Raspberry viruses: what have we learned in Michigan?

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Introduction

Twenty years ago, Ramsdell and Perry (1994) stated that viruses were largely responsible for the decline in Michigan raspberry production from about 14,000 acres in 1950 to less than 1,000 acres in 1980. The culprits at the time were Raspberry mosaic virus, Raspberry leaf curl virus, Tobacco streak virus and Tomato ringspot virus. Availability of certified virus-tested planting material since then may have lowered the awareness of viruses as a threat to raspberry production. However, in recent years, an increasing number of raspberry growers in Michigan has reported crumbly fruit and plant decline. One field was so severely affected that it was left unharvested; Tomato ringspot virus and Raspberry bushy dwarf virus were detected by ELISA testing. Some new viruses have been described in the US and other parts of the world that we have not even considered, like raspberry leaf blotch virus (Martin et al. (2013). They describe many new viruses found in raspberries and blackberries. The goal of this project was to assess the virus infection status of Michigan raspberries and develop recommendations for monitoring and management.

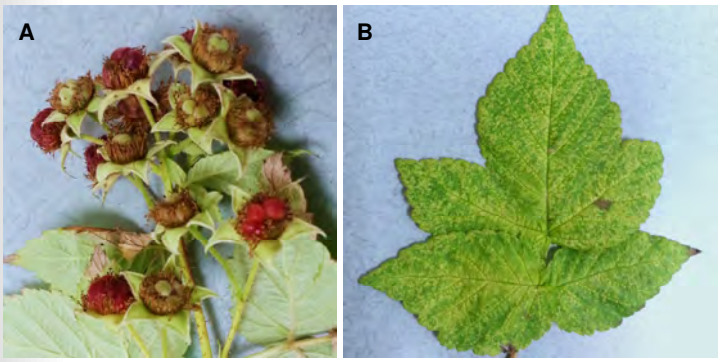

Figure 1. A) Crumbly berry symptoms seen in a Michigan raspberry field, B) Mosaic-type symptoms which may be due to virus infection or herbicide injury. Laboratory testing is needed to confirm virus infection.

Materials and Methods

In the fall of 2015, we collected leaf samples from 20 commercial and experimental raspberry fields (100 samples total) throughout Michigan. Plants with crumbly berries or other symptoms such as interveinal yellowing, mosaic and stunting that may be indicative of virus infection were selected. In 2016, leaf samples were collected from 34 raspberry fields on 11 farms (85 samples in total). Leaves were collected from 3-5 symptomatic plants per field or, if symptoms were not apparent, from areas that the grower identified as having problems with crumbly fruit. Samples were kept refrigerated until shipment to Dr. Bob Martin at the USDA-ARS in Corvallis, Oregon for PCR (DNA-based) testing for viruses known to occur in raspberries (Blackberry chlorotic ringspot virus, Beet pseudo yellows virus, Black raspberry necrosis virus, Blackberry virus X, Sejo Blackberry virus X, Blackberry virus Y, Blackberry yellow vein-associated virus, Cherry Leaf roll virus, Impatiens necrotic spot virus, Raspberry bushy dwarf virus, Raspberry latent virus, Raspberry leaf blotch virus, Raspberry leaf mottle virus, Rubus yellow net virus, and Strawberry latent ringspot virus. Samples were also tested for Phytoplasmas (phloem-limited bacteria) and *Xylella fastidiosa* (xylem-limited bacteria). In 2015, pooled samples from 15 sites were also sent to Agdia, Inc. in Elkhart, IN for testing by ELISA for 9 different viruses in their "berry screen" (Apple mosaic virus, Arabis mosaic virus, Cherry leaf roll virus, Impatiens necrotic spot virus, Raspberry bushy dwarf virus, Strawberry latent ringspot virus, Tobacco ringspot virus, Tomato black ring virus, and Tomato ring spot virus). In 2016, pooled samples from 34 sites were sent to Agdia, Inc. and tested by ELISA for Tobacco ringspot virus, Tomato ringspot virus and Raspberry bushy dwarf virus.

References

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2. Martin, R. R., MacFarlane, S., Sabanadzovic, S, Quito, D., Pudel, B., and Tzanetakis, I. 2013. Viruses and virus diseases of *Rubus*. Plant Disease 97: 168-182.

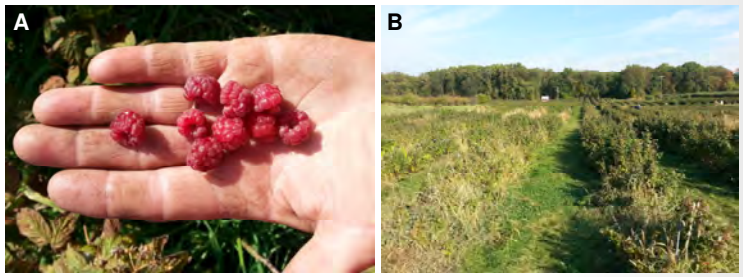

Figure 2. A) Crumbly fruit from field-grown raspberries becoming more common as fields get older may be caused by virus infection. B) Declining raspberry field in Michigan.

Results and Discussion

Tomato ringspot virus (ToRSV) was detected by ELISA in 8 and Raspberry bushy dwarf virus (RBDV) in 1 out of 15 plantings in 2015. In 2016, ToRSV was found in 10 and RBDV in 5 out of 34 fields. These two viruses are probably responsible for most decline ("weak plants") and crumbly berry symptoms observed in raspberry fields in Michigan. Tomato ringspot virus is transmitted by dagger nematodes and is native to Michigan soils. This virus also infects many other crops, including grapes, blueberries, stone fruit and pome fruit and common weeds such as dandelion, plantain and thistle. In contrast, raspberry bushy dwarf virus is pollen transmitted and may spread from infected fields nearby or from wild brambles in the vicinity. Other viruses detected in the PCR tests were Blackberry chlorotic ringspot virus (pollen-transmitted), Rubus yellow net virus and Raspberry leaf mottle virus (both aphid transmitted) (Fig. 3A). Of these groups, the nematode- and pollen-transmitted viruses were the most prevalent (Fig. 3B) and the aphid-transmitted viruses less common. The pollen- and aphid-transmitted viruses probably originated from wild plants or old, infected fields nearby. Aphids have been found in raspberry planting in Michigan and are probable vectors.

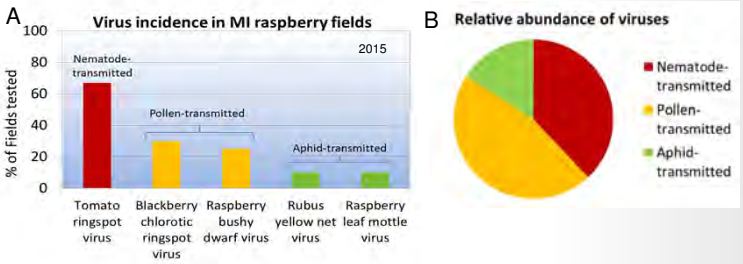

Figure 3. A) Incidence of plant viruses in Michigan raspberry fields in 2015 and their mode of transmission. B) Relative abundance of viruses by mode of transmission.

Conclusions

Tomato ringspot virus (nematode transmitted) and Raspberry bushy dwarf virus (pollen transmitted) appear to be causing the majority of raspberry decline and crumbly fruit symptoms in Michigan. Rubus yellow net virus, Blackberry chlorotic ringspot virus, and Raspberry leaf mottle virus were detected for the first time in Michigan and may be responsible for various other symptoms. Symptoms are more likely when multiple viruses are present in the same plant. Management is needed since certified virus-tested plants are likely to become re-infected within a year or two from the soil, nearby infected plantings or wild brambles, resulting in economic losses and a shortened lifespan of the field. Tomato ringspot virus is probably the most difficult to manage due to its soilborne nature. Options include chemical fumigation, fallowing, biofumigation with a cole crop or a grass cover crop with strict broadleaf weed control for 1-2 years. Pre-plant soil testing for nematodes and weeds for ToRSV is recommended.

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