UNIVERSITY OF MINNESOTA EXTENSION

AGRICULTURE, FOOD AND NATURAL RESOURCES

Pest management for the home raspberry patch

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INTRODUCTION

For home gardeners, raspberries are one of the easiest fruits to grow. Raspberries grown in Minnesota have relatively few insect pests and diseases. Gardeners who use Integrated Pest Management (IPM) practices often have good yields every year without applying pesticides. IPM is a sustainable approach that allows gardeners to reduce pests to a tolerable level by using the best

balance of cultural, physical, biological, & chemical management strategies. IPM takes into account the level of damage a pest is capable of causing, as well as the possible risks to humans and the environment associated with each pest management strategy.

In order for IPM to be effective, home gardeners must be able to recognize common raspberry pests and the damage they cause. Gardeners can find additional help identifying common pest problems by using the online diagnostic tools What insect is this? and What's wrong with my plant? or by sending a sample to the UMN Plant Disease Diagnostic Clinic.

To properly diagnose pest problems on raspberry plants, it is important to understand the normal growth pattern of these plants. Raspberry plants consist of first year canes (primocanes) and second year canes (floricanes). In Minnesota, gardeners may grow summer-bearing raspberries or fall-bearing raspberries. Summer-bearing raspberries only produce fruit on floricanes, while fall-bearing raspberries produce fruit on primocanes as well as floricanes. Floricanes die after harvest in the middle of summer, while primocanes actively grow through August and have green bark until early September. When trying to identify what is killing leaves or canes, always check to see if the symptoms are on the primocanes or floricanes. Since floricanes die in the middle of summer, yellow and dying leaves on floricanes after June is considered normal, but yellow leaves on primocanes may indicate a problem.

Cultural controls can be very effective in protecting raspberries from most insect pests and diseases common in Minnesota. The first step is proper care of the plants. Information on the best way to care for raspberries is provided in the University of Minnesota Extension publication "Growing raspberries in the home garden." Cultural practices such as site selection, cane removal, variety selection and irrigation all contribute to developing a good, healthy raspberry stand. One key to effective IPM is to prevent diseases before they occur and to treat the pathogen or insect pest at susceptible life stages, before significant damage can occur. Many cultural control practices should be implemented before insect pests and disease become evident as they are largely preventative in nature.

In IPM, pesticide sprays are used only when cultural controls are not effective or as a supplement to cultural controls. If using pesticides, gardeners should choose an effective product that has the lowest impact on human health, non-target organisms like bees and the environment. Information on using pesticides safely for home gardeners can be found at the Pesticide Environmental Stewardship website or the National Pesticide Information Center website. Information on the correct way to apply specific pesticides can be found on the product label. If pesticides are necessary, always use them exactly as directed by the product label as mandated by federal law.

Preventing pests before and during the establishment year

Some of the worst pest problems in raspberries can be avoided or reduced with proper care before planting and during establishment. If possible, remove or kill any wild brambles, old raspberry plants, or weeds near the site of the new raspberries. Wild raspberries and weeds can act as a source of viral and fungal diseases that can harm your new plants as well as hosts for insect pests, thus providing a potential reservoir for pests in the area.

Obtain plants only from a reputable wholesale or a retail nursery, preferably one that sells certified virus-free planting stock. Raspberry plants can be bought as dormant crowns, or as potted plants from a retail nursery. Dormant crowns come as roots with a cane. Cut the cane back

to five inches. About half of the time, the cane will not sprout, but multiple canes will sprout from the roots.

Choose a site with well-drained soil or amend the soil to improve drainage. Avoid sites that could have alkaline or clay soils. A soil test will tell you if the soil is deficient in any major nutrients or if the pH is too high or low. To reduce fungal diseases, the raspberries should also be in a place where breezes can dry the foliage off after a heavy rain or dew.

Weeds

Weeds can stunt raspberry plants and make raspberries more vulnerable to diseases by decreasing air movement in the patch and by acting as a source of pests or pathogens. Perennial weeds should be controlled before planting, and annual weeds should be controlled during the first year. Once raspberries are well established, raspberry plants crowd out most annual weeds.

Kill perennial weeds in the site where the raspberries will be the summer before planting. The two worst perennial weeds in Minnesota raspberries are quackgrass and Canada thistle. When possible, choose a site without any Canada thistles. Canada thistle is most susceptible to herbicides just before it blooms in late June, but stays susceptible to herbicide until the middle of October. Quackgrass is most susceptible to herbicides in late fall. Both quackgrass and thistles are hard to kill by hoeing and pulling due to their extensive root systems. Both weeds will choke out young raspberry plants if the weeds are not removed prior to planting.

Annual weeds need to be controlled after planting. Avoid using herbicides during the planting year as most herbicides have the potential to harm the plants. The most effective way to control weed seedlings is with a combination of hand weeding and mulch. Shallow hoeing around the plants is necessary to kill weed seedlings. By the middle of summer, healthy plants will start sending out rootsuckers that can sprout and become new canes away from the mother plants. Since hoeing can damage new canes, many growers apply straw mulch in July. The straw mulch prevents most annual weeds from sprouting. New canes will usually be able to sprout through the straw mulch.

Forming the raspberry row

Always grow raspberries in a row. Left uncontrolled, raspberries will grow into a large, round, impenetrable patch. Confining raspberries to a row that is two feet wide or less will cut down on the most common fungal diseases, such as the fruit disease gray mold or the cane disease spur blight. Red raspberries spread underground through rootsuckers, with roots extending ten or more feet from the original mother plant in just one year. Black raspberries primarily spread through tip rooting, which occurs when the tip of a new cane touches the soil and starts forming roots. All raspberries have the potential to spread into ornamental perennial beds, tilled vegetable gardens and shrub gardens, including blueberry patches. Placing sod between the raspberries and the garden will keep raspberries in a row while keeping them out of other desirable plants.

PEST MANAGEMENT SCHEDULE

In order to be successful, an IPM program should follow a schedule of monitoring and cultural controls that begin before the plants are put into the ground and are repeated each year. Read

about the specific pest to determine how to monitor for the pest, and to decide what level of pest infestation can be tolerated.

Table 1: Pest management schedule when establishing a patch

Time	Action
Summer or fall before planting	Locate site where the raspberries will be planted. Kill old raspberries or wild raspberries near the proposed site. Take soil for pH and nutrient testing. Kill all perennial weeds, especially quack grass and thistle.
Winter	Order or buy plants from an established nursery that sells plants that have been certified virus-free.
Spring	Plant raspberries.
Summer	Control annual weeds with hoeing or mulching. Choose row width and plant grass between rows.

Table 2: Pest management schedule in established raspberry patches

Time	Action
Early spring	Mow canes for fall bearing raspberries. Mow summer-bearing raspberries producing in alternate years. Do not mow summer-bearing canes if a crop is desired that summer. If spur blight, cane blight, or anthracnose have been a serious problem in the previous year, apply copper to dormant canes.
May	Scout dormant or recently sprouted canes for cane borers. Prune and remove any infested canes. Prune dead canes on summer-bearing plants after leaves have sprouted. Cut the tops of canes that died from either winter injury or cane borer. Cut below the gall on canes with cane borer.
Mid May to early June	If spur blight, cane blight or anthracnose have been a serious problem in the previous year and weather conditions are consistently wet, apply fungicides to protect young primocanes. Place traps for spotted wing Drosophila and check the traps regularly throughout the growing season.
Mid June to August	Check leaves regularly for Japanese beetle. Remove Japanese beetles as they land on raspberry leaves when it is practical. Check leaves for raspberry sawfly. Remove green larvae when they appear.
Late June through September	If spotted wing Drosophila is present, harvest ripe berries, properly dispose of infested fruit and apply insecticides.
Late July	Remove dying floricanes to improve air movement through the bed and reduce the spread of fungal cane blights. If gray mold has been a problem in past years, and weather is favorable for disease development, spray fungicides on fall-bearing raspberries during bloom. Remove berries with gray mold to prevent the disease from spreading to ripening berries.
August	Monitor for fruit-eating beetles in fall-bearing raspberries by walking rows. Properly dispose of any overripe or rotting berries.
September	Scout for spur blight on mature primocanes. Remove any canes showing symptoms of disease.

DISEASES

Cane diseases: Spur blight, cane blight and anthracnose

There are three cane diseases in Minnesota that can reduce or destroy a crop in summer-bearing raspberries. For red raspberries, the most common cane diseases are **cane blight** (*Leptosphaeria coniothyrium*) and **spur blight** (*Didyimella applanata*). For black raspberries, the most common cane disease is **anthracnose** (*Elsinoe venata*). Anthracnose also can infect red raspberries but is less common.

Crop losses due to cane diseases

In fall-bearing raspberries, spur blight is primarily a leaf disease. Older leaves near the ground are the first to be infected and die. When only the older leaves in the bottom third of the cane are killed, crop losses are minor. During severe outbreaks spur blight will kill younger leaves towards the top of the cane, resulting in reduced vigor, shorter canes and reduced yields.

In summer-bearing red raspberries, spur blight is a cane disease that can weaken or kill canes that have overwintered. In raspberry patches that have not been properly pruned, spur blight and cane blight can kill over 90% of the canes to the ground following summers with high disease pressure.

Severe anthracnose weakens small black or red raspberry canes, by killing parts of the bark and causing large cracks in the bark. Anthracnose makes the canes more susceptible to winter injury, and canes with anthracnose often die to snow level. In heavy snow years, there may be little winter injury in infected canes, while in low snow years infected canes may die to a few inches above the ground.

Spur blight on the leaves of 'Autumn Britten' red raspberry. The edges of the leaves in the middle of the cane are dead, and the leaf stems on the lower leaves are still attached after the leaf blade fell off. Thaddeus McCamant, Central Lakes College.

Identification

The best time to identify all three cane diseases is to look at primocanes in late summer and early fall. Primocanes are first year canes that sprout in the spring. In summer, the primocanes have green bark, which is susceptible to infection by the fungi that cause cane diseases. The distinctive symptoms of each disease can be seen in early fall before the bark turns brown. In the spring, the overwintering canes are often dead from the disease, and diseased canes are often mistaken for winter injury. Disease symptoms are not easy to distinguish in brown bark and dead canes. Each disease has specific symptoms, and each infects a different part of the cane.

Spur blight infection at the node of 'Nova' raspberry cane. The infection started in the leaf and spread into the cane. Thaddeus McCamant, Central Lakes College.

- Spur blight infects the leaves and the node (the part of the cane where the leaves emerge).
- Cane blight infections start at wounds in the canes.
- Anthracnose infections occur in the internodes (parts of the cane between the leaves).

Spur blight

Spur blight is both a leaf disease and a cane disease. Infections start out in the leaves, causing the edges of the leaves to turn yellow and die. Lower leaves are most likely to be infected, and the damage can be mistaken for normal leaf senescence. When leaves are killed by spur blight, the petioles (leaf stem) remains on the cane even after the leaf falls off, whereas when leaves senesce, the entire leaf falls off. The spur blight fungus moves from infected leaves into the cane.

In the canes, spur blight starts out as an indistinct chocolate brown or purple spot just below the point where a leaf was attached to the primocane. The lesions start out about 1/2 inch in diameter, but quickly grow, sometimes encircling the entire cane. These lesions are easily seen in primocanes, but may not be noticeable the following year when the canes develop brown bark.

Peeling bark on 'Killarney' floricanes that had spur blight the previous summer. Thaddeus McCamant, Central Lakes College.

In overwintered canes, buds next to the infected nodes usually do not sprout in the spring, causing the plants to be "leggy", with large areas of the lower cane producing no leaves or flowers. In the spring, the bark peels away from the cane in floricanes. When looking at the peeled bark with a magnifying glass, little black dots are visible. The little black dots are the spore producing structures of the spur blight fungus that will infect primocanes the next summer.

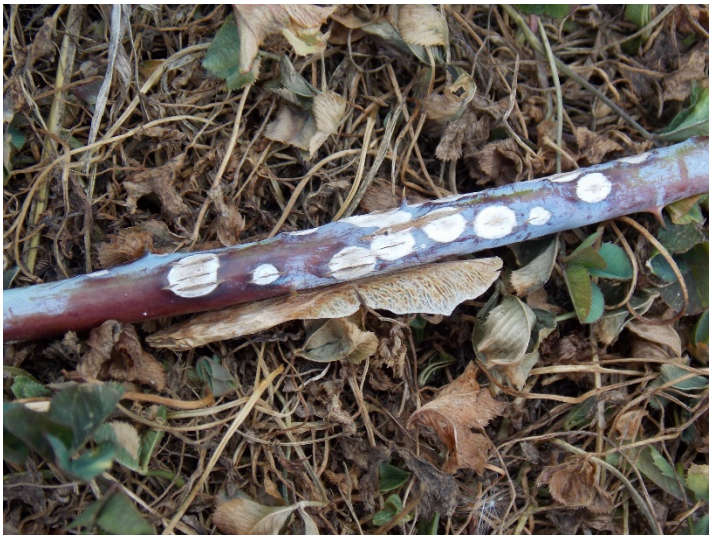
In the spring, spur blight is often confused with winter injury. When winter injury is the only cause of cane death, the canes die to snow level, and the floricanes will sprout in living buds below the snow level (see abiotic diseases). In raspberry patches infected with spur blight, the floricanes die to the ground. With spur blight, small canes that sprouted later in the summer are more likely to die than large canes, and canes inside the row are more likely to die than canes on the edge of the row. With winter injury, dieback is fairly even across a row.

Cane blight

Cane blight infections start in wound sites of the primocanes. A wound site can be where the primocanes were tipped, or where canes rubbed against each other or against a trellis wire. The infection spreads through the cane from the wound and causes cankers to form. Cankers caused by the cane blight fungus start out as reddish- brown streaks under the bark. The cankers can span several inches up and down the cane and may girdle the cane. Leaves arising from the infected section of the stem may wilt and die. If the infection girdles the stem, the entire cane may wilt and die.

Anthracnose

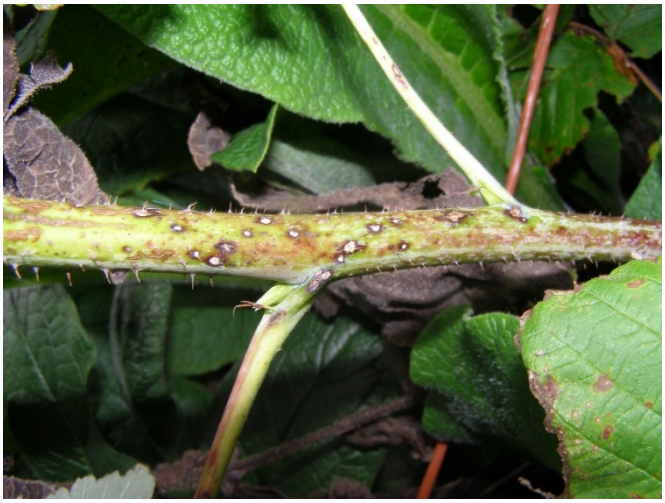
Anthracnose can be identified by little round, sunken pits in the bark of the cane. Quite often the margins of the lesions are slightly raised above the surrounding bark. The spots are white to pale tan, while the margins sometimes are a purplish red. Anthracnose spots tend to be less than 1/4 inch in diameter, which is smaller than spur blight or cane blight. Unlike spur blight, the anthracnose lesions are scattered throughout the cane between the nodes . Anthracnose is very common on black raspberries but it can also occur on susceptible red raspberry varieties. When disease pressure is high, the leaves will also have small round purple spots with a light colored center. In the winter, raspberry canes with anthracnose often die to snow level.



Jewel black raspberry internode with anthracnose lesions.
Thaddeus McCamant, Central Lakes College.

Important biology

All three cane diseases spread from the floricanes to the primocanes in early summer. None of the cane diseases infect the roots, and the new primocanes must be infected each summer for the disease to continue. The fungi that cause anthracnose and cane blight can only be spread by splashing water, while the fungus that causes spur blight can spread by the wind as well as splashing water. Fungal spores of all three diseases are produced on infected floricanes and spread when irrigation water or rain splashes spores to new primocanes. Once the primocanes are infected, splashing water can move spores throughout the plant.



Anthracnose on a red raspberry primocane. Michelle Grabowski, UMN Extension.

Anthracnose can be introduced to a raspberry patch on newly purchased raspberry plants that are infected with the disease or from nearby, wild plants. In black raspberries, the disease spreads readily from infected floricanes to new primocanes that sprout next to the mother plants. Because anthracnose is primarily spread by water, new plants that sprout by tip rooting away from the mother plant can escape infection.

Since spur blight spores travel through the air, the disease is found in nearly every raspberry patch in Minnesota. Fungal spores land on the leaves and germinate and infect leaves during warm, wet spells. Young leaves are fairly resistant to the fungus, and most infections start in leaves on the lower third of the cane. The infection spreads from the leaf to the stem and from the stem to the cane. The infection then spreads both up and down the cane. Spur blight epidemics are most common in years with frequent rain during the month of June.

Management

All three cane diseases thrive in moist conditions. Improving air flow through the patch will allow plants to dry quickly after rain or dew. Use drip irrigation when possible. If sprinkler irrigation is the only option, apply water early on a sunny day so that leaves dry quickly in the sun. Keeping the rows narrow will help the plants dry quickly. A recommended row width is 18 inches at the soil. Mow canes that have spread into the walking aisle to maintain a narrow planting row. Remove all weeds from the raspberry patch to improve air circulation around the canes.

Always remove floricanes after they have produced a crop. Typically, old floricanes start dying towards the end of harvest, but some will remain green until early fall. For disease control, the best time to remove dead canes is during the weeks following harvest in late July or early August, even if some of the leaves are still green. At this time, any primocanes showing clear disease symptoms should also be removed from the patch. Cutting dead and infected canes removes the fungal pathogen from the patch and increases air flow through the raspberry patch so that the canes can dry quickly after a rainfall. Be sure not to discard diseased canes in the immediate vicinity of the raspberry patch as they will be a source of spores for new infections.

Anthracnose in leaves of a red raspberry plant. Michelle Grabowski, UMN Extension.

A more drastic way to control spur blight and cane blight is to mow the whole raspberry patch down in late winter or early spring and remove or burn the canes. Mowing will reduce cane diseases and protect the crop for the following summer. All cane diseases move from the overwintered floricanes to the newly-sprouted primocanes. Cutting and removing all floricanes will sharply reduce new infections. Mowing is often used for fall-bearing raspberries to reduce labor. Fall-bearing raspberries will produce fruit on primocanes and therefore will still produce a crop after the patch is mowed. Mowing can be done for summer-bearing raspberries if spur blight or cane blight has been a significant problem. If all the canes are removed from a patch of summer-bearing raspberries, however, the patch will not produce fruit that summer. In some years, spur blight kills nearly all of the canes in certain raspberry patches, resulting in little or no crop the following summer. Inspect the patch after the leaves sprout in the spring. If most of the canes died to the ground during the winter, removing all the canes will help protect the plants in future years.

Fungicides are rarely necessary, but they can be used to reduce cane diseases in severely infected patches. The best time to spray for cane diseases is in early summer, before a wet spell allows the primocanes to become infected. Fungicides with the active ingredients copper sulfate, copper sulfur or myclobutanil provide some protection from cane diseases in raspberries. Actinovate and Oxidate also provide some control and are approved for organic production. All fungicides should be aimed at the primocanes. Fungicides alone provide only partial disease control and are more effective at controlling cane diseases if the canes have been mowed in late winter.

Raspberry leaf spot

Raspberry leaf spot (*Sphaerulina rubi*) is a common disease in certain raspberry cultivars across Minnesota. Leaf spot can be a devastating disease in susceptible summer-bearing raspberry cultivars. During humid summers, up to 75% of the leaves can be lost from the primocanes (first year canes). When leaves fall off due to leaf spot, the primocanes stop growing and become more susceptible to winter injury. In some cases, primocanes with leaf spot are half the size of uninfected primocanes. Small canes produce less fruit, and severe leaf spot can reduce yield by over half.

Leaf spot tends to be rare in the first two years after planting. In susceptible varieties, the disease gradually becomes worse each year unless the disease is controlled by cultural controls or fungicides.

Leaf spot on 'Killarney' summer red raspberries at the end of August.
Thaddeus McCamant, Central Lakes College.

Identification

Raspberry leaf spot starts as small spots on the upper surface of young leaves. As the lesions grow, the infected tissue may fall out, leaving holes in the leaves. Badly infected leaves curl downward at the edges and drop prematurely.

Important biology

The fungus that causes leaf spot overwinters in infected leaf debris and in cane lesions. Only young, expanding leaves are susceptible to infection. Spores are spread by splashing water, and leaf spot is common in years with frequent rain. The disease continues to spread all summer, as long as susceptible leaves are present. Leaf spot causes the most damage following summers with heavy rains in June and July.

Management

When assessing leaf spot, first determine if the diseased leaves are on primocanes or floricanes. Leaf spot is a more serious disease if it occurs on primocanes, because the leaves on floricanes naturally die towards the end of harvest.

The summer-bearing red varieties Latham and Nova are resistant to raspberry leaf spot. The summer-bearing red varieties Boyne and Killarney are susceptible and can be largely defoliated by leaf spot on years with high disease pressure. Royalty, a purple variety (a cross between red and black raspberry species), is highly susceptible. Royalty cannot be successfully grown in patches where leaf spot disease is present because the canes become weaker each year as the leaf spot becomes worse.

Leaf spot can be minimized by cultural practices that help the leaves dry out after rainfalls. Maintaining narrow raspberry rows at 18 inches wide or less will help the leaves dry faster. Thinning primocanes during the first summer will also reduce infections by helping leaves dry quickly. As with the cane diseases, removing floricanes after harvest is critical in reducing damage from raspberry leaf spot.

Fungicides are typically not necessary if good cultural practices are utilized. In patches with a history of severe leave spot, fungicides can slow the spread of the disease. Sprays should be directed towards the recently sprouted canes. Sprays need to be applied according to label instructions and repeated throughout the season as long as new leaves and shoots are developing. Fungicides with the active ingredient copper, captan or myclobutanil can help prevent leaf spot.

Gray mold

Gray mold (*Botrytis cinerea*) causes raspberry fruit to rot and become moldy while still on the canes. The gray mold fungus can also infect blossoms, stems and senescent leaves of raspberry plants. Gray mold is most common in fall-bearing raspberries, in dense patches of raspberries, and in patches with little air movement due to surrounding trees and buildings. In ripe fruit, gray mold may not appear until after picking, resulting in reduced shelf life. The disease can rapidly spread among fruit in a container.

Identification

Mature red fruit are most commonly infected with gray mold, although blossom blight occasionally occurs in cool, wet weather. Velvety gray spores completely cover infected areas of the fruit. The top of the fruit is often infected first, near where the fruit attaches to the stem, but this very quickly spreads to the entire fruit. Infected fruit remain attached to the plant and dry up into a shriveled black mummy. The shriveled fruit may produce new spores in wet weather.

Lower leaves on densely planted canes are commonly infected. Mature leaves turn dark brown in color and fall off. Young leaves are unaffected. On green primocanes, gray mold causes pale brown lesions that often have darker growth rings layered within the infection. Lesions on canes often start as ovals but grow to encircle the cane and spread both upward and downward. As the cane matures and turns brown these lesions disappear. Over winter, the epidermis turns white in the infected area and eventually falls off in spring, revealing hard round to oval shiny black fungal sclerotia pressed against the stem. Lateral branches that develop from buds within gray mold infected canes grow poorly or do not develop at all.

Important biology

Gray mold overwinters on infected canes, decaying leaves and other plant matter. During humid, cool (59-72˚F) weather, fungal spores are produced and blown by wind to susceptible blossoms or leaves. Plants that remain for more than one day will have many infections. The majority of fruit infections start as flower infections. The fungal spores germinate and grow through the stigma into the developing fruit. The damage usually does not show up until the fruit ripens several weeks later. At first, the infected fruit is soft, with a water-soaked appearance. After a few days, infected parts of the fruit become covered in velvety gray fungal spores that can spread from the infected fruit to other ripe fruit.

Only mature to senescent leaves can be infected with the gray mold fungus. The fungus moves from the leaves into the canes and spreads both up and down the cane. Buds within the infected area may be killed or may grow poorly the following year. Sclerotia, hard black fungal resting structures, are produced on infected canes and allow the fungus to survive from one season to the next.

Raspberries with gray mold. Michelle Grabowski, UMN Extension.

Management

The most effective way to reduce gray mold in raspberries is to reduce free water on leaves and blossoms. Choose a location with full sun and good air movement. Raspberries should be planted in narrow rows that dry quickly after dew, irrigation or rain. Use drip irrigation or soaker hose to keep leaves and blossoms dry. If sprinkler irrigation is the only option, water in the morning on a sunny day so plants dry quickly. Always remove dead floricanes to increase air movement within the row and thin new primocanes to maintain a narrow bed size.

Remove potential overwintering sites of the fungal pathogen by removing dead floricanes and pruning out any canes showing symptoms of gray mold on the cane. Infected canes should be composted well away from the raspberry patch in a compost pile that heats up. Alternatively, infected canes can be burned, buried, or brought to municipal composting facilities depending on local waste management regulations.

Gray mold pressure can be reduced by regularly harvesting the fruit and not allowing overripe and rotten berries to accumulate in the patch. Pick raspberries early in the day when fruit is still ripe. Take care not to bruise or damage fruit during harvest. Cool raspberries quickly after picking. Remove infected fruit from the patch to reduce spread of the fungal pathogen to developing blossoms and fruit.

If the patch has a history of gray mold, and there is a long wet spell during bloom, then fungicides are advisable. The best time to apply fungicides to prevent gray mold is during bloom, when the first infections can start. Fungicides can also be sprayed during picking, but they are less effective at this time. Several formulations of captan are labeled for gray mold in raspberries. Captan will prevent gray mold from infecting fruit but will not cure gray mold that has already started.

Virus diseases

There are 15 known viruses that infect raspberry plants in North America. Tomato Ring Spot Virus (TomRSV) is common in Minnesota and Raspberry Leaf Curl Virus (RLCV) occurs rarely. Once a plant is infected with a virus, it will never recover. Virus infected raspberry plants suffer from reduce growth, low fruit production and poor fruit quality.

Identification

Raspberries infected with viral pathogens exhibit a wide range of symptoms, depending on the variety of raspberry, the virus, weather conditions and the stage of infection. Virus infection can result in yellow rings, lines or blotches on leaves (Figure 1), leaf distortion, crumbly underdeveloped fruit or severely stunted plants. In other cases, raspberry plants with viruses may show few or no symptoms. The only way to determine exactly which virus is causing the symptoms is to send a sample to the UMN Plant Diagnostic Clinic, where laboratory tests will be conducted to identify the virus.

Virus disease on raspberry leaves. Michelle Grabowski, UMN Extension.

Raspberries infected with **tomato ring spot virus** produce small, crumbly raspberries. Leaves in infected plants show fine yellow lines and yellow rings. Leaves may or may not show the symptoms, depending on the age of the plant and the variety.

Plants with **raspberry leaf curl virus** have slightly yellow, small leaves which curl downward and inward. The disease becomes worse each year, and by year 4, the plants are stunted and produce no fruit. The symptoms can be confused with injury by the herbicide glyphosate. Raspberry leaf curl is often found on only one plant in a row, while glyphosate injury will usually affect several plants with different degrees of severity.

Important biology

Tomato ring spot virus infects a wide range of woody and herbaceous plants, including many common landscape ornamentals and weeds. Red raspberries can be severely affected by the disease, whereas black raspberries are unaffected. Tomato Ring Spot Virus is spread by the dagger

nematode, a microscopic roundworm which lives in the soil and feeds on plant roots. Dagger nematode is common in many areas of Minnesota.

Raspberry leaf curl virus infects red and black raspberries and less commonly, black berries. It is spread from plant to plant by aphids. In Minnesota, Raspberry Leaf Curl Virus spreads very slowly and it is not uncommon to see only one to a few plants infected in a patch.

Once a raspberry plant is infected by either virus, the virus spreads throughout the whole plant from the roots to the canes. Viruses also spread from mother plants to daughter plants, and new canes that sprout from an infected mother plant always have the same viruses.

Management

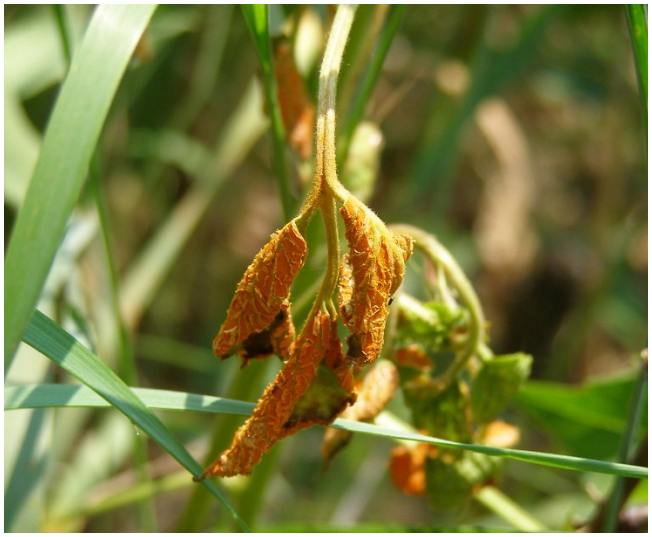
Before establishing a new raspberry patch, remove or kill any wild brambles, old raspberry plants, or weeds at the site.

Obtain new raspberry plants only from a reputable wholesale or a retail nursery, preferably one that sells certified virus-free planting stock. Never transplant daughter plants from an existing patch with virus infected plants. These new plants will already be infected even if they are not yet showing symptoms of the disease.

Plants infected with a virus should either be dug up or killed with an herbicide. Infected plants will never recover and will only continue to decline and produce poor fruit. If plants were infected with **raspberry leaf curl virus** new plants can be replanted at the same site. Unfortunately, the site should not be replanted to red raspberries if **tomato ring spot virus** was causing disease. The nematodes that carry tomato ring spot virus remain in the soil and it is likely that replacement plants put in the same site will also become infected. If tomato ring spot virus occurs, it is best to plant new plants in a new location or replant with black raspberries.

Orange rust

Orange rust is a serious disease of black raspberries and blackberries that is caused by two closely related fungi. ***Arthuriomyces peckianus*** is the rust fungus that infects black raspberries while ***Gymnoconia nitens*** infects blackberries and dewberries. Orange rust does not infect red raspberries. Although uncommon in Minnesota, orange rust can be devastating when it does occur. Black raspberry plants with orange rust are unproductive. The plants survive, and produce new canes each year, but they no longer produce flowers or fruit.



Orange rust on a young black raspberry cane. Michelle Grabowski, UMN Extension.

Identification

Orange rust is unmistakable in the spring on young black raspberry shoots. When black raspberry canes sprout in the spring, infected shoots are weak and spindly, with small pale green or yellowish leaves. After 2 or 3 weeks, the fungus makes distinct cushion-like spore producing structures on the lower surface of the leaf. Initially, the spore producing structures are pale orange and waxy, but they rupture to produce visible reddish orange spores. After the fungal spores are released, the infected leaves fall off, and the primocane will often grow normally.

Important biology

Orange rust is one of the few fungal diseases that spreads systemically through the plant. The fungus grows throughout the plant, from the roots to the canes. Once a plant is infected, all the canes produced by that plant will have the disease for the life of the planting. The fungus survives the winter within the infected crown. The disease spreads by spores produced from weak primocanes in early spring or by spores produced in late summer. The spores infect new leaves, shoots or buds, and the disease spreads towards the roots.

Management

The best time to scout for orange rust is in early spring, when the new primocanes are less than a foot high. Also scout nearby wild black raspberries for the distinctive orange young canes each spring, and kill any wild plants with the disease. Always remove or kill infected plants in early spring before the new canes release powdery orange spores which will spread the disease.

Late leaf rust

Late leaf rust is caused by the fungus ***Pucciniastrum americanum***, and only infects red and purple raspberries. Late leaf rust infects both leaves and fruit. In rare cases, late leaf rust can cause premature defoliation of both summer-bearing and fall-bearing raspberries, reducing the yield and quality of the fruit while making the canes more susceptible to winter injury. Defoliation from late leaf rust is rare in Minnesota. In fall-bearing raspberries, late leaf rust directly infects the fruit, making the fruit unappealing.

Identification

Late leaf rust is most commonly seen on the fruit of fall-bearing raspberries. Typically, one to three drupelets will be covered with bright orange powdery spores in September. The disease can also cause spots of bright orange powdery spores to form on the underside of the mature leaves.

Late leaf rust on fall-bearing raspberry fruit. Michelle Grabowski, UMN Extension.

Important biology

Like many rust diseases, the late leaf rust fungus has two hosts: the white spruce and raspberries. In areas with white spruces, spores are blown from infected spruce to nearby raspberry plants. Infection usually starts on mature lower leaves, where higher humidity aids in spore germination. Infected raspberry leaves and fruit produce abundant powdery orange spores that start new infections throughout the growing season. In areas without spruce trees, late leaf rust appears to be able to survive from one season to the next on infected canes.

Management

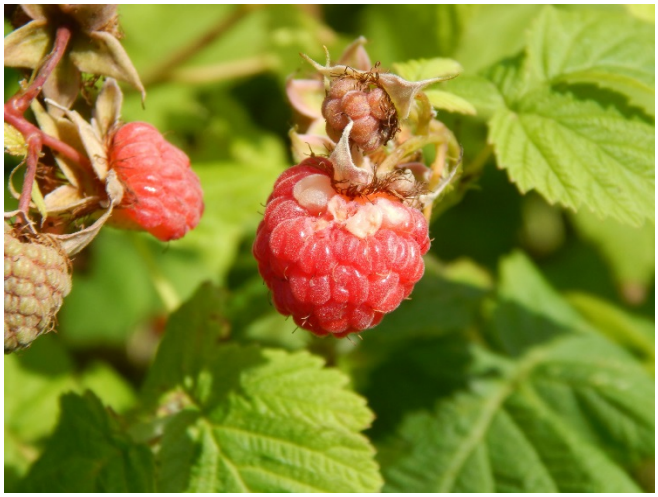
Crop losses from late leaf rust are rare in Minnesota, and control measures are rarely needed. The summer-bearing red raspberry Nova has shown to be resistant to late leaf rust, while the fall-bearing red raspberry Heritage is susceptible. New cultivars of fall-bearing raspberries are continually being released, but their susceptibility has not yet been determined.

Cultural practices that reduce humidity within the raspberry patch will help to reduce late leaf rust. Maintain narrow rows, use drip irrigation or water early on sunny days. Remove all old floricanes as well as any primocanes showing symptoms of disease. Removal of infected canes will improve air movement through the patch and will also remove an overwintering site of the fungal pathogens.

ABIOTIC PROBLEMS

Sunscald

Raspberry fruit often develop small white to tan spots in response to hot weather and exposure to direct sunlight. Typically one or two drupelets are white, while the others are healthy. Sunscald is most common when a long cloudy spell is followed by a hot spell while the berries are starting to turn red. Sunscald usually only affects those berries that ripen shortly after the weather warms, and berries that ripen a day or two later will be normal. Affected fruit can still be eaten.



Raspberries with sunscald. Thaddeus McCamant, Central Lakes College.

Herbicide injury

Herbicide injury is most serious with systemic, post-emergence herbicides. Systemic herbicides are taken up into the raspberry plant, and the plant redistributes the herbicide to the roots and new leaves, and the new leaves show symptoms. Common systemic herbicides that hurt raspberries include glyphosate (Roundup), 2,4-D, and clopyralid (used in many broadleaf herbicides for lawns). Pre-emergence herbicides that are used to prevent crabgrass and other weeds from sprouting rarely injure established raspberry plants. Pre-emergence herbicides are most likely to stunt raspberry plants if the soil was sprayed prior to planting or within two

months after planting. Contact herbicides (Sythe, vinegar) can temporarily injure raspberries, but new growth will be healthy.

Herbicide injury usually shows up on the leaves of primocanes, the canes that sprout in the spring. Plants with glyphosate injury have narrow leaves that are often white or yellow. Leaves with 2,4-D injury are distorted and cupped with large veins. Plants with clopyralid injury have small, cupped leaves.

Glyphosate injury on red raspberry canes. The old canes were sprayed the previous fall. Thaddeus McCamant, Central Lakes College.

Herbicide injury can be caused by spray drift, from raspberries being directly sprayed or from herbicide sprayed on the soil. Glyphosate is rarely absorbed through the soil, and glyphosate injury usually is caused by drift or by the canes being directly sprayed. Raspberry canes can absorb glyphosate through their bark, and canes can absorb glyphosate even during dormancy. 2,4-D and clopyralid can be absorbed by the roots if the herbicide is sprayed on bare soil, but most injury is caused by spray drift when nearby lawns are sprayed. While herbicide injury can occur at anytime of the year, some of the most severe cases occur from fall herbicide applications. In fall, raspberries easily take up and store systemic herbicides in their roots and bark. Plants that were exposed to herbicides in the fall often show few symptoms in the weeks after being sprayed, but the injury will show up the following spring.

If the herbicide injury is minor, the plants will outgrow the injury. Plants sprayed in the spring and summer are more likely to grow out of herbicide injury than plants sprayed in late fall. If the injury is severe, either due to high rates of herbicide or fall applications, the plants will either die or become permanently stunted.

Iron chlorosis

Raspberries grown in heavy soils or soils with a high pH will often have yellow or white leaves with green veins. The lack of chlorophyll is called chlorosis. When the chlorosis is caused by an iron deficiency, the disorder is called iron chlorosis. With iron chlorosis, the lightest colored leaves are always the youngest leaves, which in raspberries are at the tips of the primocanes (first year canes).

Iron chlorosis is caused by a deficiency of the nutrient iron. Without iron, the plant cannot manufacture chlorophyll, and without chlorophyll, the leaves cannot turn green. Iron chlorosis usually grows worse as the plant grows taller. The oldest leaves usually stay green, while the youngest leaves become lighter in color towards the tips of the canes. Unlike glyphosate injury or virus diseases, iron chlorosis rarely deforms the leaves. When the deficiency first shows up, the

chlorotic leaves still have the same size and shape as green leaves lower down the cane. With severe iron chlorosis, the leaves will be smaller than healthy leaves, but will still retain a normal shape.

Iron chlorosis often occurs in small sections of a raspberry patch. Iron deficiencies are most common in soils with a pH higher than 7.4, and are more likely to occur in clay soils than in sandy soils. Flooding can also cause temporary iron deficiencies. Soils surrounded by concrete can also have a high enough pH for iron chlorosis to occur. In Minnesota, iron chlorosis is most common in the western part of the state, where heavy soils with a high pH are common.

The fastest way to alleviate iron chlorosis is to spray the plants with **chelated iron**. Chelated iron is iron that has been combined with a type of sugar. The sugar helps the plant absorb iron. With most cases of iron chlorosis, chelated iron only needs to be sprayed once in May or June when the canes first show symptoms. Iron sprays can be found at many garden centers.

If chelated iron sprays do not cure the chlorosis, or if the patch requires multiple sprays, then the patch should either be moved, or the soil amended. Before planting, take a soil test to determine if the pH needs to be amended prior to planting. The best way to amend the soil is to mix acidic peat into the planting hole. The acidic peat both lowers the pH and improves drainage, which will alleviate iron deficiencies.

Winter injury

Very few raspberry varieties are completely hardy in Minnesota; even hardy varieties can exhibit symptoms of winter injury following severe winters. Winter injury can also occur after winters when the temperature fluctuates between mild and extremely cold.

Winter injury is often confused with cane blight, but it can be distinguished from biotic diseases due to its characteristic symptoms. The tips of the canes are most susceptible to winter cold. Mild winter injury will result in the death of the top few inches of a cane. With severe winter injury, the top few feet of the canes will die. In almost all cases of winter injury, there will be healthy leaves at the bottom of the cane. If the winter injury occurred with a few inches of snow, then the canes die to snow level and will produce healthy leaves and fruit from the lower canes.

Winter injury on ‘Nova’ raspberries. Thaddeus McCamant, Central Lakes College.

Raspberries that produce flowers and fruit on first year canes (primocanes) will always show some dieback in the spring. Dieback in fall-bearing raspberries is normal and is not considered winter injury. Flowering in primocanes always starts at the tips of the canes and later flowers sprout lower in the cane. Any part of the cane that produces flowers will die in the winter. The summer-

bearing variety Nova produces flowers on the top six inches of the primocane each fall, so dieback is minor. Fall varieties like Autumn Britten, Heritage and Caroline often produce flowers and fruit on the top 3/4 of each cane, and only 1/4 of the cane will survive each winter.

Always choose varieties that are suitable for your zone in Minnesota. Nova, Killarney and Boyne red raspberries are all rated for zone 3. Royalty purple is rated for zone 4, but will often survive colder winters, if the canes are healthy. The canes of some fall-bearing raspberries, such as Autumn Bliss, are killed even during mild Minnesota winters. Those varieties can successfully be grown here, because the new canes sprout and bear fruit each year, and the dead canes are removed each spring.

Winter injury can also be aggravated by biotic diseases. Leaf spot, spur blight, cane blight and anthracnose can make raspberries more susceptible to winter injury. Healthy plants will survive the Minnesota winters better.

INSECTS

Fruit eating insects

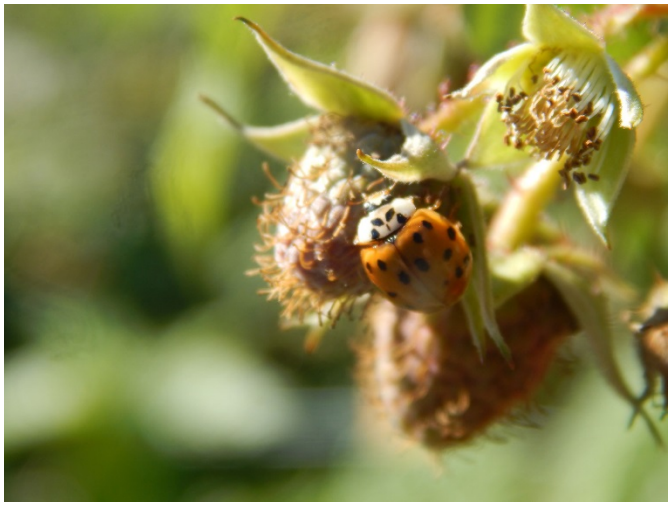
Three different beetle species and yellowjackets feed on raspberry fruit during mid-to late summer. **Sap beetles** (*Glischrochilus quadrisignatus* and other species), which are also called picnic beetles, are found statewide and will eat both summer-bearing and fall-bearing raspberries. **Multi-colored Asian lady beetles** (*Harmonia axyridis*) are found over most of the state and are particularly common near soybean fields and wooded areas. Multi-colored Asian ladybeetles primarily eat fall-bearing raspberries. **Corn rootworm beetles** (*Diabrotica barberi*) are only found in the southern third of the state and primarily eat fall-bearing raspberries. All three beetles tend to aggregate on fruit, so that one raspberry fruit may have several different beetles feeding on it at one time. **Yellowjackets** (*Vespula and Paravespula* spp.) are common in all parts of Minnesota; they are a problem in raspberries in late summer and fall.

Sap beetle. Thaddeus McCamant, Central Lakes College.

Identification

Sap beetles are the most common of all the fruit-eating beetles and the most widespread. These beetles are about 1/4 inch long and dark colored. They often have yellow or orange spots. These beetles primarily eat overripe raspberries.

Multi-colored Asian lady beetles are orange to yellow with black spots, just like native ladybeetles, but are generally larger, about 1/3 of an inch long. The number of spots on the beetles varies from none, to a few, and up to as many as 19 spots. The most reliable identifying characteristic of the multicolored Asian lady beetles is a prominent black "M" shaped marking behind its head. This "M" can look thick, thin or broken in appearance.



Multicolored Asian ladybeetle on 'Autumn Bliss' raspberry. Note the M-shaped black marking in the back of the head. Thaddeus McCamant, Central Lakes College.

Northern corn rootworm beetles are tan to dark green, about 1/4 of an inch long. These beetles tend to be slender and almost rectangular shape. Corn rootworm beetles burrow through the raspberries.

Yellowjackets are about 1/2 inch long, with a slender black and yellow body. They have four wings which they hold over their back when not flying.

Damage

Sap beetles usually burrow beneath overripe raspberries. People often don't see the beetles until after the raspberry is picked, and then they find two or three black beetles inside the raspberry cap. Sap beetles primarily feed on overripe fruit that has turned into a dull red or fruit that has been previously damaged.

Multicolored Asian lady beetles feed on the tops of overripe raspberries, often taking a few bites of one raspberry and then moving to other raspberries. Because the skin of the raspberry has been damaged, the raspberries quickly dry out on the cane.

Corn rootworm beetles will burrow into and eat under ripe and fully ripe raspberries. All the fruit that the beetles eat are destroyed. Corn rootworm beetles often attack raspberries and other edible garden plants in large numbers, and can destroy the majority of the fruit during late August.

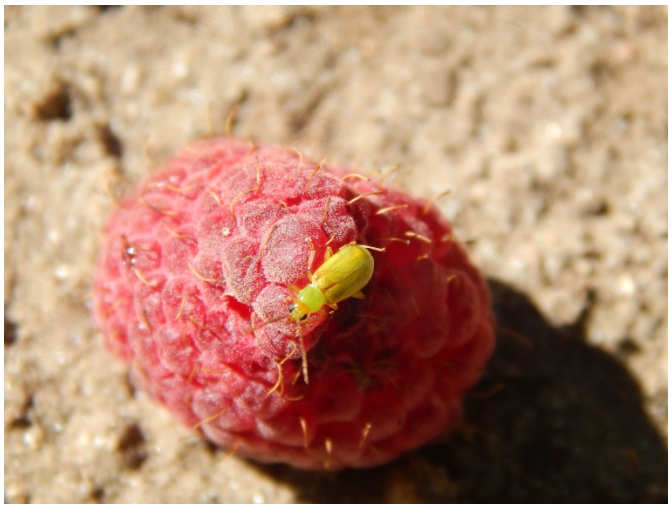
Yellowjackets are attracted to overripe and damaged raspberries but will also attack ripening fruit as well. If they are present when raspberries are being picked, yellowjackets can sting people.

Important biology

Sap beetles overwinter as adults and lay their eggs in organic matter. Occasionally, they will also lay eggs in overripe fruit such as strawberries. New adults emerge in July and immediately start feeding on overripe fruit. Sap beetle pressure increases from July through August. There is one generation per year.

Multicolored Asian lady beetles overwinter as adults and lay their eggs on plants in spring. Both the adults and larvae are beneficial, because they eat aphids. In Minnesota, these beetles are especially common in soybeans, helping to control soybean aphids. At the end of the summer, as aphid numbers decline, the lady beetles look for new food sources, and will eat most types of fruit that ripen in late August and September. Like picnic beetles, multicolored Asian lady beetles prefer overripe fruit or fruit that has previously been damaged by birds and other insects. There are two generations per year.

Corn rootworm beetles overwinter as eggs that female beetles lay in late summer and early fall. In the spring, the grubs hatch and start feeding on corn roots. In July, the adult beetles emerge and continue to feed on different parts of the corn plant. In late August, the beetles start moving, and will often find other food sources, including fall-bearing raspberries. By mid-September, the beetles start to die. Raspberries that ripen in the second half of September are more likely to escape damage from corn rootworm beetles than raspberries that ripen at the end of August. There is one generation per year.



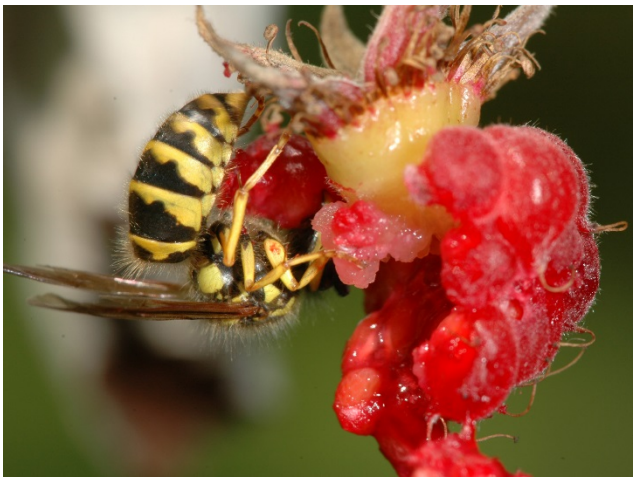
Corn rootworm beetle on 'Autumn Bliss' raspberry. Thaddeus McCamant, Central Lakes College.

Yellowjackets are social insects that construct nests made from papery materials. Their nests are located in a variety of locations, including in the ground, on trees and shrubs, and on or in buildings. Through most of the summer, yellowjackets capture insects to feed to their young. By the end of the summer, when young are no longer are being produced, yellowjackets are more interested in sources of carbohydrates and are attracted to berries and other fruit. Once freezing temperatures arrive in the fall, the workers and the old queen die.

Management

The best management for sap beetles, multicolored Asian ladybeetles, and yellowjackets is to pick raspberries regularly. They are primarily attracted to overripe fruit, and are less likely to be attracted to a raspberry patch that has been picked clean. Insecticide sprays are not recommended for sap beetles, because the beetles are often hidden underneath the raspberry fruit and are protected from sprays. Baited traps can reduce the number of sap beetles in some cases, but will not destroy all the beetles in a raspberry patch. Common traps consist of a container of fermenting plant juices and vinegar. One common trap contains overripe bananas and vinegar. Other people use stale beer or molasses and water with yeast. Place the traps just outside the raspberry patch.

If corn rootworm beetles or multicolored Asian lady beetles are especially common, the plants may have to be protected with an insecticide in order to save the first one or two pickings of the fall raspberry crop. Treating plants to protect against yellowjackets is not effective or practical. When spraying ripe raspberries, be very careful to observe the preharvest interval, i.e. the number of days after the spray before you can harvest. Be sure to check the label of the product you intend to use in order to make sure that it is labeled for raspberries and to verify the preharvest interval. Insecticides that can be effective against beetles include malathion, carbaryl and bifenthrin.



Yellowjacket attacking a raspberry during late summer. Jeff Hahn, University of Minnesota.

Treat yellowjacket nests when they can be found. However, yellowjackets can fly several hundred yards when searching for food and their nest may not be on the same property as the garden.

Spotted wing Drosophila (SWD)

The spotted wing Drosophila (*Drosophila suzukii*) (SWD) was first detected in Minnesota in August, 2012 and has since become a major pest in summer red raspberries, fall-bearing red raspberries and black raspberries. SWD is closely related to the common fruit flies that feed on decaying fruit, but SWD larvae will infest raspberries before they ripen on the canes. SWD larvae have been found infesting many different types of fruit, including raspberries.

Male spotted wing Drosophila. Martin Hauser, California Dept. of Food and Agriculture.

Identification

SWD adults look very similar to the fruit flies that accumulate near overripe fruit during late summer. They are about 1/8th inch long, have a tannish body, red eyes, and brown bands on their abdomens. Male SWD can be recognized by a distinct black spot near the tip of each wing. The female SWD can only be distinguished from other species by looking at the tip of their abdomen under a dissecting microscope; you need to examine their distinctly serrated ovipositor to properly identify them.

The larvae (maggots) are white, with a body that tapers to one end. The largest larvae are only 1/8 of an inch long and blend in easily with the seeds and white fibers of a raspberry. Smaller larvae are difficult to see, especially in a raspberry that is not fully ripe. The best way to check for SWD larvae is to place four or five ripe raspberries in a water and salt solution (one tablespoon salt per one cup of water) in a plastic zip bag. Gently crush the fruit to break the skin. Any larvae that are present will float to the surface. Infested raspberries typically have multiple larvae.

SWD are difficult to detect in raspberries before the fruit is picked. The oviposition scars where the female laid eggs are small and difficult to see in raspberries, and there are no entrance holes. During picking, SWD are easier to detect. Infested fruit are soft to the touch when picked. Even fruit with larvae too small to see with the naked eye will be softer than uninfested fruit. Fruit with large larvae fall apart when picked, causing the pickers' fingers to become covered in juice. Fruit that are infested "bleed" juice onto the white receptacle. When the fruit are picked, the normally white receptacle that stays on the plant will be stained with red raspberry juice.

Damage

SWD burrow through the berries, making the fruit soft and unappealing. During egg laying the female may introduce fungi that cause the fruit to rot, and infested fruit often develop a fermented or a sour smell. If berries are stored at room temperature, larvae can hatch after picking, causing raspberries that looked normal during picking to deteriorate a few hours later. SWD populations are highest between the middle of July and the first frost, so both summer-bearing raspberries and fall-bearing raspberries can be destroyed. During severe infestations, nearly all the fruit will have larvae.

Close-up of the female spotted wing Drosophila's ovipositor. Martin Hauser, California Dept. of food and Agriculture.

During minor infestations, infested fruit can be processed into wine or jelly. During severe infestations, the berries are difficult to harvest and should not be processed.

Important biology

SWD overwinter as adults in raspberry fields or in brush near the fields. SWD have a wide host range, and are known to attack other soft-skinned fruit, including strawberries, cherries, blueberries, plums and grapes. They particularly like to infest raspberries. They are also known to infest buckthorn fruit. SWD first appear during late June or early July, and the numbers increase rapidly during the middle of summer. The populations appear to peak in August. SWD mature extremely rapidly. During warm weather, SWD can go from egg to mature adult in seven days. The female lays several eggs on each raspberry.

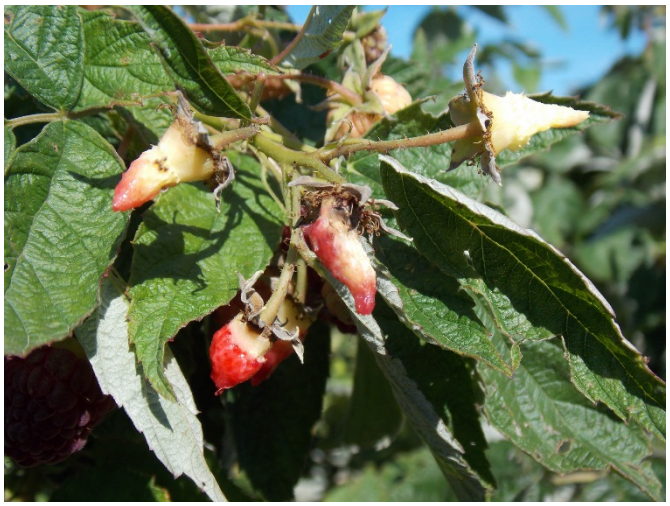
Management

Management of SWD can be challenging but is best achieved through a combination of detection, sanitation, and insecticides.

Detection

Gardeners who are concerned about SWD should monitor for the presence of adults. Take a large clear plastic cup with a cover. Make holes, 3/16 in diameter on the sides of the cup. Larger holes will allow larger flies and other insects such as sap beetles to enter the trap, making detection of the SWD more difficult.

The easiest way to make the holes is to heat a small (8 or 10 penny) nail, which can melt the right size hole in the cup. Put apple cider vinegar in the bottom of the cup. You can then either add a yellow sticky card slightly above the vinegar or a little bit of soap (e.g. dish soap). Check the trap several times a week for SWD adults, especially early in the growing season.



Evidence of SWD on raspberry receptacles that were recently picked. Thaddeus McCamant, Central Lakes College.

Sanitation

Keep the patch picked clean to keep SWD numbers low. When picking, put good fruit in one container and the soft, infested fruit in another container. Be careful to keep fruit from falling on the ground. Infested fruit should be disposed of in a manner that kills the larvae. The larvae can be killed by microwaving the fruit, cooking the fruit or placing the fruit in a sealed plastic bag that will be put in the trash. Do not bury infested fruit or place fruit in a compost pile.

Insecticides can kill adult SWD, but tend to be ineffective on larvae in the fruit. Insecticides should be applied in the evening to avoid killing honeybees and other pollinators. Readily available insecticides that kill adult SWD include carbaryl, malathion, spinosad and pyrethrin. Spinosad and pyrethrin are approved for organic production. Always read and follow labels when spraying pesticides, and follow the pre-harvest interval for all products. Be sure the specific product you intend to use is labeled for raspberries.

Japanese beetles

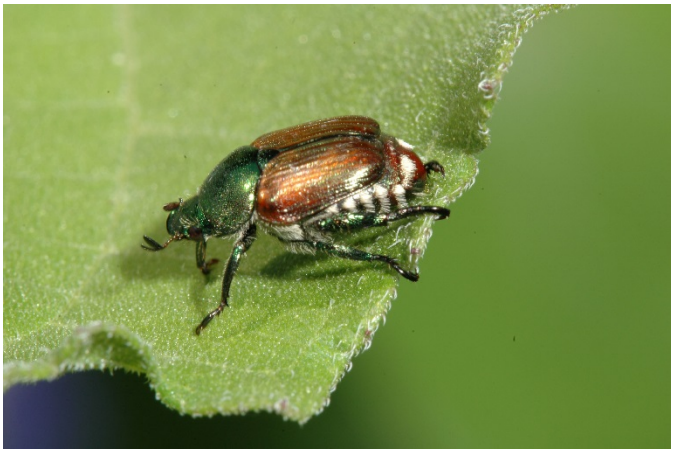
In Minnesota, Japanese beetles (*Popillia japonica*) are primarily found in the Minneapolis-St. Paul Metropolitan area, and in some areas in southeast Minnesota. Japanese beetles have an exceptionally large host range, feeding on the leaves of over 300 species of plants, including apples, grapes, blueberries, raspberries, roses and plums.

Identification

Japanese beetles are 3/8 long and oval. Their head and prothorax (the area behind the head) are metallic green, while the wing covers are a shiny bronze. Look for five white patches of hair along each side of their body and two white patches on the tip of their abdomen to verify that they are Japanese beetles.

Damage

Adult Japanese beetles feed on the leaves of many different plants including birches, basswood, apples and raspberries. They feed on the leaves between the veins, so when they are finished, they leave a skeleton of brown fibers where the leaves used to be, a type of damage referred to as skeletonizing. Damage to raspberries can occur where the beetles eat flowers along with the fruit or if the beetles kill so many leaves that the plant is weakened and cannot support fruit.



Japanese beetle on tip of a leaf. Jeff Hahn, University of Minnesota.

Important biology

Japanese beetles spend the winter as grubs in the soil of turf grass areas. In spring, they move near the soil surface, where they finish feeding and pupate. They emerge as adults in late June or early July and can fly a long distance to suitable feeding sites. When an adult starts feeding on a shrub, it emits a pheromone that attracts other beetles, so that beetles will aggregate on that shrub. This behavior results in large numbers of beetles feeding on one plant while neighboring plants are left alone. The female releases pheromones to attract males. After mating, adult females lay up to 60 eggs in turf grass. The eggs hatch in about one to two weeks, and the grubs feed on the roots of grasses and other plants. As the soil starts to cool in the fall, the grubs dig deeper in the soil, where they overwinter. Adults primarily feed in July and August, although you can find some activity into the fall. Japanese beetles have one generation per year.

Japanese beetle feeding damage. Jeff Hahn, University of Minnesota.

Management

For fruit growers, Japanese beetles are best controlled as adults. Physical removal is a viable option for small raspberry patches. Remove the beetles by hand and put them in soapy water. Hand picking is most effective as the beetles first arrive, before they release their aggregation pheromones to attract others. The best time to handpick beetles is in the evening and early morning, when they are less active. Don't use Japanese beetle traps. Research has shown that traps attract more Japanese beetles than they catch, and will typically cause more damage to plants in a garden.

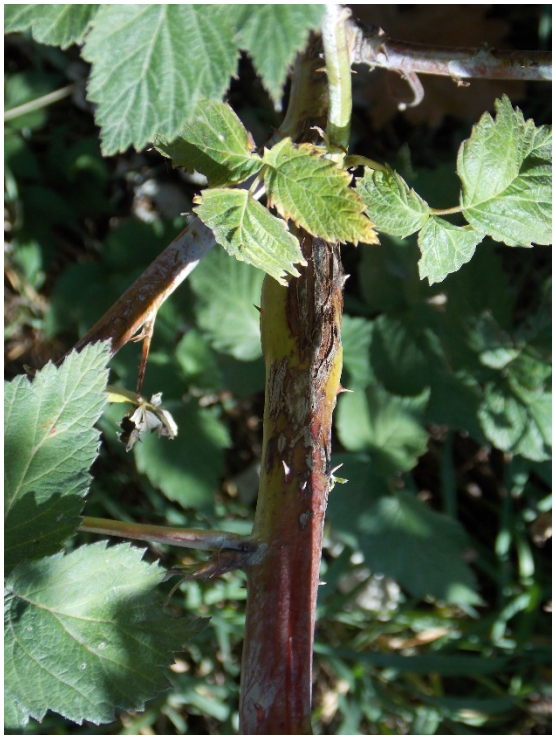
Insecticides can help manage adults. Neem extracts like Azadractin have been shown to provide short term protection, especially if only small to moderate numbers of Japanese beetles are present. There are several contact, residual insecticides including permethrin, bifenthrin, malathion or carbaryl. When using insecticides, always read and follow the label. Be sure the specific product you intend to use is labeled for raspberries.

Flat-headed cane borers

Flat-headed cane borers lay their eggs in raspberry primocanes or first year canes that sprout in spring. There are two species: the red-necked cane borer (*Agrilus ruficollis*), and the bronze cane borer (*Agrilus rubicola*). Although cane borers are common throughout Minnesota, they cause minor damage in home gardens.

Identification

Cane borer adults are small beetles that are 1/4 inch long and narrow. The red-necked cane borer is all black except for a reddish thorax. The bronzed cane borer is the same size, but with a coppery color. The white, legless larvae live in the raspberry canes, and are up to 1/2 inch long and have flattened bodies. However, cane borer adults and larvae can be difficult to find in raspberry patches.



Swollen cane or gall with cane borer in late August.
Thaddeus McCamant, Central Lakes College.

Damage

When larvae hatch, they burrow through the cane just below the bark, causing the cane to develop a distinct swelling or gall one to three feet above the ground. On primocanes the swellings can be seen starting in August. Damaged canes often occur in groups, with multiple canes in one part of the patch having galls and other parts of the patch with no galls.

The cane above the borer usually dies after the winter, while the cane below the swelling remains healthy. Damage from cane borers tends to be minor. In many cases, the lower part of the cane will overcompensate for the loss of the top of the cane, and the cane will still produce over 50% of a normal crop. In most raspberry patches, less than 10% of the canes are affected by flat-headed borers.

Raspberry canes with galls from cane borers in May. Typically, the cane dies above the gall.
Thaddeus McCamant, Central Lakes College.

Important biology

Flat-headed cane borer adults emerge in June and July. They feed on raspberry leaves for a few days before laying single eggs on the bark of the primocanes. After hatching, the larvae bore small tunnels that spiral through the bark. The spiraling causes the primocane to swell. After spiraling through the sapwood, the larvae burrow into the pith and eat through the pith for several inches before they overwinter. After overwintering, the larvae pupate, turn into adults and emerge in late spring or early summer. There is one generation per year.

Management

The best way to reduce the number of adults is to cut the canes five inches below the galls and burn or dispose of the canes during late winter pruning. The larvae are still in the canes at the end of winter, and removing the canes will prevent adults from emerging. Treating flat-headed cane borers with an insecticide is ineffective, because treatments cannot reach the larvae when they are under the bark. Killing adults before they lay their eggs is difficult and impractical.

Raspberry sawfly

The raspberry sawfly (*Monophadnoides geniculatus*) is a small, black, wasp-like insect that appears in early summer. The female lays eggs on the leaves of primocanes. The larvae are small and green and look like little caterpillars. They feed on the leaves, while avoiding the larger veins. The result is a leaf that is peppered with small holes, creating a distinct netted look, a type of feeding referred to as skeletonizing. Be sure to look for the presence of the sawflies as this damage could be confused with Japanese beetles. Sawflies have one generation per year.

Damage

The skeletonizing done by sawflies can look serious on canes where an adult laid multiple eggs, but raspberry sawflies rarely causes a loss in yield. Typically, only a small number of canes have sawfly larvae. The damage only occurs in early summer. Individual primocanes can often outgrow the damage. Gardeners may find the middle of canes with damaged leaves, while the tops and bottoms of the same canes have normal, healthy leaves.

Management

Sawflies rarely need to be managed in Minnesota. In small patches with minor infestations, the larvae can be removed by hand. If the majority of primocanes have sawfly damage, an insecticide may be necessary. Only spray insecticides if the little pale green "worms" are visible and still feeding on the leaves. If there are no worms, and the cane is forming healthy new leaves above the skeletonized leaves, the larvae may already be gone. Sawfly larvae are susceptible to 'soft' insecticides, such as insecticidal soap. Contact residual insecticides such as permethrin, malathion and carbaryl are also options.