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report on
PLANT
DISEASE

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VIRUS DISEASES OF BRAMBLES IN THE MIDWEST

Raspberries probably suffer greater infection and more serious damage from virus diseases than any other fruit crop in the United States. Fruit yields may be reduced 50 to 70 percent, or more. Once infected, a plant remains diseased for life. Since all parts of an infected plant carries the virus, suckers or tips propagated from it are also diseased. All raspberry viruses in the Midwest, except black raspberry streak, are spread by the feeding activities of aphids. The viruses are **not** spread by pruning or otherwise mechanically injuring plants in the field.

Virus-like disorders of raspberries and blackberries may be produced by cool weather and late spring frosts, powdery mildew, mineral-element deficiencies (such as iron), pesticide injury, genetic disorders (yellowing of leaves and crumbly berries), or feeding by leafhoppers, aphids, and red spider mites.

Figure 1. Leaf curl of red raspberry.

Positive identification of the virus or viruses responsible for the disease syndrome cannot be based entirely on foliage symptoms. Greenhouse and laboratory tests using specific indicator plants and serology are required. Positive identification is necessary to facilitate appropriate control measures and to help detect possible new virus diseases of brambles in Illinois.

RASPBERRY LEAF CURL

This important and easily recognized disease occurs on red, black, and purple raspberries and upright blackberries. The yield of infected red raspberries may be reduced 20 to 70 percent. Black raspberries may degenerate and die after two or three years.

Symptoms on Red and Yellow Raspberries. The symptoms of leaf curl vary according to the virus strain and the type of raspberry infected. During the initial year of infection, plants show no symptoms or perhaps only a mild down-curling of the leaf tips. The following spring, leaflets near the tips of the canes appear rounded, dwarfed, and crinkled with margins curled tightly downward and inward (Figure 1). Fruiting lateral are shortened and a proliferation of the shoots may produce a rosette. When diseased shoots first appear they are a pale yellowish green, soon turning dark green, becoming stiff and brittle, and

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usually do not branch. Each year the plant loses vigor, and new shoots are progressively more dwarfed until they are only a few inches tall. Infected plants produce little fruit and berries that do form are small, dry, seedy, and crumbly.

Symptoms on Black and Purple Raspberries. The symptoms are similar to those on red and yellow raspberries with tip leaves arched upward, stiff, dwarfed, and nearly round, becoming a dark, greasy green (Figure 2). Affected plants are dwarfed and bushy. The berries are small and dry. In following years, the young canes are severely dwarfed, rigid, brittle, lack side branches, and cannot bend to the ground to root at the tips.

Figure 2. Leaf curl on black raspberry. The tip leaves are round and a dark greasy green.

Symptoms on Erect Blackberries. Leaf curl is rare and unimportant on blackberries. Some cultivars show curl symptoms similar to those on red and yellow raspberries (Figure 1). Other cultivars may be infected symptomless carriers of the virus.

Disease cycle

Leaf curl viruses are commonly spread from plant to plant by the feeding of a small sluggish aphid (*Aphis rubicola*). Heavy populations of this aphid on young foliage can cause severe in-rolling of the leaves in the absence of the leaf curl virus(es). Winged forms of the aphid transmit the virus to healthy raspberries from nearby infected cultivated or wild brambles. Windborne aphids may spread the virus several miles. All commercial cultivars are susceptible.

COMMON RASPBERRY MOSAIC

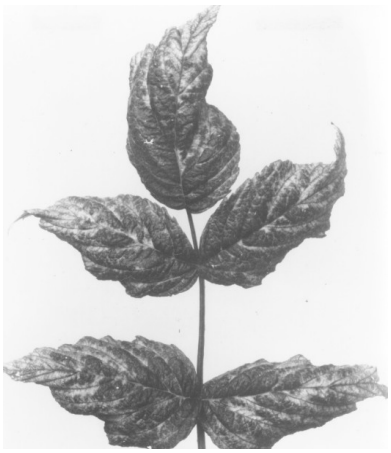

Figure 3. Mosaic symptoms on red raspberry in the late spring, green and yellowish-green mottling appear along with blisters on a leaf of a new cane (USDA photo).

The common raspberry mosaic complex is widespread and may cause the greatest reduction in growth, vigor, fruit yield, and quality of any of the bramble viruses. Fruit yield may be reduced 50 percent or more. No raspberries are immune, however, black and purple raspberries are damaged more severely than red varieties. The symptoms differ with the cultivar grown, the virus or viruses involved, geographical location, and seasonal growing conditions. Symptoms are **most** evident in the cooler weather of spring and fall, being masked (or disappearing) when temperatures are high in summer. Mosaic symptoms are sometimes confused with a late spring frost, powdery mildew, feeding by red spider mites and aphids, pesticide injury, or a soil deficiency of boron.

Symptoms on Red Raspberry. The canes are short, growth is weak, and leaves produced in cool weather are mottled and puckered with large, irregular, green blisters that arch upward. The leaf tissue around the blisters turns yellowish or yellowish green and severely blistered leaves curl downward (Figure 3). The leaves that develop in hot weather are symptomless, or show a faint mosaic pattern with yellow flecks. Leaves that form in late summer show a fine, yellowish, speckled mottling. Mosaic-affected plants are often progressively more stunted

each year. The leaves are dwarfed, yellow mottled, sometimes deformed and fruit yield from such plants is reduced; the berries are dry and seedy (often crumbly) and lack flavor.

Figure 4. Young black raspberry cane affected with heat-labile component of raspberry mosaic.

Symptoms on Black and Purple Raspberries. The tips of young, black and purple raspberry canes, newly infected with mosaic, often curl downward, turn black (necrotic), and die (Figure 4). The fruit tends to be small, dry, and seedy. Leaves produced in hot weather are often nearly symptomless. Those formed in cool weather are faintly to severely mottled and puckered. Chronically infected plants become severely dwarfed and rosetted, with brittle cane tips and usually die in two or three years.

Symptoms on Erect Blackberries. Infection on cultivated or wild blackberries is uncommon. They may be symptomless or show severe mottling, similar to that described for raspberries.

THE VIRUSES

The raspberry mosaic virus complex is composed of at least two viruses, each containing numerous strains. One group survives three months or longer in infected plants at 100°F (37°C), the other does not. The heat stable group is called the rubus yellow-net (RYN) virus because of the distinctive netlike yellowing that develops along the veins of leaves on infected plants. The heat-labile virus (which can be eliminated experimentally by growing plants at 100°F or 37°C for a week or more) is named the black raspberry necrosis (BRN) virus because it causes a dieback (necrosis of the terminal leaves and cane tips of black raspberry seedlings followed by a mottling of the lower leaves). Common raspberry mosaic is usually caused by a virus complex composed of the RYN and the BRN viruses.

Many of the BRN virus strains produce no external symptoms of mosaic or only an obscure leaf mottling, especially in red raspberries. Infected plants are weaker, produce fewer canes, and have a reduced yield. Since these plants appear to be healthy in all other respects, they are seldom removed from the planting. In addition, numerous virus strains that are symptomless in red raspberries produce striking symptoms (stunted mottled leaves on dwarfed shots) when transferred to black or purple raspberries. The viruses are not soilborne nor seed transmitted.

Disease Cycle

The large, European raspberry aphid (*Amophorophora idaei*), which is widely distributed on the tips of wild and older cultivated raspberries and some blackberries throughout much of the growing season, is the most common carrier (vector) of raspberry mosaic viruses. These aphids acquire ("pick up") the mosaic viruses after feeding on an infected plant. Winged aphids may transmit the mosaic viruses from the source plant to a healthy plant a quarter of a mile or more away. Aphids transmit the viruses by feeding on healthy plants for a few minutes. Where black and purple raspberries are grown near aphid-infested red raspberries or other brambles that have mosaic, the aphids will colonize the black and purple raspberries and quickly inoculate them with the mosaic virus(es).

Mosaic spreads naturally by commercial propagation from infected plants and by movement of diseased nursery plants. It may also spread along a field row through the establishment of suckers or rooting tips from an infected plant.

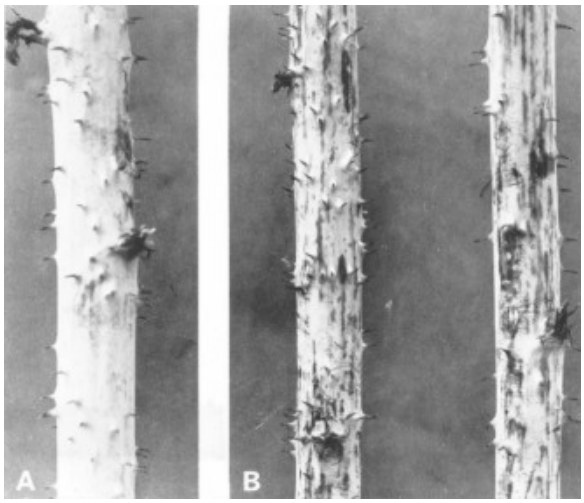

Figure 5. Black raspberry streak; A, normal cane; B, canes showing severe streak symptoms.

BLACK RASPBERRY STREAK

This is presently a minor disease that is limited mostly to the Lake Erie fruit gelt in northern Ohio, western Pennsylvania, and western New York. Black raspberries, and possibly blackberries, are the only known hosts.

Symptoms

Numerous (often faint), blue-to-purplish or gray dots and narrow, water-soaked lines or streaks (usually less than an inch long) develop on and under the surface on the lower parts of young canes in warm weather, and sometimes, on fruiting canes at fruiting time (Figure 5). Infected plants do not always show streaks, especially if they are not growing vigorously. Diseased plants, however, are usually vigorous and propagate well. The severity of the symptoms may vary from season to season among cultivars, even on the same plant. Infected plants do not always show streaks, and in fact symptoms may vary from season to season among cultivars.

Tip leaflets on infected new canes are often hooked or recurved, spirally twisted or rolled, and a darker green than normal (Figure 6). Sometimes the lower leaves on such canes show yellowing along the veins (vein-clearing) or mottling. Leaf symptoms are more consistent than cane streaks in field plantings.

Fruits on infected plants are about three-quarters of the normal size, dull, seedy, crumbly, and lacking in flavor. The individual drupelets often ripen unevenly, giving the fruit a blotched appearance.

Figure 6. Black raspberry cane-'hooking' and recurving of leaves caused by streak virus.

Disease Cycle

How black raspberry streak spreads in nature is not known. Insect vectors whose identity is unknown may play an important role. The virus is **not** soilborne, and is **not** transmitted by the common raspberry aphids and other insects that frequently colonize brambles. There is good evidence that the virus does spread in the field. Healthy plants within 10 feet of an infected plant are three times more likely to become infected than are more distant plants. The number of visibly infected plants in a fruit planting may double each year because of the difficulty of detecting black raspberry streak, it is easily carried along with rooted tips in nursery propagation.

RED RASPBERRY RINGSPOT

Laminated evidence suggests that red raspberry ringspot, caused by the tomato ringspot virus (TomRSV), is the most widespread and damaging virus disease of red raspberry in North America, yet it was not

identified until 1962. However, "running out" or "decline" of raspberry plantings, characterized by the gradual loss of productivity, has been known for many years.

Symptoms

The symptoms in red raspberries vary depending to a large extent on the cultivar, the duration of the infection, and the time of year when plants are examined. Infected plants, which normally occur in patches, usually show no symptoms during the season in which they acquire the virus. In the spring of the following year, some leaves on the primocanes develop yellow rings, line patterns, or vein yellowing. These "shock reaction" symptoms are rare in subsequent years. Chronic symptoms are delayed foliation in the spring, a tendency for leaves on the fruiting canes to develop various degrees of chlorosis, and for diseased plants to produce a higher proportion of misformed or crumbly fruit than do healthy plants. These symptoms are all variable, unreliable, and can be missed in disease surveys based on field observations. Field surveys are of little value unless visual observations are supplemented by (1) mechanical inoculations to herbaceous indicator hosts, or (2) highly specific serological tests such as ELISA.

It is not unusual when examining plants in fields with a history of poor productivity, to have apparently healthy plants index positive for TomRSV using the ELISA technique.

Disease Cycle

Tomato ringspot virus is spread from plant to plant in the soil by the feeding of one or more species of dagger (*Xiphinema*) nematodes on the roots of red raspberry plants. Field spread is restricted to plantings where these very common nematodes occur. The nematodes by themselves cause little damage to red raspberry plants unless the virus is also present.

RASPBERRY BUSHY DWARF

Raspberry bushy dwarf, caused by the raspberry bushy dwarf virus (RBDV), infects red and black raspberries and blackberries. Not all red raspberry cultivars are susceptible to this vigor- and yield-reducing virus. When a planting becomes uneconomical, the planting can be replaced with a resistant cultivar. Some cultivars in Europe previously considered to be immune have become susceptible to few strains of RBDV. There is no evidence that any of these severe strains occur in North American cultivars.

Symptoms

The severity of symptoms of raspberry bushy dwarf vary with the cultivar and the season. Some cultivars produce leaves with varying degrees of interveinal chlorosis; other leaves develop irregular line or "oak leaf" patterns. Plants that show symptoms one year do not necessarily develop symptoms in subsequent years. Variations in leaf symptoms are believed to be dependent on genetic resistance to symptom expression and on environmental factors.

Disease Cycle

Raspberry bushy dwarf virus is transmitted through pollen from which infection spreads to a high proportion of the seeds and to the pollinated plant. The virus is confined to species of brambles (*Rubus*) and natural spread only occurs through pollen or seeds.

Control of Virus Diseases

The cultural and chemical practices outlined below, if vigorously followed, will keep virus diseases in check. Remember: once infected, a plant remains diseased, it cannot be cured.

1. Select a planting site that is sunny and fertile and has good air and soil drainage. Where possible destroy all wild and neglected raspberries, blackberries, wineberries, and other brambles located within 600 to 1,000 feet. These plants are likely to harbor viruses, other bramble diseases or disorders, and insects.

2. If both black and red raspberries are to be grown, separate them by 150 feet or more to reduce virus cross infection. If possible, plant the blacks on the windward side which further decreases virus spread by windborne aphids.

3. Start new plantings with the best quality plants available. Avoid the illegal, neighborhood exchange of noninspected plants (many plants are protected by patents). The U.S. Department of Agriculture has developed virus indexed stocks of many desirable red, black, and purple raspberries, and blackberries that are true to cultivar and genetically equivalent to the best available stock. These are propagated under rigidly controlled conditions by growers in well designed programs certified by state authorities. Virus indexed plants sell at a premium, but are well worth the extra expense.

   Certification schemes that involve only visual examination with approval based on the absence of symptoms, are next to worthless. Several of the raspberry and blackberry viruses induce either no symptoms or symptoms that are so vague and variable as to be unreliable indicators. Sap inoculation, graft inoculation, serology (e.g., ELISA), elegron microscopy, or combinations of these techniques are required to detect infections. Extensive indexing of an individual plant and then subdividing this plant to establish a certification block of "mother" plants is preferable to establishing a certification block from several mother plants.

4. After growth has begun, go through the planting several times each season and remove all visibly infected plants. The best time to detect virus symptoms is during cool, cloudy weather in the mid to late spring, early summer, and again in the early to mid fall. A day or two **before** removal, thoroughly spray affected plants with malathion (25 percent wettable powdery), using 2 tablespoons per gallon of water, or scorch the diseased plants with a weed burner. These treatments will kill any virus carrying aphids and prevent their migration to healthy plants. All plants showing even faint symptoms of leaf curl, mosaic, black raspberry streak, or other diseases should be removed. Bush removal or roguing is most effective during the first year, since this decreases the source of the virus(es) for the following season and also saves the work of digging out a much larger plant with an extensive, virus-infected root system. Removing or marking black raspberry plants that leaf out later than normal in the spring is advisable, as they are very likely to have mosaic. In established plantings, where more than 5 to 10 percent of the plants are visibly virus-infected, roguing will probably not pay. Maintain the fruit planting until the yield of fruit becomes unprofitable, then destroy it.

5. Maintain strict aphid control at all times, especially in late spring and early summer when aphid populations are likely to be high. Various insecticides can be used. Follow the cultural and chemical recommendations outlined by entomologists at the University of Illinois as given in the "Illinois Commercial Small Fruit and Grape Spray Guide" (updated annually); (website:

http://www.ag.ohio-state.edu/~ohioline/b861/index.html), and "Compendium of Raspberry and Blackberry Diseases and Insects", published by the American Phytopathological Society, St. Paul, Minnesota. The pesticide manufacturer's directions concerning rates and time should be carefully followed. Because the harvest season and aphid buildup may coincide, pay careful attention to insecticide residues. Observe the recommended safe interval between application and harvest.

6. Fumigation of soil with methyl bromide, chloropicrin-methyl bromide mixtures, Vorlex, or D-D prior to planting to eradicate nematode (*Xiphinema* spp) vectors or red raspberry ringspot is necessary where these nematodes are present. The manufacturer's directions should be carefully followed when applying these highly toxic pesticides.

Genetic resistance to some bramble viruses and their aphid vectors is being incorporated in the development of new raspberry and blackberry cultivars with plant breeding a promising new method of controlling bramble viruses.