Observations on Rose Rosette Disease

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Rose rosette is a viral disease of commonly cultivated roses. It is caused by Rose Rosette Virus (RRV) which is transmitted by the eriophyid mite *Phyllocoptes fructiphilus.* Rose rosette was first observed in 1940 in Manitoba, Canada and in California and Wyoming in 1941. In the late 70's and early 80's, it was reported to be widespread in rural and urban rose plantings in Arkansas, Kansas, Missouri, Nebraska, Oklahoma. The disease has become widespread in regions of north-central, south-central and southeast U.S. In recent years, rose rosette has been identified on cultivated roses in the mid-west and portions of the northeast U.S. Rose rosette is also found in a few western states. Recently, rose rosette was found in Florida. The incidence of rose rosette has grown exponentially in cultivated roses in the Mid-South U.S. due to increased use of mass plantings of shrub roses in residential and commercial landscapes.

The host range of rose rosette is restricted to the genus *Rosa*. Multiflora rose (*Rosa multiflora*) is particularly susceptible to the disease. Rose rosette virus has been used as a biocontrol agent for multiflora rose infestations with some pasturelands being reclaimed in 5-6 years after introduction of infected plants. In many other locations, use of rose rosette as a biological control agent for multiflora rose has failed because of the prolific number of seed that multiflora rose plants can produce annually as many as 500,000 seed per plant and the length of time seed may remain dormant on soil more than a decade; in these situations, control of multiflora will take several decades. Currently, the seed chalcid, *Megastigmus aculeatus* nigroflavus, (Hymenoptera: Torymidae) is reducing the seed burden of multiflora rose throughout the eastern U.S. All cultivated roses (shrub type, hybrid tea, floribunda, grandiflora and miniature roses) are thought to be susceptible to the disease. Other roses reported to be susceptible are: *Rosa woodsii, R. bracteata, and R. eglanteria.*

There have been a number of articles written on rose rosette and many have described the variable symptoms associated with the disease. However, few articles have offered management strategies for combating the disease other than rogueing symptomatic plants. In the few cases where control recommendations have been made (such as the use of miticides), the recommendations were based on research observations made for other diseases of roses or on diseases and/or eriophyid mites on

other crops. Published research that has investigated methods for managing rose rosette in different aspects of rose culture (production nurseries, retail centers, landscape beds, etc.) is limited.

Symptoms of RRV Infected Plants.

Rose rosette symptoms are complex and variable as plants of the same cultivar may have different symptoms at the same or different location(s). Whether this is due to variable genetics within the virus population, environmental influences including the time of season when a plant becomes infected or plant age at time of infection is unknown. Because of the variation in symptoms, RRV can be difficult to diagnoses in the field and may be confused with herbicide damage. In mass plantings of a single cultivar of rose, rose rosette may be difficult to detect. Often reddening of a rose stem due to rose rosette is difficult to detect among healthy, red young foliage (red flush) of other plants within the rose bed (Fig.1. A, B). In most roses, red flush disappears in 3-4 weeks whereas red pigmentation associated with rose rosette may persist for the life of the foliage.

In spring and fall, many healthy roses have reddened foliage. When roses are infected with RRV, the foliage may be red throughout the summer (Fig. 2. A). Diseased roses may also have strapped (unusually long, thin) leaves. However, in some plants, little red pigmentation is obvious (Fig. 2. B). Increased thorniness and flattening of stems (fasciation) is often observed (Fig. 2. C), but may be absent in symptomatic tissues (Fig. 2. B). Canes may become a large mass of distorted shoots (witches' brooms) (Fig. 2. D).

Infected rose plants may exhibit unusually large masses of distorted flower buds (Fig. 3. A) and in most cases these buds do not open (Fig. 3. A). Plants with rose rosette are easy to recognize in winter months due the witches' brooms not being masked by healthy foliage around them (Fig. 3. B). Symptomatic foliage is often more susceptible to winter kill/desiccation.

Rose bushes will decline and begin to die from rose rosette (Fig. 4.). The disease is usually fatal in 3-4 years. Large plants in the south may last a few years longer. Cane mortality is usually observed in spring when symptomatic canes fail to push out new foliage since canes with rose rosette symptoms appear to be more susceptible to winter-kill/desiccation. Low starch reserves in symptomatic canes may be responsible for decreased spring growth and ultimately death of plants. Infected roses may have diminished root systems which may be a result of decreased carbohydrate storage. Iodine tests of cut roots and cut stems infected with RRD show little or no starch present in the tissues; by comparison, healthy plants show dark blue stain of starch in all of the sections (you can make an iodine solution by dissolving 1 g of Iodine crystals & 1 g of

potassium iodide (KI) in 5 ml of water; apply directly to the stem; the reaction occurs almost immediately.) Large commercial plantings or private rose gardens can be decimated by rose rosette if the disease is left unchecked.

Spread of Rose Rosette.

As mentioned earlier, RRV is transmitted by an eriophyid mite. Although these mites do not fly, they may 'balloon' in air currents, as do dust particles, and thus can be spread surprisingly long distances. However, the closer a rose is planted to a rose infected with RRV, the more likely it is to become infected. In observations in Tennessee, rose beds located near a source of RRV have a pronounced edge effect (the roses nearest the source are more likely to become infected with the disease than roses located on the opposite side of the bed). Distribution of initially infected plants in a large rose bed will appear random if the plants were infected prior to planting or if there is a great distance between the rose planting and the inoculum source of RRV.

About 25% of multiflora roses will lose symptoms for one to three years, and then suddenly become symptomatic over the entire plant (after stress). These plants have the virus present in low titre or low concentration; they have become 'asymptomatic' but remain infected. Some ornamental roses show the same phenomenon; for this reason it is possible to buy an asymptomatic plant (or plants) that suddenly becomes symptomatic in one to three months. In a newly established garden, an asymptomatic, but infected plant become rapidly become symptomatic after planting due stresses associated with transplanting. In this case, transmission took place in the grower's fields, and not in your location. That is why it is very important for growers to develop accurate tests for the presence of RRV in roses; even asymptomatic plants may be infected.

Some growers have reported that symptomatic multiflora roses do not always die from RRD. A professor at WVU made this report to Dr. Amrine. Jim checked the "plant" that had apparently survived the RRD infection. He found four plants in a tight, intertangled bush growing together; the plant infected with RRV had died from the disease, whereas the remaining three plants were healthy and unaffected by the virus. Why didn't all four plants become infected and die? The vector mite needs access to rapidly growing tissue near the apical or lateral meristems; if the healthy plants are hardened off, then the disease cannot be transmitted by the mite. North central West Virginia had experienced moderate drought for the previous decade and the phenomenon of harden plants with little rapidly growing tissues was common as were healthy plants of multiflora intermingled with diseased plants. In rose plantings, plants are watered and fertilized regularly so that plants will bloom prolifically and this prevents plants from hardening off as multiflora plants do in natural habitats. Therefore,

horticulturally maintained roses will likely remain in a state where eriophyied mites can transmit the rose rosette.

Management of Rose Rosette.

Roses should be inspected for symptoms of RRV before being purchased. If possible, RRV tests should be conducted; the grower may have a certification that his stock has been tested for RRV. Even if the plants you select for purchase are free of rose rosette symptoms, you should inspect all roses at the nursery. If some are symptomatic, it would be best to buy elsewhere where all roses appear to be healthy. If you observe rose rosette symptoms on a few roses at a nursery, there are likely to be more infected, but asymptomatic (latent infections) roses at that location. Once roses are transplanted, plants should be inspected regularly for symptoms of rose rosette. Symptomatic plants should be rogued as soon as possible since infected plants may harbor large populations of eriophyid mites that may spread RRV to other roses. Rogued plants should be bagged at the site of removal and not dragged through the garden or left piled near the garden. At the Beall Family Rose Garden (200 bush garden located within the University of Tennessee Gardens), plants are inspected several times a week for symptoms of rose rosette. Roses are rogued at first observation of symptoms. Over a five year period, the garden has annually lost 2-4% of its roses to rose rosette. However, no rose adjacent to a rose that was rogued has developed symptoms of rose rosette. Since the garden's plan calls for replacement of 5% of its roses annually to keep the garden up-to-date and 'fresh', losses of roses due to RRV have not been noticeable by garden patrons. The key to success for a management plan based on rogueing is early detection of symptomatic plants and immediate rogueing of diseased roses.

Several publications have suggested using miticides to reduce incidence of RRV in rose gardens. While this may seem logical, there are no research data available to support the use of miticides to reduce the impact of RRV in a planting of roses and such efforts may be a waste of money. The University of Tennessee, with support from the Research Trust of the American Rose Society and Bayer CropScience LP, are investigating the efficacy of miticides for reducing the impact of RRV on rose gardens. To date, preliminary studies have not demonstrated that miticides are effective.

Several internet articles and websites have suggested that pruning of infected canes at observation of initial symptoms will eliminate RRV from an infected plant. Apparent success may not be due to the elimination of the virus from the plant, but due to a long latent period which allows the rose to appear virus free for a considerable amount of time. Time of year of pruning infected canes may also impact the effectiveness of this strategy. The University of Tennessee, with support from the Research Trust of the American Rose Society, is investigating the effectiveness of

pruning infected canes (either when first observed or 4-6 weeks after observation of symptoms) to determine if pruning is an effective strategy. Unfortunately, due to the long latent period of RRV, we are still collecting data to determine if pruning is effective or a waste of time for elimination of RRV from an infected plant. Pruning infected roses before pruning healthy plants with the same shears has been suggested as a method of transmission of RRV. Several researchers have investigated pruning as a method of transmitting RRV to other roses and concluded that pruning was not an efficient means of transmitting the virus to healthy roses. It is still prudent to use caution when pruning roses and disinfest shears before using them on healthy plants.

Since eriophyid mites 'balloon' in the air instead of being active flyers, a barrier placed between a rose planting and a possible source of eriophyid mites and RRV may reduce incidence of rose rosette in a rose garden. Experiments at the University of Tennessee, supported by the Research Trust of the American Rose Society, have demonstrated that a barrier of *Miscanthus sinensis* (Andersson, Chinese or Japanese silver grass) will reduce incidence of rose rosette in plantings of roses (Fig. 5) when compared with incidence of rose rosette in rose plantings without barriers.

Resistance to RRV.

Although all known cultivars of roses used commercially are considered to be susceptible to rose rosette, some species of roses have been reported to be resistant to RRV or transmission of RRV by eriophyid mites. Roses reported to be resistant to RRV are: *R. setigera, R. acicularis, R. arkansana, R. blanda, R. palustris, R. carolina, and R. spinosissima*. The interspecific hybrid, 'Stanwell Perpetual' (*R. spinosissima* and *R.* x *damascena*) is susceptible to RRV (Bruce Monroe, personal communication). Therefore progeny of crosses made with resistant roses may not be resistant. There is a critical need to test rose species for resistance to *P. fructiphilus* and Rose Rosette Virus in controlled experiments

A misconception exists that Knock Out® roses are more susceptible to RRV than other types of roses. There are no data to support this premise. The supposed enhanced susceptibility of Knock Out® roses to RRV is due to the commonality of Knock Out® roses in mass plantings that are not frequently checked for symptoms of rose rosette and diseased plants are therefore not immediately found and rogued. Knock Out® roses are not known to be more susceptible to eriophyid mite infestations or RRV infections than any other cultivar of rose. However, unpruned Knock Out® roses may become very tall and may intercept more 'ballooning' eriophyid mites than roses that are shorter in stature. This phenomenon may explain why RRV is seldom

reported in miniature roses although miniature roses are considered to be as susceptible to RRV as any other type of roses grown in the garden.

Future of Roses as Impacted by RRV.

There is little doubt that more roses will succumb to this disease before effective management plans can be developed at the wholesale, retail, and landscape level because asymptomatic, infected rose are apparently moving undetected in the nursery trade. Rose rosette will continue to spread into new areas providing the climates in those areas are conducive for supporting populations of multiflora roses or other rose species able to function as a reservoir for both Rose Rosette Virus and *P. fructiphilus*, e.g. *R. woodsii* in the high plains along streams. However, research is underway to develop management plans to reduce the impact of this disease and there are reasons to be optimistic that successful management plans will be developed. The University of Tennessee is also working to develop an inexpensive, rapid detection tool for RRV which could reduce incidence of asymptomatic plants in the nursery trade. A portion of this research has been supported by the Research Trust of the American Rose Society, but funding for this endeavor is critically low. Rose companies and several universities are working to develop RRV resistant roses. Unfortunately, research takes time and is costly, but most efforts are likely to be successful at reducing the impact of RRV on rose culture sometime in the future. In our opinion, rose rosette will prove to be controllable as are other diseases in the garden such as black spot, downy mildew, rose mosaic, etc. However, these efforts will take time, and will require increased levels of research funding and a lot of hard work.

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About the authors.

Mark and Alan Windham are professors of ornamental pathology. Between the two of them, they have nearly 60 years of ornamental pathology experience and yes, they are brothers. Both brothers have been growing roses in their yards for more than 20 years. Mark is a past president of the Holston Rose Society in Knoxville, TN. Frank Hale is a professor of horticultural crop entomology. He has been working in the area of ornamental entomology for 25 years and has grown roses for 15 years. All three authors are in the Department of Entomology and Plant Pathology at the University of Tennessee. James (Jim) Amrine, Jr. is a professor emeritus at the Division of Plant and Soil Sciences (Entomology) at the West Virginia University. Email addresses for Mark, Alan, Frank, and Jim are mwindham@utk.edu, awindham@utk.edu, fahale@utk.edu, and jamrine@wvu.edu, respectively.

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Fig.1. A) Rose plant symptomatic with rose rosette (arrow) nestled within a bed of asymptomatic and presumably healthy plants. B) An infected, symptomatic cane may not be apparent initially.

Fig.2. A) Reddening of a stem infected with rose rosette; note the thin, elongated leaves and the unusually thickened cane (stem) with increased number of thorns (pickers). B) In some infected canes, foliage stays mostly green and may or may not display increased thorniness. C) Increased thorniness is common in many plants symptomatic for rose rosette and may be accompanied with flattened stems (fasciation). D) Masses of shoot proliferation (witches' brooms) are often associated with plants that are very susceptible or have been symptomatic for more than one year. These witches' brooms may become so large (larger than a bushel basket) that the plant cannot support them and the plant may fall over.

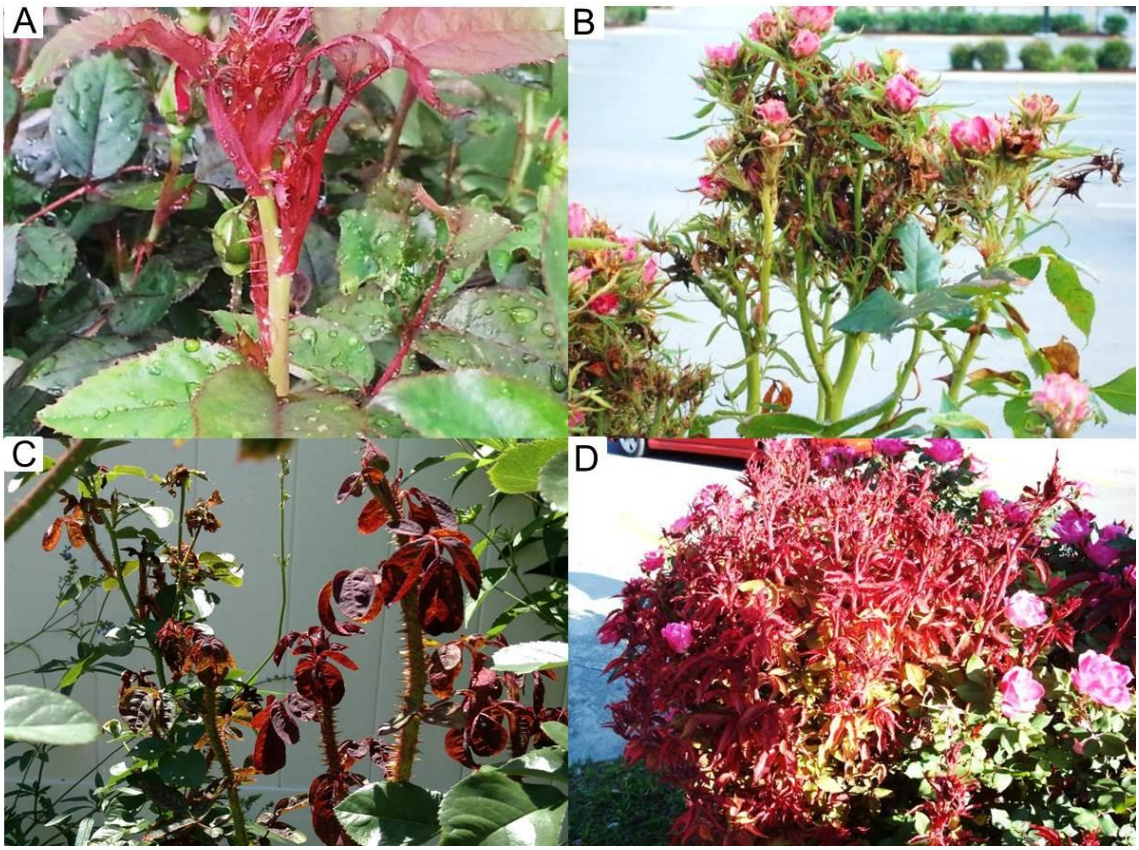

Fig.3. A) Large clusters of distorted flower buds on a rose infected with rose rosette will normally not open. B) Witches' broom symptoms of rose rosette become very obvious in winter when other foliage has dropped. These witches' brooms may become desiccated and die during the winter.

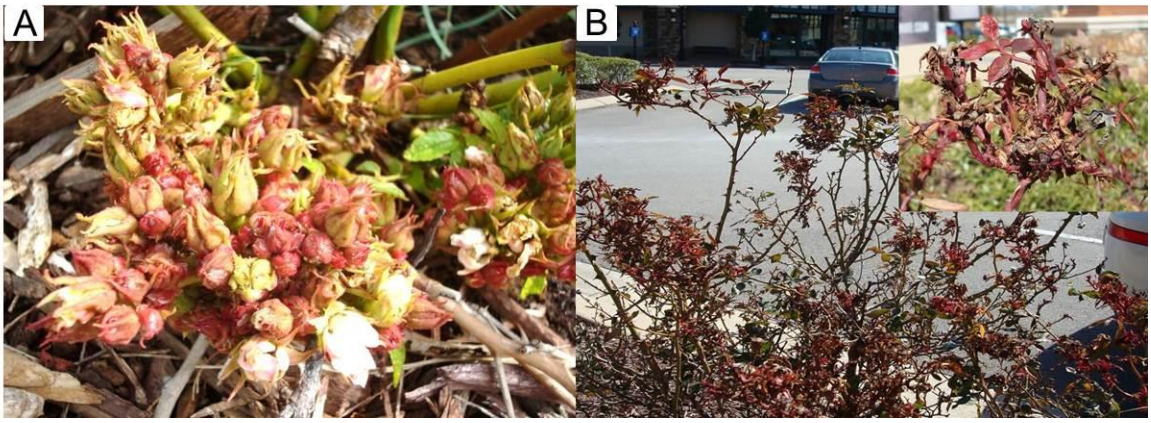

Fig.4. A) Death of these rose bushes will occur twelve months to three years after first symptoms were apparent depending on age and susceptibility. B) If left unchecked, rose rosette will destroy entire beds of roses. Spread may appear slow at first due to long latent periods in

newly infected plants. It is common for incidence of symptomatic roses to remain low in a large bed of newly planted roses for 1-2 years and in the next year, have nearly all plants become rapidly symptomatic.

Fig.5. Research using rose plots with a barrier of *Miscanthus sinensis* between a reservoir of RRV infected roses that harbor large populations of eriophyid mites and RRV have demonstrated that barriers are useful in reducing incidence of RRV in rose plantings. These rose plots are located at University of Tennessee's Plateau Research and Education Center near Crossville, TN. The rose plot is the foreground is not protected by a grass barrier whereas the rose plot in the background is protected by a barrier of *Miscanthus sinensis*. Note the plant in the unprotected plot with a witches' brooms associated with infection by RRV (arrow).