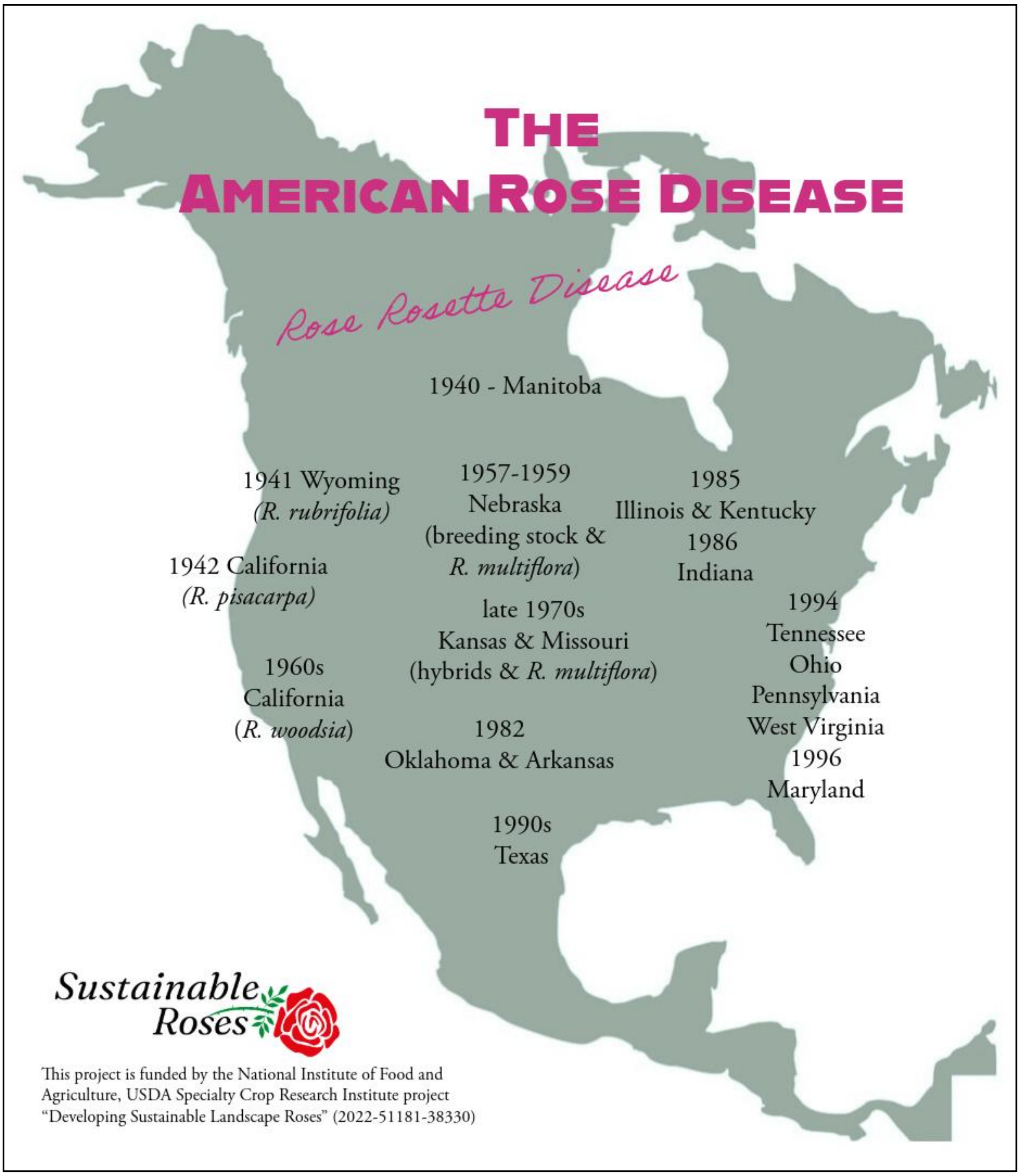

Figure 1. History of rose rosette disease (RRD) in the USA.

BIOLOGY AND PATHOLOGY OF ROSE ROSETTE DISEASE (RRD)

As early at 1953, RRD was suspected to be caused by a virus. However, there exact causal agent was not clearly known. But through some studies, an eriophyid mite (*Phyllocoptes fructiphilus*) was implicated as the vector of the RRD pathogen (Allington et al., 1968) (**Fig. 2**).

These mites are microscopic, wingless, and travel between plants either by walking, wind dispersal or by attaching themselves to other insects and animals. These mites are believed to acquire the virus from feeding on infected roses, and then transmit the virus to healthy plants at subsequent feeding (Amrine et al., 1988).

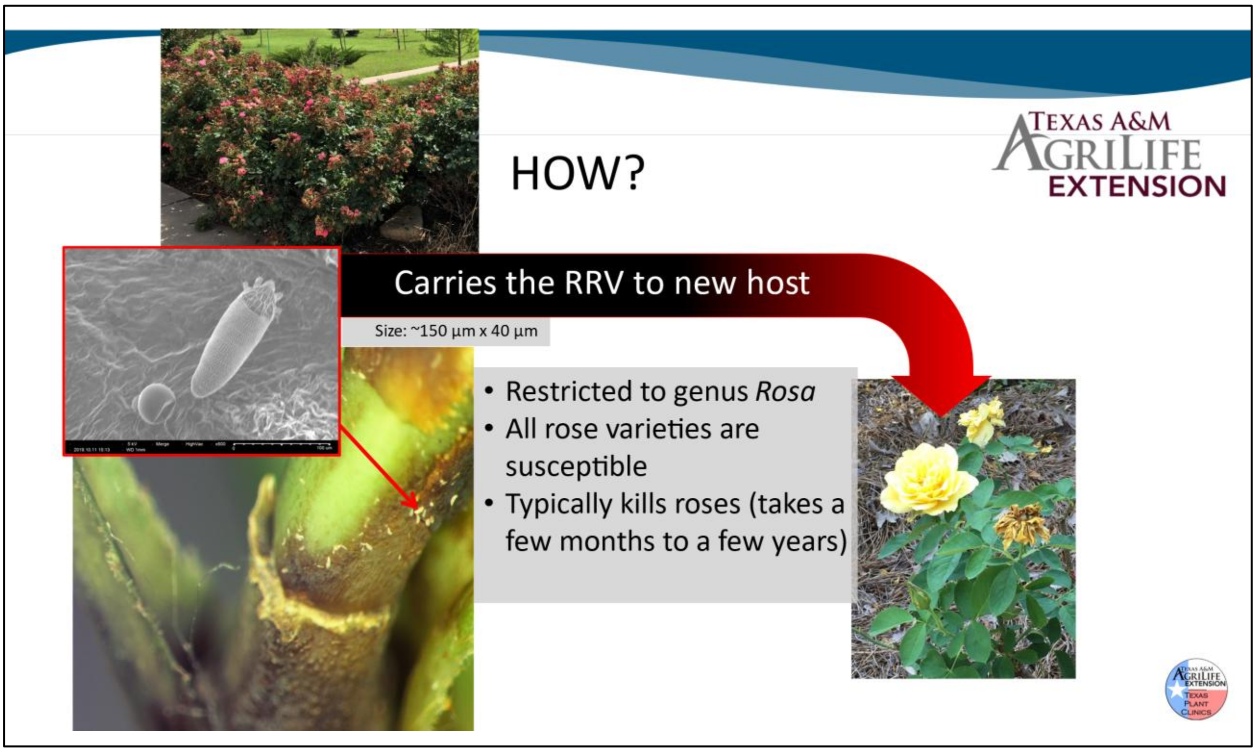

Figure 2. The microscopic, eriophyid mite, *Phyllocoptes fructiphilus*, that carries the rose rosette virus (RRV) can be spread by wind and contaminated clothing and equipment.

The first conclusive report demonstrating the causal agent to be a virus, rose rosette virus (RRV) was in 2011 by Laney et al. (2022). RRV is a negative-sense RNA virus belonging to the genus *Emaravirus* (**Fig 3**). This virus appears to only infect roses (*Rosa spp.*). Current understanding suggests that RRV can systemically spread throughout the infected plant. Infected plants exhibit characteristic symptoms such as abnormal red pigmentation, distorted leaves, elongated stems, excessive thorn production, and "witches' brooms" (dense, bushy clusters of growth) (Doudrick et al., 1983) (**Fig. 4**). Over time, infected plants suffer reduced vigor and eventually die prematurely: naturally or from other factors such as cold/freeze incidences) (Epstein et al., 1995).

RRD poses a significant threat to rose cultivation, especially in landscapes and commercial rose production (Solo et al.,2020). RRV can spread rapidly and may have a long incubation period before visible symptoms appear, making early detection challenging. Once infected, plants cannot be cured, and the only control method is to remove and destroy the affected plants to prevent the virus from spreading. Integrated management strategies, such as vigilant monitoring, utilizing resistant rose varieties, managing the mite population would be essential in mitigating the impact of this disease. Unfortunately, we know very little about the resistance to roses to this disease or effective miticide treatments to manage the eriophyid populations.

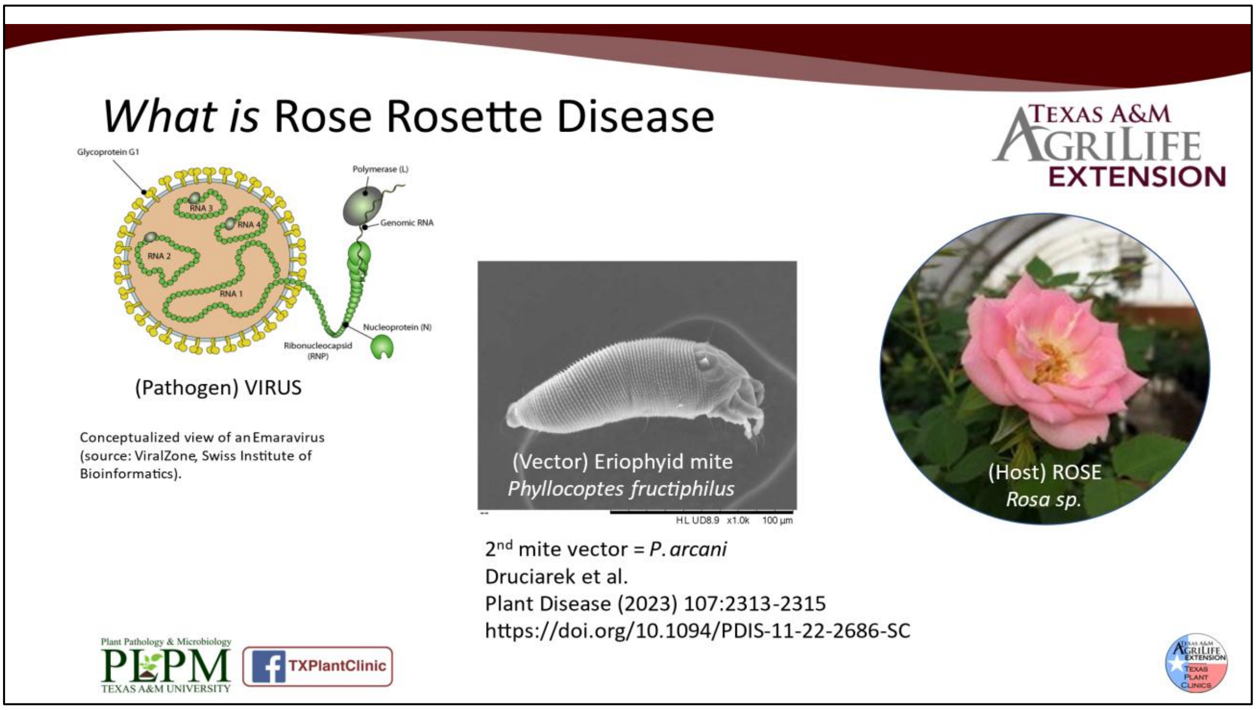

Figure 3. In rose rosette disease (RRD), there are three players: 1) Susceptible rose cultivars, 2) the rose rosette virus (RRV) [negative-sense RNA virus (genus *Emaravirus*)] that causes the disease; and 3) a wind-dispersed eriophyid mite (*P. fructiphilus)* that serves as the vector of the disease – infecting rose plants. The wild rose is believed to be instrumental in the epidemic of this disease and spread of the pathogen.

DIAGNOSTICS

Diagnostics of RRD in the early years relied on symptomology. Later, the presence of the eriophyid mite along with visible disease symptoms were indication of RRD. Only in 2011, a genomic based tool was available to use to detect RRV (Laney et al., 2011). Various research groups have furthered our knowledge and ability to detect RRV using genomic techniques.

Today, there are a number of different genomic based tests that are available to detect RRV in suspect plants. Progress is continually made in this area to find cheaper, accurate and easy to execute test procedures (Claros et al., 2022). Other technologies are explored as RRV detection tools. For example, Raman spectroscopy has been shown (proof of concept) to be able to detect infection in rose plants prior to RRD symptoms appearing (Faber et al., 2019).

Figure 4. There may be rose rosette disease (RRD) with only a single symptom.

CLEAN PLANT PRODUCTION

Efforts to produce virus-free roses in commercial operations against Rose rosette virus (RRV) have intensified due to the devastating impact of rose rosette disease (RRD) on the ornamental rose industry. Since there is no cure for infected plants, prevention and virus-free propagation are critical strategies. Even then, there is always the challenge to maintain the plants in a manner to keep them free of RRV.

Virus indexing, a process of testing plant material for the presence of RRV, is routinely employed during the propagation phase. This involves molecular techniques (such as PCR) to detect the virus even when symptoms are not visible. More recent, high throughput sequencing (HTS), a molecular technique which allows for generating large genomic data sets that can provide insight into looking for RRV or other viruses within the rose plant.

Mitigating the spread of *Phyllocoptes fructiphilus*, the eriophyid mite vector responsible for transmitting RRV, is another essential component of producing virus-free roses. Mite management includes chemical control measures, like miticides, as well as cultural practices such as spacing plants properly to reduce contact and using physical barriers to prevent mites from spreading between plants.

Currently, there is ongoing efforts by rose breeders and researchers to develop resistant varieties through traditional breeding and genetic research. Identifying genetic traits associated with resistance and incorporating them into new cultivars offers a potentially promising long-term solution to the problem.

INFORMATION GAP AND CONTINUED CHALLENGES

Despite advances in understanding RRD, several critical information gaps remain. One major gap is the complexity of the relationship between the RRV and its vector, the eriophyid mite *Phyllocoptes fructiphilus*. While we know the mites transmit the virus, the precise mechanisms of how they acquire, harbor, allow for virus multiplication, and spread the virus within rose populations are not fully understood. This lack of detail hinders the development of effective mite control strategies.

Another gap lies in the variability of symptoms among rose species and cultivars (Epstein and Hill, 1999). Symptoms of RRD can vary significantly, ranging from subtle changes to severe deformities, and may take months to appear. Understanding why certain roses show delayed or less severe symptoms, or why some are more resistant than others, is key to breeding and selecting more resilient varieties.

Additionally, research into the genetic basis of resistance to RRV is still in its early stages. While some rose species show partial resistance, the genes and mechanisms behind this resistance remain poorly understood. Furthermore, the nature of RRV in the rose plant, such as movement and distribution to infection points, is also poorly understood. These contribute to limiting our ability to develop resistant cultivars.

The irregular incubation period of the virus complicates early detection strategies, and current diagnostic tools need further refinement to ensure more accurate and rapid identification of the virus in asymptomatic plants (early detection).

There remains much to be learned of this virus and the disease it causes. Research is still being done and we can look forward to new information in the near future.

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