5.3 Insect & Mite Pests of Grape

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Grapes grown in British Columbia are attacked by few insect and mite pests relative to those in many other major production areas. Economic losses from a small number of 'key' pests can be considerable, however, requiring that producers implement timely and appropriate control measures. Although many growers in BC utilize conventional spray programs, the small number of economically important insect pests of grapes in this region more readily allows for adoption of sustainable and organic approaches to pest management that includes preservation of beneficial insects and predacious mites that help regulate secondary pests such as spider mites and thrips. **Adoption of sustainable* and integrated pest management (IPM) practices that minimize the use of chemical sprays reduces production costs and human exposure to insecticides and helps preserve the local environment.** The companion to this guide, *Insect and Mite Pests of Grape in British Columbia* (Lowery *et al*., 2014), contains colour photographs of many of the pests outlined in this chapter. In the following descriptions of grapevine pests, numbers and letters indicated in parentheses refer to the corresponding pages and plates of the pest photo guide. *Beneficial Insects and Mites of Grape in British Columbia*, (Lowery *et al.* 2015) contains photos of natural enemies of grape pests. Additional sources for information on insect and mite pests of grapes are listed at the end of this chapter.

Integrated Pest Management

IPM uses a number of principles and integrated practices for the management of pests, including biological, cultural, physical, and chemical controls. **Insecticides remain an essential component applied as a last resort only when monitoring has shown that pest numbers are likely to exceed the economic threshold; i.e. when the derived economic benefits exceed the costs of control.** When insecticides are required, their selectivity, persistence, and effects on non-target organisms should be considered. Some have minimal effects on beneficial insects and predacious mites, while others cause significant reductions in natural enemy populations. A brief description and a few examples of the various components of a grape IPM program are outlined below. For additional information, refer to the Integrated Pest Management section (5.1) of this guide.

*For details on the BCWGC *Sustainable Winegrowing British Columbia* program, visit www.bcwgc.org/sustainable-winegrowing-british-columbia.

Biological Control of Insects and Mites

Insect and mite pests of grapes are attacked by many species of beneficial organisms, including bacterial and viral diseases, spiders, insect predators and parasitoids, predatory mites, and vertebrates such as toads and birds. **Maintaining and enhancing numbers of these natural enemies of grape pests forms the cornerstone of a successful IPM program.** Healthy populations of predators and parasitoids prevent outbreaks of secondary pests and also reduce the numbers of sprays required for the control of primary pests such as leafhoppers.

Beneficial organisms can be preserved or enhanced in several ways. The negative impact of pesticides can be minimized by spraying only when and where required. Monitoring of pest numbers will often indicate that only a small portion of a vineyard requires treatment, and selection of the most appropriate spray material will help reduce damage to non-target organisms. Broad-spectrum insecticides are often more toxic to beneficial insects than the pests they are intended to control. Insecticides that are less damaging to beneficial insects and predacious mites (e.g. Altacor™) should be chosen whenever possible. Malathion is considered to be less damaging to beneficial insects and mites than other insecticides in the same class (organophosphates), and although it is an option for managing Virginia creeper leafhopper, *Erythroneura ziczac*, it will not control the western grape leafhopper, *E. elegantula*, that is resistant to this and other insecticides. Other materials, such as the microbial insecticide Dipel™ (*B.t.*), are quite selective and require that the pest consumes the treated plant part, reducing toxicity to most non-target species. As listed on the BC Ministry of Agriculture website '*Pest Control Products Recommended for Use on Grapes in British Columbia*', all of the Class 4 neonicotinoid insecticides (Admire™, Assail™, Clutch™, Closer™) combined should not be applied more than twice per season to avoid mite outbreaks. These materials are listed as toxic to bees. The Class 3 pyrethroids (Pounce™, Ambush™, Ripcord™) and natural pyrethrins (Pyganic™) are toxic to most beneficial insects, but their activity persists for only 1-2 days to little more than a week.

Thoughtful choice of management practices can also help preserve beneficial insects. Mowing less often and mowing only alternate rows at one time are simple and cost-effective ways to increase populations of most natural enemies. Adults of many beneficial species feed on nectar of flowering plants that also serve as hosts for alternate prey species. As a general rule, increased plant diversity is associated with greater numbers of beneficial insects. A diversity of plants can be provided in the vineyard in mixed ground covers, or in hedgerows and uncultivated areas within or adjacent to the vineyard.

Cultural and Physical Controls

Vine Vigour and Resistance

For most crops, varieties can be selected that are partially or wholly resistant to one or more pests and diseases. Except for rootstocks that are resistant to grape phylloxera or nematodes, this is generally not a viable option for wine grapes. Some hybrid grape varieties having dense hairs on the leaf underside are less susceptible to leafhoppers, but most desirable wine grape varieties possess little resistance to foliar feeding pests. Vine vigor does, however, influence insect and mite numbers. Leafhoppers and grape mealybug, for example, will reach significantly higher numbers on overly vigorous vines as they prefer the darker, sheltered environment and elevated humidity that excessive vine growth provides. Insects developing on these plants survive better and grow faster due to better nutrition, softer tissues, and changes in concentrations of secondary plant compounds. At the other extreme, chlorotic vines with low vigor are less able to tolerate insect feeding damage and are more susceptible to attack by wood boring beetles. **Fortunately, the optimum balance in vine growth that results in the highest quality wines is also best for minimizing the growth of pest populations.**

Management of vine vigor is an important consideration in the establishment of a new vineyard and is discussed elsewhere in this guide. After vines are established, growth is controlled by pruning, cropping, selection and management of appropriate ground-cover plants, and the provision of water and nutrients. Some of these practices can be manipulated to help manage grape pests. Recent research in California, for example, has shown that moderate deficit irrigation from berry-set to veraison reduced leafhopper numbers by more than 60%. The modest reduction in yield, around 15%, was more than offset by a significant improvement in wine quality. In addition, berries were smaller and exposed to more light and air and pruning costs were slightly lower.

The presence of broadleaf weeds in and between vine rows is associated with lower levels of cutworm damage. Having shepherd's purse and other winter annual broadleaf weeds in the vine row until after buds have broken can provide effective control of cutworm. Removal of these alternate sources of food forces cutworm larvae to feed more on the buds of grapes. Perennial grasses in the vine rows should be managed over the summer, as they compete with the vines and with these beneficial plants.

Pruning

Pruning can be altered to help reduce damage from cutworm larvae. Slightly more buds can be left on vines to compensate for damage, but this will require the removal of more unwanted shoots later in the season. Some growers delay suckering and shoot thinning to divert some leafhopper feeding and egg-laying to these unwanted plant parts. Thinning of the canopy by shoot removal, shoot positioning, and removal of basal leaves improves air flow and light penetration, which is important for the management of diseases as well as insects.

Leafhoppers and erineum or blister mite infest the first leaves that emerge in spring, and these lower leaves can be removed in June to reduce numbers of these pests. A study conducted in commercial BC vineyards showed that removal of basal leaves in June rather than August reduced numbers of leafhoppers and the incidence of bunch rot. Vine growth and berry size were reduced only slightly and there was little effect on ripening or quality of fruit. Early season leaf removal might not be suitable for stressed vines or vines on sandy sites with intense heat and light where fruit can become sunburned. As for late season removal, partial removal of leaves from only the shaded sides of the vines might be more suitable in these areas.

Physical controls

For some vineyards, the use of yellow sticky tape applied below the cordon in spring can be an effective way to manage leafhoppers. Although costly to implement and remove, this physical control method can often reduce or eliminate the need for additional insecticides later in the season. In comparison to sprays of broad-spectrum insecticides, this method helps preserve beneficial insects. Use of yellow sticky tape is most practical in vineyards where damaging numbers of leafhoppers occur in small, isolated areas or on a few outer rows of the vineyard. Some other physical controls include the use of barriers to prevent cutworm larvae from reaching the buds, collection of cutworm larvae from vines at night, and removal of infested shoots or leaves.

Monitoring and Chemical Controls

Insecticides should only be applied when monitoring indicates that sprays are warranted. **The mere presence of a pest does not indicate that a spray is required.** Established grapevines can tolerate moderate amounts of leaf damage and small numbers of pests may have little or no effect on vine growth and yields. Even when pests have reached damaging levels sprays should be withheld until the economic benefit of treating the crop exceeds the cost of controlling the pest, taking in to account the possible disruption of beneficial insects. In other words, **sprays should only be applied when pest populations reach the economic injury level where control of the pest provides an economic return to the grower. Sprays should be applied at the appropriate time and life-stage of the pest.**

Monitoring of grape pests and determining thresholds is currently based mostly on visual inspections. Yellow sticky cards can be useful indicators of general population trends and pest developmental stages. Care should be taken to conduct a thorough inspection that takes into account the variable nature of the crop and the uneven distribution of most grape pests. Particular attention should be given to field edges and to areas that have experienced damage previously. The use of double sided clear tape applied around shoots or the vine cordon can be used to assist with timing of sprays for the control of the young motile stages of grape mealybug and soft scale insects. Maintaining yearly spray records and mapping of pest damage severity can be a useful tool.

Grapevines should be monitored for pests throughout the year. It is easier to spot scale infestations during pruning or early in spring before leaves are present. Grapes need to be visually inspected frequently in spring when unopened buds are susceptible to cutworm and rootworm damage. When the first leaves have fully expanded, watch for early infestations of erineum mite and note the presence of leafhopper adults that begin laying eggs at this time. Thrips damage table grapes from 75% bloom to fruit set, and if scale or mealybug were noted earlier, sprays can be timed based on the presence of crawlers. The need to spray for first generation leafhoppers should be based on monitoring for small nymphs from mid June to mid July, while second generation nymphs will reach their peak usually after the first week of August. In summer, the presence of soft scale and mealybug is often betrayed by the presence of honeydew and attendant ants. Throughout summer, monitor for thrips, spider mites and grape leaf rust mite. For table grapes, watch for mealybug infesting clusters in mid-summer and for snailcase bagworm and earwigs closer to harvest.

If chemical control of a pest is indicated, refer to the BCMA website *Pest Control Products Recommended for Use on Grapes in British Columbia* for suitable spray materials, or consult with private consultants or your chemical supplier. **It is the legal responsibility of pesticide appli-**

cators to follow the label instructions and apply only those products that are registered for use on grapes. The BC Wine Grape Council and the authors of these pest management sections do not assume legal responsibility for the misuse of any pesticides mentioned in this guide. For grapes or wines destined for export, check to ensure that the importing country has maximum residue levels (MRL) for the control products. Observe the days to harvest interval (PHI = pre-harvest interval) to avoid exceeding the MRL. Producers of organic grapes should also refer to the list of acceptable products and consult with an organic growers' organization.

Major Pests of Grape

The major insect and mite pests of grapes in BC are cutworm larvae that attack buds in spring, leafhoppers that feed on leaves throughout the summer, wasps that eat ripe fruit and annoy or sting workers, and mealybug and soft scale that transmit grapevine viruses. Grape phylloxera is an important pest of grapes worldwide, but it occurs at damaging levels in only a few scattered locations in the southern interior of BC, and was discovered more recently on Vancouver Island. Other than wasps and phylloxera, these pests are largely absent from the Lower Mainland and Vancouver Island. In addition to the major pests listed above, producers of table grapes need to worry about spotted wing drosophila, earwigs and scarring of fruit by thrips. Earwigs do not cause direct damage to grapes but are considered a contaminant by many vendors of table grapes.

Proper management of these primary pests is the most important consideration in an IPM program. Grape pests and the damage they cause needs to be recognized so that populations can be monitored at the appropriate time of the season to determine if insecticide applications are warranted. Avoiding unnecessary sprays will help prevent outbreaks of secondary pests that are normally regulated by an assortment of predators and parasitoids.

Leafhoppers

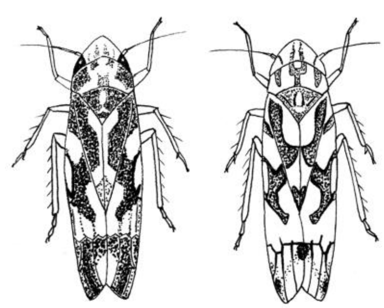
Virginia Creeper Leafhopper, *Erythroneura ziczac*
Western Grape Leafhopper, *E. elegantula*
(Hemiptera: Cicadellidae)

In addition to the widespread Virginia creeper leafhopper (VCL), the western grape leafhopper (WGL) that was first found in BC in 2007 infesting grapes on the east side of the Okanagan Valley from the north end of Penticton south to the U.S. border has now spread throughout much of the Okanagan Valley and into parts of the Similkameen Valley. The WGL is more tolerant of insecticides and it is important to determine relative numbers of the two species in your vineyard. Malathion, for example, is an option when the leafhopper population is almost entirely VCL, but its use can result in increased numbers of the resistant WGL. Leafhoppers are often distributed unevenly in vineyards and monitoring will help determine which areas require treatment. Unnecessary sprays reduce numbers of beneficial insects and spiders and can result in a rapid resurgence in pest numbers and outbreaks of thrips, mites, mealybugs, and soft scale.

Experience has shown that WGL numbers are generally lower in organic vineyards; damaging populations in conventional vineyards generally result from repeated sprays of insecticides that do not control this species but damage numbers of its most important natural enemy, the egg parasitoid *Anagrus erythroneurae*. Successful control of leafhoppers relies on proper monitoring of numbers throughout the vineyard and the judicious use of insecticides in order to preserve beneficial insects and spiders.

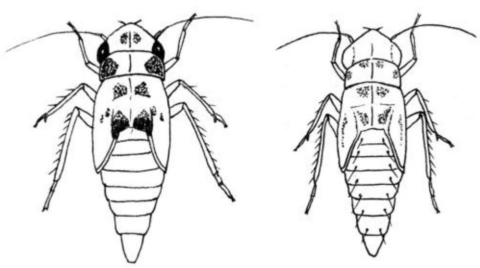
Identification

Adults of both species are similar in appearance, nearly ½ cm in length with reddish-brown



VCLH adult (left) and WGLH adult (right) markings on a pale white or yellowish background. Adult WGL (2d in photographic guide) can be distinguished by their pale eyes and irregular reddish-orange markings on a whitish background. VCL (2a) have reddish-brown eyes and a more regular reddish-brown zigzag pattern on the wings. The background body colour is pale yellow to light brownish-yellow, producing an overall darker appearance. Adult leafhoppers are best identified on yellow sticky cards placed in outer vineyard rows during late April and May that can be inspected with the aid of a hand lens or magnifying glass.

Immature WGL (nymphs) (2e) are distinguished by their pale white colour, eyes appearing red due to lack of pigmentation, and the presence of one to three pairs of pale indistinct yellow spots on the thoracic segments of larger nymphs. Under magnification a double row of longer spine-like hairs are visible on the upper side of the abdomen. VCL nymphs (2b) have reddish-brown eyes and a pale yellowish body colour. Larger VCL nymphs develop a pair of dark reddish-brown spots on the first body segment behind the head and a pair of reddish-orange spots on the other two thoracic segments. Nymphs of both species can be identified feeding on the undersides of fully expanded leaves that show signs of feeding damage (stippling).



VCLH nymph (left) and WGLH nymph (right)

Life Cycle and Damage

The biology and life cycles of the two species are similar. There are two generations each year, with occasionally a partial 3rd. Adults of both species spend the winter in leaf litter or under plant debris in the vineyard or in nearby vegetation. Adults emerge on warm spring days to feed on a wide variety of plants, moving to grape, Virginia creeper and Boston ivy when the first leaves appear. The overwintered females deposit eggs in the leaf tissue on the undersides of fully expanded leaves during May and June. The small, flattened opaque eggs (2c) are deposited side by side, usually in small groups of around two to six for the VCL and singly for the WGL. Nymphs of this 1st generation emerge from mid-June to the end of July. There are five nymphal stages. Winged adults that appear in July and August lay eggs that produce the 2nd generation nymphs that develop throughout the fall into overwintering adults. The WGL develops more slowly than the VCL and nymphs will occur later into the year.

Both adults and nymphs feed by piercing individual leaf cells and sucking out the contents. Light infestations cause leaves to appear stippled (2f) due to the death of individual cells. Heavier feeding results in brown, dried leaves that fall prematurely. Some studies have shown that light infestations can actually improve the quality of grapes on vines that are overly vigorous, but excessive feeding reduces the photosynthetic activity of the vines, resulting in delayed maturity, yield losses, and reduced fruit quality. Large infestations deplete carbohydrate stores and weaken the vines. Light coloured fruit varieties can become spotted and unsightly with excrement, which is a particular concern for table grapes (2g). Adult leafhoppers are also an annoyance to pickers during harvest.

Monitoring and Spray Thresholds

Overwintered adults usually congregate in higher numbers on the edges of vineyards or in sheltered locations, and these areas should receive particular attention in the spring. Leafhoppers prefer vigorous vines and those that leaf out earliest. Monitoring numbers of adults captured in spring on yellow sticky cards can help determine relative infestation levels, but because some eggs fail to develop and predation rates are variable, these numbers do not correlate well with subsequent nymph counts. It is helpful to note where large numbers of adults occur early in the season, as these areas should be observed more closely later on.

Adults are more tolerant of insecticides and are repelled by some materials; therefore, sprays should be targeted against the wingless immature stages. Depending on the location of the vineyard, monitoring of 1st generation nymphs should begin in early to mid-June. Monitor populations by counting the numbers of nymphs on the lower surfaces of 5-10 leaves in at least 5 locations per block or variety. Select older bottom leaves up to just above the fruiting zone. In order to prevent damage to any vines, sampling should focus on more heavily infested areas. Sample from the north and east sides of rows where more nymphs will be found and focus on the leaf zone showing signs of feeding damage. Infestation levels are based on the average number of nymphs per leaf.

Established grapevines are tolerant of leafhopper damage during the first half of the season when growth is rapid. Because of this, there are no established thresholds for 1st generation nymphs. The threshold of approximately 20-25 nymphs per leaf established for the 2nd generation in late summer can also be used as an approximate threshold for early summer sprays. A higher threshold can be used for 1st generation nymphs if healthy populations of predators are present and a high rate of parasitism is likely. Control of 1st generation nymphs is often more effective as there is less foliage, nymphs are confined to leaves around the fruiting zone, and sprays can be directed in a narrow band to ensure good coverage. It is recommended, therefore, to treat vineyards with a history of heavy leafhopper damage during this time. Soap and oil sprays are much more effective when targeted against 1st generation nymphs when most of the eggs have hatched. Egg hatch can only be determined with the aid of a low power microscope, but the presence of mostly small, young nymphs can be used as an approximate measure.

Special considerations are required when managing leafhoppers in organic vineyards. Soaps and oils are not as effective as conventional insecticides, and because BC currently lacks certain effective organic spray materials widely used elsewhere (e.g. azadirachtin), control of leafhoppers in organic vineyards here is currently very difficult; requiring usually several complimentary practices. As such, it is best to take preventative actions and to consider the action threshold to be extremely low.

Second generation nymphs should be monitored beginning in late July/early August in a manner similar to that outlined above. Greater attention should be paid to vines in the center of the field as infestations will have spread from field edges and ‘hot spots’ to a larger area of the vineyard. Nymph counts should be collected at least weekly as the time for spraying approaches. **For wine grapes, an approximate threshold of 20-25 nymphs per leaf on the more heavily infested leaves can be used as a rough guideline.** This is an average value based on counts from several leaves as outlined above. Again, for a particular area of the vineyard, collect 5-10 leaves from at least 5 areas and calculate the average number of nymphs per leaf. For 2nd generation nymphs, sample leaves from the middle of the canopy above the fruiting zone and from the north or east sides of vines where numbers will be higher. Leafhoppers will be distributed unevenly in a vineyard and it is important to sample adequately to determine which areas require treatment. Although the above threshold provides a rough guideline, an acceptable spray threshold should be determined by individual growers based on their past experience and additional factors such as vine vigor and numbers of beneficial insects.

Biological Control

Predators, such as birds, spiders, and several species of hemipteran bugs, and parasitic wasps attack leafhopper eggs, nymphs or adults. Although occasionally contaminating table grapes, earwigs consume large numbers of leafhopper eggs, leaving behind small, shallow scraped areas on the undersides of leaves. A small egg parasitoid, *Anagrus daanei*, helps control VCL in some vineyards where parasitism rates can approach nearly 100% late in the season. A different parasitoid, *A. erythroneurae*, parasitizes eggs of the WGL and is largely responsible for the biological control of this pest. *A. erythroneurae* overwinters in eggs of the rose leafhopper on wild and domestic roses, apple, blackberry and plum. In early spring this parasitoid utilizes eggs of a leafhopper on a wide range of mints, including catnip and catmint. **Most vineyards have good numbers of *A. erythroneurae* and outbreaks of WGL are largely associated with sprays of insecticides that do not control this leafhopper but are toxic to the parasitoid.** Excessive rates or unnecessary insecticide sprays will also reduce numbers of other beneficial insects and spiders.

Cultural and Physical Control

Leafhoppers prefer excessively vigorous plants and vines should be irrigated and fertilized to maintain moderate growth best suited to the production of superior quality wine grapes. The use of yellow sticky tape applied below the cordon in spring just before bud break can be an economical way to manage leafhoppers in some vineyards. Although costly, this method helps preserve beneficial insects relative to insecticide sprays. The use of sticky tape is likely not cost effective for large areas but it can be a useful method where infestations are confined to small areas or to the edges of vineyards.

A study conducted by SuRDC researchers beginning in 2001 demonstrated that the removal of basal leaves during the 2nd to 3rd weeks of June when most eggs of the 1st generation had been laid effectively reduced numbers of leafhoppers by about 70%. As an added benefit, early season removal of leaves from the fruiting zone also reduces the amount of bunch rot. No significant differences were noted in fruit quality other than a slight reduction in yield and berry size. This practice might not be suitable for stressed vines or on sites with intense heat and light that might lead to sunburn. However, sunburn is less likely to occur following early removal of leaves (June) as compared to late (August) removal. Exposure to light and air causes developing berries to produce thicker skins and more wax, and the subsequent growth of lateral shoots will provide some shading. This practice is labour intensive, but many growers routinely remove leaves from the fruiting zone later in the season in order to improve fruit quality. Mechanized removal of leaves offers an approach, perhaps a little less effective, that might be more cost effective over time.

Chemical Control

Some insecticides registered for leafhopper control are ineffective against the WGL and it is important to determine if this species is present in your vineyard. Malathion is currently registered for the control of leafhoppers on grapes, but it is ineffective against the WGL that is resistant to this and other insecticides. The VCL has not developed resistance to insecticides. When monitoring of leafhopper nymphs indicates that insecticide sprays are required, apply one of the materials listed in the BCMA website publication, *Pest Control Products Recommended for Use on Grapes in British Columbia*.

Natural enemies should be preserved by applying the lowest effective rate only to areas where the pest has exceeded the threshold level. **It is often sufficient to spray small areas or treat only the perimeter of the vineyard**. Spraying in this fashion is more economical and helps preserve beneficial insects. Neonicotinoids (e.g. Assail™) and other broad-spectrum insecticides (e.g. pyrethroids such as Pounce™) are toxic to predacious thrips and beneficial insects and have been shown to cause increases in spider mites and other secondary pests. Assail™ is also repellent to adult leafhoppers and will cause them to move to unsprayed portions of the vineyard. Sprays should, therefore, be targeted against small nymphs. Research at SuRDC has shown that certain strobilurin fungicides (e.g. Pristine) and some organosilicone surfactants are also repellent to adult and immature leafhoppers. Their use might eliminate the need for an insecticide spray, but this increased movement of adult leafhoppers within and between vineyards requires greater vigilance.

Leafhopper numbers will be suppressed with sprays of Safer's Insecticidal Soap™ or Surround™ (kaolin clay), or by PureSpray Green™ or Vegol™ spray oils applied for the control of other pests. These products act by direct contact to smother the leafhopper nymphs and should be applied in high volume sprays with nozzles directed to ensure that the bottom leaf surfaces are covered thoroughly. These materials are most effective when targeted against 1st generation nymphs.

Sharpshooters

(Hemiptera: Cicadellidae)

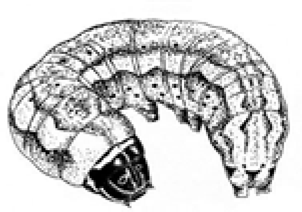
The poplar sharpshooter, *Neokolla heiroglyphica*, and the willow (=purple) sharpshooter, *N. confluens*, occasionally infest the shoots of grapevines in sufficient numbers to warrant control. The dark coloured adults appear oversized in relation to the other leafhoppers found on grapes in BC and they have more pronounced triangular shaped heads (2h). The large nymphs appear a uniform brown colour. Infestations are generally restricted to vines growing in close proximity to the preferred host plants after which these species are named. There are no chemicals registered for the control of sharpshooters in BC, but sprays applied for the control of leafhoppers should also help control these species.

Climbing Cutworms

(Lepidoptera: Noctuidae)

More than 25 species of cutworm have been identified feeding on the buds of grapevines in the southern interior of BC; some of the more common being Barnes' (= well-marked) climbing cutworm, *Abagrotis orbis*, Reed's dart, *A. reedi*, and *Abagrotis nefascia*. The W-marked cutworm, *Spaelotis clandestina*, old man dart, *Abagrotis vetusta*, dark-sided cutworm, *Euxoa messoria*, and others can also cause considerable damage in certain locations in some years. The invasive lesser yellow underwing, *Noctua comes*, has increased in numbers and distribution since it was first found in the Okanagan in 2001. **Cutworm feeding damage to the buds of grapes can vary greatly between years and locations and it is not uncommon for only parts of vineyards to be seriously damaged**. Because populations fluctuate greatly and monitoring of cutworm larvae is difficult, damage can be considerable.

Identification



Cutworm larvae are smooth, soft, thick-bodied caterpillars measuring about 4 to 5 cm when fully grown (1a, 1b). Larvae typically live in the soil or under debris and will curl up when disturbed or handled. Depending on the species, larvae are most often light to dark grey or brown and marked with spots and stripes. Adults are mostly drab moths with bodies around 2 to 2.5 cm long (1a insert). The hind wings, which are sometimes distinctly marked, are usually lighter in colour than the forewings. The lesser yellow underwing moth is most noticeable by the bright orange hind wings that are edged in black (1b). Cutworm moths are active at night and rest during the day in sheltered locations.

Life Cycle and Damage

Cutworm that feed on grapes spend the winter as small larvae in the soil or under fallen leaves or debris. When the weather warms in spring they resume feeding and complete their development. Damage to grapes occurs during this time when the rapidly growing larvae feed on developing buds and new shoots. Moths emerge in June and remain in a quiescent state throughout the summer. In fall they become sexually mature and begin laying eggs on the surface of the soil that will hatch into the overwintering larvae. There is a single generation each year. Unlike the *Abagrotis* species, the underwing moth lays eggs in clusters on the upper surfaces of leaves.

Damage to grape buds varies with the size of the cutworm larvae. Small larvae will often burrow into a bud, creating nearly circular holes that were previously attributed to feeding by adult click beetles (1c). Larger cutworm larvae will chew sizeable, sometimes ragged, holes and remove a significant portion or all of the bud. Feeding on new, tender shoots can cause the shoots to break or wilt (1d). Larvae climb the vine trunks or support posts each night and return to the soil during the day, or they find refuge under loose bark of older vines.

Monitoring and Spray Thresholds

Cutworm numbers vary over time and between and often within vineyards. Some vineyards rarely experience significant levels of cutworm feeding damage while others are damaged yearly. Damage is often higher in areas with dry gravelly or sandy soils that do not support good stands of broadleaf weeds, or when weeds are controlled too early in the spring before shoots have elongated. The new invasive yellow underwing moth is an exception in that it prefers heavier soils. Maintaining a record of previous damage can help suggest which areas need to be monitored more closely and where damage is likely to occur first; however, bud damage needs to be assessed throughout the vineyard.

New vines planted in untreated land previously in pasture are prone to damage. Cutworm larvae are often sheltered and somewhat confined within the protective milk cartons or sleeves placed around new vines. Loss of buds on new vines can limit growth and delay fruiting, and they should be closely inspected in spring for signs of damage and treated when necessary.

Significant amounts of damage can occur over a period of two or three days when the nights remain warm. It is especially important to frequently monitor for damaged buds during this time. At other times it is usually sufficient to monitor vines weekly or twice weekly until shoots have elongated. An accurate threshold based on the degree of bud damage is difficult to determine as it is influenced by the variety, training system, method of pruning, presence of predators and parasitoids, and tolerance level of the individual vineyard manager.

Suggested economic thresholds provided by growers range from virtually zero to over 15%; a value around 3% bud loss is likely for most *vinifera* varieties. Establishment of spray thresholds should also consider the potential for secondary pest outbreaks that will require additional insecticide sprays later in the season.

Biological Control

Cutworm eggs are consumed by various predators and are parasitized by small wasps. Larvae are eaten by ground beetles, hunting spiders and birds, and are parasitized by wasps and flies. Fungal and bacterial diseases that attack cutworm larvae are common, particularly when conditions are cool and wet. The combined effect of these natural controls is to eliminate most cutworm eggs and larvae. Of the hundreds of eggs laid by a female moth, only a few survive to become reproductive adults. Even so, damage resulting from the few remaining larvae can be considerable.

Cultural Control

Damage is generally much lower in vineyards with mixed ground cover vegetation and where broadleaf weeds, particularly winter annual mustards such as shepherd's purse, *Capsella bursa-pastoris*, are present in the vine rows and drive rows in spring. **Where possible, broadleaf weeds growing in the vine rows should not be controlled in spring until shoots have elongated and the first leaves have expanded**. With the exception of lesser yellow underwing that prefer heavier soils, cutworm damage is usually more common in areas with well-drained sandy or sandy-loam soils that support fewer broadleaf weeds. Diseases that infect larvae are also likely to be more prevalent in soils that retain moisture.

Control of vegetation with herbicides, cultivation, or establishment of a suitable cover crop the year prior to planting will help reduce damage to newly planted vines by cutworm, flea beetles, root weevils and June beetles.

Cutworm damage is partially related to pruning practices and grape varieties. Vines with a greater number of retained buds in spring will suffer marginally less damage; however, there will be added costs related to removal of extra shoots. Most grape varieties produce fruit on secondary shoots, but yields will still be reduced and ripening can be delayed or uneven.

Chemical Control

Sprays of the pyrethroid insecticide Pounce™ (permethrin) should be directed to the soil at the base of vines, to vine trunks, and to support posts so that larvae contact the insecticide while moving from the soil to the canopy. Do not cultivate or disturb the soil for several days after treatment. Sprays should be directed into the milk cartons or other protective structures placed around newly planted vines. Pounce™ is harmful to all beneficial insects and can cause increases in secondary pests such as mites and soft scale.

Altacor™ (rynaxypyr) and Intrepid™ (methoxyfenozide) cause larval mortality through ingestion, and sprays should be directed to the developing buds. These materials are less toxic to beneficial insects due to their greater selectivity and reduced toxicity to non-target organisms. Follow the label instructions and wear appropriate protective clothing as for all pesticides. The list of materials registered for cutworm control is likely to change before the next printing of this guide and it is important to refer to the most recent edition of *Pest Control Products Recommended for Use on Grapes in British Columbia* for appropriate registered materials.

Grape Phylloxera

Viteus vitifoliae (Hemiptera: Phylloxeridae)

Grape phylloxera, native to eastern North America, is a type of aphid found on the roots of grapes or in galls formed on the leaves of wild grapes and some hybrid varieties. European *vinifera* varieties are particularly susceptible to this pest and the accidental introduction of phylloxera to California, Europe, and elsewhere initially devastated these industries. Management of phylloxera with insecticides was not successful and the wine grape industry was only rescued with the development of resistant rootstocks derived from American *Vitis* species or hybrids between these and susceptible *V. vinifera*. Phylloxera were first identified in the Penticton area in 1961; infestations currently are scattered and at relatively low levels mostly due to the use of resistant rootstocks and the failure of this pest to thrive on sandy soils. Phylloxera were discovered infesting leaves of hybrid grapes on Vancouver Island in 2020, but the extent and severity of the infestation is not yet known.

As early as 1914 it was recognized that grape phylloxera consisted of several distinct biotypes or races. Biotypes differ in their ability to form galls on the leaves of certain cultivars, in the degree of feeding damage caused to roots, and their propensity to form sexual or winged forms. One study demonstrated that rootstocks with unsatisfactory levels of resistance to phylloxera in Europe and South Africa were suitable for California, Australia and New Zealand. Loss of resistance can also occur over time as new biotypes of phylloxera arise.

Identification

Adults are very small, usually wingless, and less than 1mm long and half as wide (4a). Colour varies from pale green, yellowish-green or light brown on vigorous roots, to brown or orange-brown on declining roots; as adults age they become a darker brown or even purplish-brown. Winged sexual forms are rare in BC and the northwestern United States, and they do not appear able to reproduce sexually on *vinifera* grapes. Leaf galls are formed on French-American hybrids, Concord juice grapes and some rootstocks. The relatively small galls on the undersides of leaves are green and roughly circular (4c). These should not be confused with the white or brown fuzzy galls of variable sizes and shapes formed on the undersides of leaves by erineum (leaf blister) mite (4d).

Life Cycle and Damage

Phylloxera overwinter on roots as eggs or small, dark hibernating nymphs that complete development in spring to become females that reproduce without having mated. Two or three generations are produced each year. When populations are large or the vines are declining, some newly hatched nymphs leave the roots through cracks in the soil and migrate to the roots of nearby vines. These small crawlers have been known to climb vine trunks and be blown on the wind for some distance. In late summer a portion of the nymphs develop into winged females (alates) that leave the soil and fly to other vines where they lay eggs in the crevices in the bark that hatch into both males and females. After mating, these late summer females produce a single larger overwintering egg. In spring the eggs hatch into females that feed on developing leaves and produce galls on susceptible varieties. Nymphs produced in the galls can infest other leaves or migrate down to the roots. Most grapes grown in BC are not susceptible to leaf galls and the life cycle here largely consists of asexual forms confined to the roots of grapes. For this reason, infestations spread at a relatively slow rate.

Feeding by phylloxera on the roots of grapevines results in severe water and nutrient stress and eventual death of the vines. Roots become stunted and galled and die prematurely from the injection of harmful saliva and invasion of fungal pathogens (4b). Depending on vine vigour and the size of the infestation, vines can slowly become stressed and chlorotic, or they can decline rapidly.

Monitoring and Spray Thresholds

Vines that fail to thrive and become chlorotic and unproductive should be inspected for the presence of phylloxera. Galls on leaves are an obvious indication of phylloxera on hybrid varieties; however, damage confined to roots of *vinifera* wine grapes can be confused with damage from nematodes or root diseases. To determine the cause of damage, carefully expose the roots and search for the typical swellings and dying roots caused by phylloxera. A hand lens or dissecting microscope will help verify their presence. Areas of vineyards with phylloxera will appear as expanding patches of severely stunted or dying vines.

Insecticide treatments were previously not effective and there are no spray thresholds for phylloxera on roots. Hybrid cultivars that develop leaf galls are better able to tolerate or resist feeding damage to roots, but elimination of the leaf gall forms soon after they are detected might help reduce the extent of the infestation.

Biological Control

Biological control of phylloxera has not been studied in detail. A number of generalist predators are known to feed on phylloxera in leaf galls. In Ontario, larvae of two species of predaceous flies were commonly associated with leaf galls. Predaceous soil-dwelling carabid beetles undoubtedly feed on phylloxera infesting roots, and because they do not produce honeydew, ants are likely to feed on phylloxera rather than protect and 'milk' them as they do aphids. Natural enemies and diseases are not thought to provide effective control of phylloxera established on roots of susceptible *vinfera* vines.

Cultural Control

When establishing a new vineyard, purchase plants from reputable suppliers and ensure that planting material is healthy and free of phylloxera. Vines imported into BC are given a hot water treatment to prevent the importation of phylloxera and other grapevine pests. To ensure that phylloxera are not moved from infested to clean areas on farm machinery, disinfest all equipment. Less frequent cultivation is thought to be helpful.

Resistant rootstocks provide an effective means of combating phylloxera. Almost all resistant rootstocks were developed from crosses between several species of wild grapes native to eastern and southern North America (*V. riparia*, *V. rupestris*, *V. berlandieri* and others). Some of the grape rootstocks with good phylloxera resistance that are commonly grown in BC include SO4, 5BB, 5C, 420A, and 161-49C..

Resources for resistant rootstocks:

Rootstock Selection (PDF), pgs 12-15. In, *Wine Grape Varieties in California* by L.P. Christensen. U.C. Agric. & Nat. Res. Pub. http://iv.ucdavis.edu/files/24347.pdf

Rootstocks: Protection Against Phylloxera. Vinehealth Australia, Gov. South Australia. https://vinehealth.com.au/tools/rootstocks/

Rootstocks vary in characteristics such as vigour and it is often difficult to select an appropriate rootstock for a particular vineyard. Soil types, resistance to nematodes, vine spacing and several other factors need to be considered in addition to phylloxera resistance. Prior to planting it is advisable to read appropriate publications and consult with vineyard managers or consultants. A more complete listing of phylloxera-resistant rootstocks that includes other characteristics can be found in other sections of this guide

Vigorous vines resist phylloxera damage better than stressed vines. Provision of additional water and nutrients can help delay the rate of decline. Infested vines should not be heavily cropped and extra care is required to prevent additional stresses from insects and diseases. Some varieties are more vigorous and are better able to resist damage. **Phylloxera infestations are more damaging and spread more rapidly on heavier soils that are prone to cracking**, while vines planted in sandy soils can be nearly immune to attack.

Chemical Control

Movento™ (spirotetramat) and Clutch™ (clothianidin) are systemic insecticides effective against plant-feeding insects with sucking mouthparts that are registered for the control of grape phylloxera and mealybug. Sprays should be applied in a minimum spray volume of 500 L/ha as per the label instructions. Do not apply Movento to table grapes. Clutch is listed as being toxic to bees. Sprays of this and other materials belonging to the same chemical class (4, neonicotinoids) should be limited to no more than 2 applications per season to prevent mite outbreaks.

Wasps

(Hymenoptera: Vespidae)

A number of species of yellowjacket wasps are pests of grape; the most numerous and troublesome being the western yellowjacket, *Vespula pennsylvanica,* and the German yellowjacket, *V. germanica*. Two uncommon species of paper wasp (*Polistes* sp.) are native to our area. The European paper wasp, *P. dominula*, was found in BC in 2003 and has since become very common, particularly around buildings. Yellowjackets, hornets and paper wasps are important predators of grape pests throughout most of the year, but in fall they often feed in large numbers on damaged and intact fruit. Wasps are also an annoyance and potential health hazard to vineyard workers and to pickers during harvest operations. Paper wasps are less aggressive than yellow-jackets or hornets and are not as prone to sting.

Honey bees occasionally feed in large numbers on ripe fruit. The extent of the damage is variable, mostly occurring on the edges of only certain vineyards and in association with wasp damage. Honey bees will be unintentionally damaged by sprays directed at other grape pests and it is important to try to preserve these beneficial pollinators.

Identification

Yellowjacket workers are about 1.5 cm in length; the abdomen appears largely yellow with thin black bands. Hornets are slightly larger and appear largely black with yellow or white bands. Paper wasps have thinner bodies with a more pronounced constriction (stalk) between the thorax and abdomen. The body is dark with some yellow markings, but they appear reddish-brown due to the colour of the wings and distal parts of the legs (5h). In flight the legs of paper wasps dangle visibly below the body. All of these wasps produce paper nests, but the brood cells of European paper wasps are not enclosed within an outer covering.

Life Cycle and Damage

Yellowjackets and paper wasps overwinter as fertilized females in sheltered locations. These queens seek suitable nest sites in spring and establish a new colony. Nests are initially small, consisting of only a few paper cells, but as workers develop they assist in building up colony numbers and the size of the nest. Depending on the species, nests can be in the ground, under the eaves of houses, in hollow trees, the walls of buildings, milk carton vine shelters, or exposed in trees. In fall, in addition to workers, colonies produce both males (drones) and queens. When freezing weather arrives, all the drones, workers, and the undeveloped larvae and pupae are killed.

Wasps prey on other insects, scavenge food and feed on nectar and the juice of fruit. It has been reported that wasps do not damage fruit themselves but take advantage of injury caused by other insects or birds, by diseases such as sour rot, or splitting of fruit. There are contrary reports, however, particularly relating to the European paper wasp, that they are able to directly feed on intact fruit (5h). As mentioned above, wasps are also a major annoyance and their stings result in swelling and a painful itch and can trigger severe allergic reactions in some individuals.

Monitoring and Spray Thresholds

There are no established thresholds for wasps and the need to spray is determined by the variety of grape, past history of damage, and tolerance level of individual vineyard managers. Trapping of wasps is most effective early in the season before the colonies have increased in number. The arrival of the European paper wasp has made it necessary to control wasps more frequently.

Biological Control

Wasp colonies can be attacked by other wasps or hornets. Eastern and western kingbirds feed on foraging adults, and larvae are subject to certain diseases. The onset of winter eliminates established colonies. The overwintering queens may also succumb to cold or be eaten by other insects or even by mice.

Cultural Control

Elimination of nests early in the season can be an effective management strategy, but they are often located outside the vineyard or are well hidden. Aerial nests in trees or under eaves can be removed and placed in a plastic bag at night when wasps are inactive. Nests in walls or natural cavities can be treated by spraying or puffing commercial wasp control products into the entrance holes at night. Sealing of entrances can help prevent future nests.

Trapping can be used to reduce numbers of foraging wasps in localized areas. Commercial wasp traps that use an attractant dissolved in water have proven effective, as have homemade versions containing a sugary solution placed in recycled 1 litre plastic pop bottles. Wasps enter through small holes and eventually fall into the liquid solution and drown. Trapping early in the season when populations are low and queens are establishing colonies is generally more effective than attempting to remove large numbers of wasps later in the season. Baiting traps with fish or other meats in spring when wasps are seeking a protein source can be an effective alternative to other baits, but care should be taken to avoid attracting unwanted wildlife.

Chemical Control

Cypermethrin (Ripcord™) is currently registered for the control of wasps feeding on wine grapes but not on table grapes. The pre-harvest interval (PHI) is two days for wine grapes harvested by machine and seven days for fruit harvested by hand.

For additional information on social wasps, management strategies, and design of wasp traps, visit the UC IPM Statewide IPM Program posting *Yellowjackets and Other Social Wasps.* http://ipm.ucanr.edu/PMG/PESTNOTES/pn7450.html

Spotted Wing Drosophila

Drosophila suzukii (Diptera: Drosophilidae)

This pest of fruit crops was first found in Canada infesting blueberries in the Fraser Valley in September 2009 and trapped soon after in a cherry orchard near Kelowna. It is native to Southeast Asia where it feeds on a range of soft skinned fruit. Unlike most species of vinegar fly (fruit fly) that feed on very ripe, damaged, or rotting fruit, the spotted wing drosophila (SWD) is able to attack ripening, firm fruit.

Identification

Adult SWD are slightly larger (2-3 mm) than other vinegar flies and males have a dark grey to black spot toward the outer margin of each wing (5g). Females lack the wing spots and have a saw-like ovipositor visible with the aid of a good hand lens or microscope. The elongate creamy white legless larvae, up to 3 mm long, are difficult to distinguish from other species of vinegar fly.

Life Cycle and Damage

SWD overwinter as adults. Beginning in spring, several generations develop throughout the year on a range of available fruit (strawberry, blackberry, cherry, etc.), including grapes in the late summer and fall. Females lay large numbers of eggs that hatch into larvae that mature at a rapid rate. A generation can develop in as little as 1 to 2 weeks when temperatures are warm, resulting in a rapid increase in numbers.

Larvae of several species of vinegar fly develop in damaged or decaying grapes late in the season, causing little apparent damage. A recently published laboratory and field study* conducted in the Okanagan Valley found that SWD cause little direct economic damage to wine grapes. It was not found in intact, healthy fruit and formed a very small proportion of all vinegar fly species in damaged or rotting wine grapes. SWD was found, however, infesting a small proportion of apparently healthy table grapes of several varieties. The presence of vinegar fly larvae and pupae in fresh table grapes is a major concern. Feeding by larvae directly damages the fruit and the holes created during egg-laying allow the entry of disease-causing microorganisms. Unlike other *Drosophila* species, SWD does not prefer rotting fruit and its relationship to the spread of sour rot and other pathogens has not been demonstrated. Sour and bunch rots are best managed through the combined use of early season removal of basal leaves and judicious use of fungicide sprays.

Monitoring and Spray Thresholds

SWD has not been shown to cause economic damage to intact wine grapes in BC and there are no established thresholds. For table grapes, trap counts do not correlate with levels of damage and producers currently need to rely on prophylactic sprays to susceptible table grape varieties.

*Acheampong, S., *et al.*, 2020. *Monitoring of Drosophila suzukii (Diptera: Drosophilidae) in Okanagan Valley vineyards, British Columbia, Canada, and assessment of damage to table and wine grapes (Vitaceae).* The Canadian Entomologist.

Biological Control

Parasitic wasps have been reared from SWD in BC and predators of other species of vinegar flies are likely to also attack this species.

Cultural Control

Sanitary measures suggested for other fruit crops (i.e. removal of infested and unharvested fruit) might not be practical for commercially produced grapes. Increased exposure of fruit early in the season (see leafhopper section for details) that results in fruit with thicker skins and a heavier wax layer, combined with judicious use of fungicides provides the best means to manage sour and bunch rots that are associated with increased numbers of vinegar flies. Additional research would be helpful to determine the relative susceptibilities of table grape varieties and conditions that favor SWD infestations.

Chemical Control

There have been frequent changes to the list of insecticides registered for SWD control on grapes, and the reader is advised to consult with a local spray advisor or visit the BCMA website '*Pest Control Products Recommended for Use on Grapes in British Columbia*'. Imidan™ (phosmet) and Harvanta™ (cyclaniliprole) were registered for the control of SWD on grapes as of June 2020. Consult the label and observe the pre-harvest interval (PHI). Imidan has a 14 day REI and is more acutely toxic to mammals than Harvanta. Both materials are listed as being toxic to bees.

*For additional information see '*Spotted Wing Drosophila (Fruit Fly) Pest Alert*' factsheet, BC Min. Agr., at: https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/tree-fruits/spotted-wing-drosophila

Grape Mealybug

Pseudococcus maritimus (Hemiptera: Pseudococcidae)

Previously, grape mealybug was not considered to be a major pest of grapes grown in BC. Numbers were generally quite low due to the activity of parasitoids and predators and direct feeding damage is of little concern. Individual bunches of table grapes touching infested vines would occasionally become infested, resulting in fruit coated with sticky honeydew that reduced their marketability. **The recent recognition that mealybug and soft scale are responsible for the sometimes rapid spread of grapevine leafroll associated viruses has raised their status to that of major pests.** Largely due to changes in insecticide use, damaging populations of mealybug have become more common in recent years. Whenever possible, apply chemicals against major pests (leafhoppers, cutworm) of grapes only when required and only to portions of the vineyard where control is warranted. Select pesticides that are least damaging to predators and parasitoids.

Identification

The grape mealybug has a flattened, oval pink body covered in a mealy white wax coating (3f). It is somewhat segmented in appearance, but the divisions between head, thorax and abdomen are not distinct. The mature wingless females are about 5 mm long. They have long waxy filaments along the edge of the body that become progressively shorter toward the head. Large numbers of eggs (50-800) are laid in cottony masses. The smaller, winged males have antennae that are half as long as their body and a pair of long, white anal filaments. Yellow to brown crawlers that emerge from the oval, orange eggs are not covered in wax. All stages are mobile though the crawlers are the most mobile stage.

Life Cycle and Damage

Females move in late fall to old wood and lay overwintering eggs in cottony egg masses under loose bark. Crawlers, some of which might have hatched in fall and remained dormant throughout the winter, move to new shoots in spring. Grape mealybugs mature around mid-summer and produce a 2nd generation that matures in late autumn. They can occur on all aerial parts of the vines but are more common in summer on leaves and new growth, usually hidden within the canopy.

Relevant to the spread of leafroll viruses, the small crawler stage is mobile and active and they can be carried on the wind. Mealybugs can also be transported during mechanical harvesting or field operations, and on workers or plant material.

Direct damage is similar to that for soft scale. Plant sap is removed during feeding and large amounts of honeydew foul the fruit (3f) and promote the growth of sooty mold fungus. Mealybugs can infest table grape bunches during the development of the second brood in summer, reducing their marketability.

Monitoring and Spray Thresholds

To detect when crawlers are active, remove the loose bark in an area near the infestation and encircle the vine with clear tape applied sticky side out, or use double sided adhesive. Replace the tape every three or four days and check for the yellowish-brown crawlers. Separating mealybug crawlers from soft scale crawlers is difficult and requires a good dissecting microscope. Inspect vines for the cottony egg masses, leaves coated with shiny, sticky honeydew, and the presence of attendant ants travelling up and down the vine trunks. The need to inspect vineyards for mealybugs can be based partly on past infestations and prior use of broad-spectrum insecticides. Grape mealybug prefer vigorous vines with thick canopies. Recent research on grapevine virus vectors indicates that grape mealybug is uncommon north of Oliver.

Biological Control

Parasitism of grape mealybug has not been studied in any detail in BC. However, a parasitic wasp formerly introduced into Canada from California for mealybug biological control was recently reared from grape mealybugs in the Okanagan. Based on the literature, more species of mealybug parasitoids are undoubtedly active in BC. Research in California has shown that at least six species of small parasitic wasps attack mealybug, with late summer and fall rates of parasitism often exceeding 90%. Silver flies were also recently reared from grape mealybug egg masses in the Okanagan where it was observed the larvae consumed a large portion of the eggs (A. Brauner, SuRDC). Other natural enemies of grape mealybug are predaceous midge larvae that feed on eggs and several species of lady beetles and other generalist predators that prey on nymphs and adults. Mealybug are susceptible to several diseases, including *Entomopthora* fungus.

Cultural Control

Mealybugs prefer vigorous vines. Ensure adequate nutrition and moisture to produce an optimum crop, but avoid excessive vigor. Research in California has shown that fruit on cane-pruned varieties is less likely to suffer damage compared with spur-pruned vines. Clusters on cane-pruned vines hang farther away from the mealybug overwintering sites on old wood. Earlier varieties are not exposed to honeydew to the same extent as later varieties.

Heavy infestations of mealybugs and other honeydew-producing pests of grape are usually tended by ants that feed on the sugary excretion and protect the mealybugs from predation. Control of ants can often contribute to a significant decline in mealybug numbers. For small backyard plantings with an isolated infestation, painting a sticky material around vine trunks and posts and ensuring that ants cannot gain access to the mealybugs often eliminates the problem. Trials in California have also shown that sprays directed against the Argentine ant, *Iridomyrmex humilis*, controlled damaging populations of the obscure mealybug, *Pseudococcus affinis*. Insecticides are not currently registered for the control of ants in BC vineyards.

Chemical Control

Vegol™ (formulated canola oil) can be applied as a late dormant spray or summer application, while insecticidal soap and malathion are best targeted against the crawler stage in spring. PureSpray Green™ horticultural oil applied in summer for mite control will also help control mealybugs. Owing to their good systemic activity, Clutch™ (clothianidin) and Movento™ (spirotetramat) can be used against all stages during the growing season. Movento should not be applied to table grapes. It and Clutch are listed as toxic to bees. Combined use of neonicotinoids should not exceed two sprays per season to avoid outbreaks of mites.

Soft Scale

European Fruit Lecanium Scale, *Parthenolecanium corni*
Cottony Vine Scale (= Cottony Grape Scale), *Pulvinaria vitis*
(Hemiptera: Coccidae)

Approximately 20 species of soft scale insects (Hemiptera: Coccidae) are known to attack grapevines in various regions of the world. Five species are now known to infest grapes in BC, but only two are commonly found: European fruit lecanium scale (EFLS) and cottony vine scale (CVS). **Both EFLS and CVS have been upgraded from minor to major pests due to their ability to transmit certain grapevine leafroll diseases, including Grapevine leafroll associated virus 3 (GLRaV-3) that is the most widespread and economically damaging leafroll disease in BC.** EFLS and CVS are also a concern in the production of table grapes where the large quantities of honeydew they produce supports the growth of sooty mold fungus that can leave fruit unmarketable.

Identification

Female EFLS, also known as brown apricot scale, when fully grown have a chestnut brown, smooth and slightly shiny protective shell that is around 5 to 8 mm long and slightly longer than wide (3e). Certain races in some regions reportedly produce males, but most females reproduce without mating. The small nymphs or crawlers that hatch from the small oval, pearly white eggs are yellow to orange in colour.

Mature female CVS are similar in size and colour to EFLS, but the body is slightly more elongate. The masses of cottony material containing orangey-red eggs that extrudes from underneath the scale tilts the female upward (3d). In other regions, male CVS are produced in late summer, do not have mouthparts, live for only a few hours to a week and mate with immature females. In North America it is presumed that the males are not present and that the females reproduce without mating, resulting in female offspring only. Mature female scales of both species become brittle after the eggs are laid and can easily be detached from the one to three-year-old wood with a fingernail.

Life Cycle and Damage

EFLS overwinter as 2nd instar nymphs on older wood where they can find shelter, often under the bark. In spring when the sap begins to flow, nymphs go through a growth spurt and moult in April to become adult females. In May, females produce 2000-3000 eggs under the body cavity that hatch into crawlers in June and July. The crawlers disperse to the undersides of leaves where they settle and feed until early fall when they moult into 2nd instars for the winter. Occasionally there is a partial 2nd generation with females producing fewer eggs while settled on the current year's shoots, clusters and leaf petioles.

CVS overwinter as young adult females primarily on new canes. In spring the adult female will increase in size, become darker in colour, more convex in shape, and form a cottony-like egg mass. Adult females produce on average 3500 eggs but have been known to produce up to 5000. Crawlers disperse in June and July to the undersides of leaves where they settle and feed until early fall. Mortality is as high as 90% during the crawler phase, primarily due to environmental conditions and failure to successfully settle on the host. Lacking a protective waxy covering, the crawler stage is susceptible to environmental conditions and is the stage most susceptible to insecticides. CVS increase in size over the summer, with the final moult in fall giving rise to the overwintering young adult female that is no larger than 3 mm in size. In autumn, the scale migrates from leaves to woody tissues and develops a hardened protective shell for the winter.

Both species of soft scale feed on the phloem of grapes and other woody plants, including fruit trees and ornamentals. Soft scales have become more abundant recently. Direct feeding damage from the removal of plant fluids is rarely a cause for concern, but the additional stress caused to weak vines might be sufficient to hasten death. As mentioned previously, the greatest cause for concern is the ability of EFLS and CVS to transmit GLRaV-3 in vineyards and for the vast amounts of honeydew they produce that fouls the fruit and supports the growth of sooty mold fungus, potentially rendering table grapes unmarketable.

Monitoring and Spray Thresholds

Look for partly grown CVS during pruning and for mature females with cottony egg masses in late spring. Watch for honeydew on leaves and fruit during late spring and summer. Ants feed on the honeydew and will protect the scale from predators (3d). They can often be seen in large numbers hurriedly running up and down posts or vine trunks to and from infested canes.

To detect when small crawlers are active, remove the loose bark in an area near the infestation and encircle the vine with clear tape applied sticky side out or use double-sided adhesive. Replace the tape weekly and check for the orange coloured crawlers. A good magnifying glass or dissecting microscope is useful for this purpose.

There are no established thresholds for direct damage from soft scale infestations and small to moderate numbers of scale on a healthy vine are unlikely to result in direct damage due to the removal of fluids and nutrients; treatment of table grapes is required when the honeydew they excrete fouls the fruit. I**t is important to control infestations of soft scale if vines or neighbouring vines are known to be infected with GLRaV-3 or other leafroll viruses.**

Biological Control

In European vineyards, scale populations are often controlled by parasitic wasps and predators. Very little was known about the natural enemies of soft scale, specifically CVS, in the Okanagan prior to an on-going study* initiated over the 2019 field season. Of 545 adult female CVS (with and without egg masses) collected in late May to early June, just over 80% were parasitized. A total of 990 parasitoids of six different species were reared from 42 adult females. On average, 23 parasitoids emerged per adult scale, while 68 were collected from one individual. The most abundant parasitic wasp species was *Coccophagus scutellaris* (94%). Of the scales producing egg masses, 93% had silver fly larvae (*Leucopis* species) consuming a very large portion of the eggs. Of nymphs collected from leaves throughout the summer, approximately 67% were parasitized by 13 different parasitoid species.

In addition to parasitoids and silver flies, soft scale are also preyed upon by lady beetles and other generalist predators. English sparrows and several species of warblers that feed on fully grown soft scale have been known to curtail infestations in some regions.

*Study of soft scale parasitism and updated information provided by A. Brauner, SuRDC, as part of the AAFC CAP, 2018-2023 Canadian Grapevine Certification Network grapevine virus project.

Cultural Control

Healthy vines of moderate vigor are less susceptible to scale infestations and are better able to withstand damage. Routine pruning removes many scales, and a small infestation might be pruned out in spring or early summer. Removal of basal leaves in late June from the fruiting zone for the control of leafhoppers will also help reduce scale populations.

Chemical Control

Oil or lime sulphur applied as high-volume dormant sprays to the trunks and cordons of vines for the control of powdery mildew will help suppress soft sale and other small, soft bodied pests of grapevines. Malathion, insecticidal soap, and Vegol™ can be used against the crawler stage, and the latter can be applied during the summer against nymphs. Repeat applications might be required as long as crawlers are active. Movento™ (spirotetramat) is registered for the control of scale on wine grapes during the growing season, **but it should not be applied to table grapes.**

Secondary and Minor Pests

Several insect and mite pests of grapes occur infrequently or only cause significant amounts of damage after chemical sprays have reduced predator and parasitoid populations that normally regulate their numbers. The best way to manage these pests, then, is to properly manage populations of primary pests in order to preserve and enhance numbers of beneficial insects and predacious mites.

Thrips

Western Flower Thrips, *Frankliniella occidentalis*
Flower Thrips, *F. tritici*
Grape Thrips, *Drepanothrips reuteri*
(Thysanoptera: Thripidae)

Several species of thrips can be found feeding, at least occasionally, on grapes; the three most common are the western flower thrips (WFT), the grape thrips (GT), and the flower thrips (FT). **Thrips are generally minor pests of wine grapes but are important pests of table grapes due to scarring of fruit.** Their populations often increase following applications of broad-spectrum insecticides that reduce numbers of beneficial insects. All species feed in a similar manner, but differences in biology and timing of infestations results in differential damage to grapes.

Identification

All species have long, slender bodies with dark protruding eyes and relatively short beaded antennae. Adults have two pairs of wings that are heavily fringed along the edges. WFT are dark yellow to brown and 1 to 1.5 mm long (5a). GT and FT are both around 1 mm long, the former is amber yellow with a yellowy-orange thorax, and the latter is uniformly pale yellow to nearly white. Nymphs of all species are similar in appearance to the adults except that they are smaller, slightly paler in colour and lack wings. Thrips tend to be very active; adults not only fly but also run and hop rapidly.

Plant feeding thrips should not be confused with predaceous thrips. Adults of beneficial thrips may be dark black or purplish black with clear wings or wings that appear light grey with white bands; or they are pale with dark bands on the wings. They are slightly larger to nearly twice as large as the pest species. Nymphs of predaceous thrips have bodies that are banded yellow and orange, are reddish purple in colour, or are pale with the joints of the appendages dark. Compared with phytophagous species, predaceous thrips have enlarged and slightly curved front legs that they use for grasping prey. These features and the slightly larger mouthparts are best observed under a dissecting microscope.

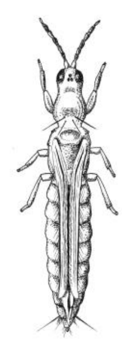
Life Cycle and Damage

Adult female thrips overwinter under leaves and plant debris on the ground. In spring they deposit their eggs into developing leaf, stem, and flower tissues. The time from egg to adult is about three weeks during warm weather and several generations are produced yearly. Most thrips feed on a wide range of host plants and large numbers will often move to a succession of new succulent hosts throughout the year. Both adults and nymphs feed by rasping the leaf surface and sucking up the escaping fluids.

WFT adults enter vineyards in early spring, often in large numbers, when Saskatoon bushes have finished flowering and other native vegetation is beginning to dry down. In addition to ground cover plants, WFT feed on flower and fruit tissues of grapes from bloom to just after fruit set. Their feeding under caps and persistent flower parts causes berry scarring and russeting (5b). White and green grape varieties are also damaged when females insert their eggs into fruit, causing dark spots or halo spots. Feeding on developing shoots is occasionally so heavy that shoots are stunted and leaves deformed (5b), but damage of this sort often only occurs around the perimeter of vineyards. WFT usually decline greatly in numbers following fruit set. FT have a similar biology and contribute to the damage caused to fruit in spring, but they are not as numerous as WFT.

GT are generally only found in significant numbers on grape during the summer months and their feeding is largely confined to leaves and shoots. Numbers can build up rapidly, however, particularly following insecticide treatments for other grape pests. Leaf veins can be scarred and fail to expand properly, leaf edges can become necrotic, and shoot growth inhibited, resulting in shortened internodes.

Monitoring and Spray Thresholds



WFT often invade vineyards in large numbers for only brief periods in spring and it and the FT are not normally an economic concern for wine grapes. Scarring of fruit has not been shown to affect wine quality and damage to leaves and shoots is usually minor. Damage usually occurs over a short period of time, which makes early detection and control difficult. Inspect table grapes for the presence of WFT and FT in spring from around 75% bloom to the end of fruit set and apply insecticides as required. Verify the presence of thrips by sharply striking fruit clusters or leaves against a dull white or green coloured surface. The decision to spray should be based partly on the table grape variety, records of past damage, and the intended market for the fruit. There are no firm thresholds for the control of thrips on grapes in BC.

Watch for GT damage to young leaves and shoots during summer and early fall. Use an eyepiece or magnifying glass to verify that thrips are present. As for fruit clusters, leaves and shoots can be held over a piece of white cardboard and sharply hit to dislodge the thrips. Control on mature vines is usually only warranted when growth is stunted sufficiently early in the summer to delay ripening and affect growth the following season.

Biological Control

Predatory bugs such as the minute pirate bug (*Orius tristicolor)*, anthocorids (*Anthocorus melanocerus*), and deraeocoris (*Deraeocoris brevis*) are all known to feed on thrips. Studies in the Okanagan and Similkameen valleys have indicated that predatory thrips are important regulators of pest thrips populations. In the laboratory, predatory thrips at a density of one every 10 to 15 leaves is sufficient to control WFT.

Cultural Control

So that thrips are not forced to feed on table grapes when they are most susceptible to fruit damage, avoid mowing cover crops during bloom and fruit set.

Chemical Control

Spinosad (Success™ or Entrust™) is registered for suppression of thrips on grapes. To protect bees, avoid using Clutch™ (clothianidin) or Harvanta™ (cyclaniliprole) before or during bloom. Avoid using Clutch and other members of the neonicotinoid class (4) of insecticides more than twice a season to avoid mite problems. Insecticidal soap and oils applied for the control of other grape pests will help suppress thrips populations.

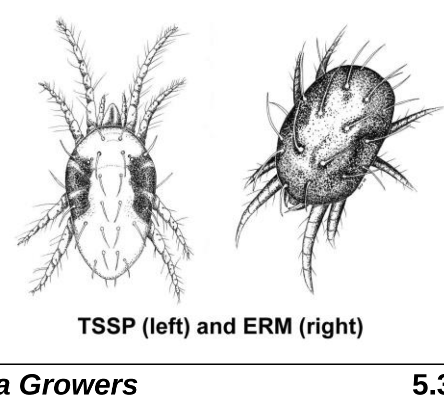
Spider Mites

European Red Mite, *Panonychus ulmi*
Two-spotted Spider Mite, *Tetranychus urticae*
McDaniel Spider Mite, *T. mcdanieli*
(Acarida: Tetranychidae)

The main species of spider mites infesting grapes in BC are the European red mite (ERM), two-spotted spider mite (TSSM), and the McDaniel's spider mite (MSM). A detailed survey would likely reveal the presence of two other species known to occur in WA. They differ somewhat in biology, but feeding damage and management strategies are largely the same. **Spider mites should be considered secondary or induced pests of grapes; their numbers increase following the use of broad-spectrum insecticides that reduce numbers of spider mite predators.** Although they can be somewhat selective, insecticides such as Assail™ and Clutch are toxic to predacious thrips that are effective predators of mites in BC vineyards. Studies in Washington State have also shown that the active ingredient in Assail and related materials increases spider mite reproduction. Due to its persistence, increases in mite numbers can occur up to several months after application. Mite outbreaks can also occur following applications of pyrethroid insecticides (e.g. permethrin) and other broad-spectrum insecticides.

Identification

Adults are small, around 0.5 mm in length, and best viewed with the aid of a magnifying lens. They are nearly spherical in shape and have eight legs and short piercing mouthparts. The ERM is dark red in colour with long pale hairs (setae) projecting from small pale circular areas on the dorsal surface (4h). The oval eggs are bright orange with a distinctive hair-like projection on the upper side. TSSM vary in colour



TSSP (left) and ERM (right)

from pale yellow to greenish yellow to orange; the common pale form has a distinct dark dorsal spot on each side of the body (4g). Its eggs are white. MSM appear similar to TSSM but with more scattered diffuse dark dorsal markings on the abdomen. All species feed on the undersides of leaves. TSSM usually congregate in clusters and produce large quantities of silk webbing, while ERM produce less webbing and are more evenly distributed over the leaf surface.

Life Cycle and Damage

ERM pass the winter as eggs laid on vine canes and trunks. Eggs hatch in spring and the young microscopic nymphs begin to feed on young foliage. TSSM and MSM overwinter as fertilized females under the bark or in other sheltered areas around the base of vines. When warmer weather arrives in spring the females begin to feed and deposit eggs. There are multiple overlapping generations each season and all stages can be found on grapes at any time during the summer months. Females are able to produce 200 or more eggs each. With an ability to grow quickly, **spider mite populations can explode rapidly under favorable conditions**.

Adults and nymphs feed by piercing individual leaf cells and removing the fluid contents. Healthy grapevines can tolerate moderate numbers of spider mites that cause chlorotic stippling on the leaves. Heavy feeding results in brown leaves that fall prematurely, reducing photosynthetic activity and vine vigour. Heavy feeding damage can delay ripening of fruit. The large amount of webbing produced, particularly by the TSSM, can also be a cosmetic problem for table grapes.

Monitoring and Spray Thresholds

Spider mites rarely cause significant damage to grapes prior to mid-summer. Stippling and bronzing of leaves and the presence of webbing and cast skins is often the first indication of damage in summer. No firm thresholds have been developed for spider mites on grapes in BC. Firm thresholds have also not been established in the Pacific Northwest of the U.S., but it is suggested there that economic damage is unlikely at levels below 15 to 20 per leaf. An approximate guideline suggested from European research for ERM and TSSM is a threshold of 60 to 70% infested leaves in spring and 30 to 45% in summer. A good hand lens or low-power dissecting microscope would help provide accurate counts of infestation levels. An alternate fairly reliable method is to monitor damage to leaves and spray when a moderate 10% amount of 'bronzing' has occurred to leaves. Because mite numbers can increase very rapidly it is necessary to monitor grapes frequently during hot weather.

When monitoring for mite damage it is useful to consider previous infestation levels and the presence of predacious mites. Vineyards with low chemical inputs that have not experienced severe spider mite outbreaks in the past are unlikely to require treatment, while those that have been treated with broad-spectrum insecticides should be observed more closely. More than five applications of Sulphur in a growing season is thought to increase numbers of spider mites, as are dry and dusty conditions.

Biological Control

Spider mites were of minor importance prior to the widespread use of synthetic pesticides. Due largely to the harmful effects of pesticides on populations of predators, spider mites are now the most important pests of grapes in many regions of the world. **The first course of action for the management of spider mites is the preservation and enhancement of beneficial species**. Pesticides should only be applied when necessary and only to parts of the vineyard where pest populations are sufficiently high to warrant control. Whenever possible select materials that are least damaging to non-target species. Numbers of spiders and beneficial insects are usually higher in vineyards with permanent, mixed groundcover that provides pollen and alternate sources of prey. Proximity to uncultivated or unsprayed areas allows beneficial insects and predatory mites to re-colonize vineyards following spray treatments.

Several species of predatory mites (e.g. *Metaseiulus*, *Typhlodromus* and *Amblyseius* species) feed on spider mites and their eggs. Most beneficial mites are a pale opaque colour, but they can appear light orange if they have been feeding on ERM. They are oblong in shape and slightly smaller than adult spider mites. The long-legged orange whirligig mite (*Anystis agilis*) is uncommon on grapes in BC. Like most other predatory mites, this large species is more active than its prey. Predatory mites are very sensitive to a range of pesticides, including sulphur at high rates and pyrethroids such as permethrin (Pounce™).

A number of spiders and predatory insects feed on spider mites or their eggs. Many species, such as the minute pirate bug (*Orius tristicolor*), are generalist predators that do not specialize on mites, while others such as the aptly named spider mite destroyer, *Stethorus picipes*, are very effective predators that feed almost exclusively on mites. *Stethorus picipes* is a small, dark species of ladybeetle with a slightly hairy appearance. The elongate bodies of the larvae are also nearly black in colour with a body covered with numerous hairs. At least four species of predatory thrips can be found in Okanagan Valley vineyards; adults of three of these are black, while the fourth, the six-spotted thrips, *Scolothrips sexmaculatus*, is pale with dark spots on the wings. All four species feed on pest thrips and spider mites. The western flower thrips is considered a pest of grapes, but it is also known to feed on the eggs of spider mites.

Cultural Control

Vineyards can be managed in ways that help alleviate mite problems. Hot, dry and dusty conditions favour the buildup of spider mite populations. Where mites are a persistent problem, roadways can be treated with oils or other materials to reduce dust. Vineyards that are continuously cultivated will produce more dust than those with permanent ground covers. Moreover, a permanent mixed groundcover will support greater numbers of beneficial insects and predaceous mites. Compared with bare soil, planted drive rows will decrease air temperatures and raise humidity levels somewhat, providing less favourable conditions for spider mites. Spider mite populations can become elevated on vines suffering drought stress and these plants are also less able to tolerate damage. Overhead irrigation will help reduce mite infestations.

Chemical Control

The miticides Envidor™ (spirodiclofen), Nexter™ (pyridaben) and Agri-Mek™ (abamectin) are listed for mite control on the BCMA guide to pest control products recommended for grapes, as is the insecticide malathion. Safer's Insecticidal Soap™, Vegol™ or PureSpray Green Spray Oil™ provide a more benign approach to mite control but offer only moderate suppression. Materials with different modes of action (chemical groups) should be used in rotation to help prevent the development of resistance.

See also *Grape-Spider Mites*, Pacific Northwest Pest Management Handbooks, available at: https://pnwhandbooks.org/insect/small-fruit/grape/grape-spider-mite

Grape Erineum Mite

= Grape Leaf Blister Mite, *Colomerus vitis* (Acarida: Eriophyidae)

Identification

Adult erineum mites are only 0.2 mm long and a dissecting microscope is required to observe them properly. Their creamy pale bodies are elongate with only two pairs of legs. Although erineum galls can be confused with certain fungal diseases or phylloxera leaf galls, their characteristic appearance is the best way to identify these pests. The hemispherical concave galls or erinea formed on the undersides of leaves initially have a felty white appearance due to the presence of densely packed long leaf hairs (4d). Opposite to these galls, bumps will be visible on the upper surfaces of leaves. These swellings are a reddish colour in spring and turn green as the leaves mature. Small numbers of mites feed on the dense hairs in each gall, which eventually turn brown.

Two other forms of erineum mite, the leaf-curling strain and bud-inhibiting strain, have been reported recently from Washington State and are possible in BC. The former causes slight to severe downward curling of leaves in summer with stunting of shoots and increased growth of lateral shoots. Feeding of the bud-inhibiting strain on buds causes a range of abnormalities, including scarified shoots, short zigzagging internodes, dead terminal buds and malformed leaves.

Life Cycle and Damage

Adult erineum mites overwinter under the scales of buds. Mites move in spring to developing shoots and create galls on young leaves around the fruiting zone. Several generations are produced each year with new galls developing higher up the shoots. Beginning in late summer, adult mites move back to the buds for winter.

Leaves with erineum galls appear to function normally and there is little or no economic damage to mature vines until almost all leaves are covered with galls. Even then, damage usually only occurs if vines are also suffering from other stresses. Establishment of newly planted vines can be delayed somewhat by erineum mite feeding that will retard or reduce fruiting.

Recently published studies have suggested that the grape erineum mite is a possible vector of Grapevine pinot gris virus. The economic status of this pest would change considerably if further research verifies this to be true.

Monitoring and Spray Thresholds

Erineum galls are usually very apparent during routine vineyard operations. Grape varieties differ in susceptibility to this pest and it is important to check individual blocks for the presence of mites. In order to prevent premature loss of leaves, new vines should be inspected and treatments applied if large numbers of galls are found on most leaves during the spring or summer months.

Biological Control

The western predatory mite, *Galendromus occidentalis*, is an important erineum mite predator. Predaceous thrips will feed on exposed mites, but their effectiveness is likely limited when mites are protected within the dense hairs of the galls.

Cultural Control

New plants may become infested in the nursery. **Ensure that material used to establish new vineyards is free of mites and other pests or diseases.** Removing galled leaves can control light infestations to some extent. Research conducted in the Okanagan Valley demonstrated that removal of infested leaves in May did not alter yields or fruit quality. Removal of basal leaves in June for leafhopper control will remove a significant portion of the erinea galls.

Chemical Control

Erineum mite is seldom a problem in vineyards where sulphur is applied routinely for powdery mildew control. **Applications of sulphur are most effective early in the season when galls are first being formed on new leaves**. Sulphur sprays should not be used on Foch or *Vitis labrusca* varieties. Oils (Vegol™ and PureSpray Green™) and insecticidal soap are registered for suppression, and miticides such as Nexter™ applied against spider mites and sprays of malathion for control of leafhoppers will also reduce numbers of erineum mite.

Grape Leaf Rust Mite

Calepitrimerus vitis (Aracida: Eriophyidae)

Grape leaf rust mite, which belongs to the same family (Eriophyidae) as grape erineum mite, was identified for the first time on grapes in the Okanagan Valley in 2009.

Identification

A microscope is required to properly identify these 0.2 mm long pale white wormlike mites that closely resemble erineum or blister mites but do not form leaf galls. They are much smaller than spider mites and elongate rather than round, tapering at the rear, and having two pair of legs near the head (4e). Their presence is best determined by the bronzing of leaves during July and August, a result of their feeding. Unlike spider mites that cause similar bronzing to leaves, grape leaf rust mites are microscopic and do not produce webbing.

Life cycle and damage

Adult rust mites that spend the winter under bark or bud scales move in the spring to the developing buds to feed and lay eggs. Large

See also: Jensen *et al.*, 2017. Grape leaf rust mite, *Calepitrimerus vitis* (Acari: Eriophyidae), a new pest of grapes in British Columbia. J. Entomological Society of B.C.

numbers of adults concentrated on the available green tissue in early spring can damage buds, resulting in deformed leaves, scarring of shoots, reduced shoot growth, reduction or loss of fruit clusters, and even death of buds (4f). Early season rust mite damage can be confused with cold injury or damage from other causes. Damage becomes less visible as the season progresses and shoots lengthen.

Immature mites that hatch over a period of several weeks feed under the bud scales, eventually moving to feed on developing leaves. Unlike spider mites, rust mites equally infest the upper and lower leaf surfaces. Many generations are produced throughout the summer. Before leaves drop in fall, adult rust mites migrate to the cordon and trunk for the winter. Bronzing of leaves is most obvious during July and August, but damage to leaves at this time is not thought to seriously damage vine health. Extensive bronzing of leaves is an indication, though, that rust mites need to be controlled the following spring.

Monitoring and Spray Thresholds

There are no established thresholds for this pest. Control the following spring is indicated when a significant proportion of leaves become bronzed in late summer.

Biological Control

As for erineum mite, western predatory mite, *Galendromus occidentalis*, other mite predators, and predacious thrips are capable of keeping rust mites in check. To maintain healthy populations of beneficial insects and predatory mites, it is important whenever possible to limit the use of insecticides and to apply selective materials that are less toxic to predatory mites.

Chemical Control

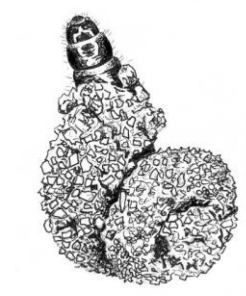
A successful rust mite control program developed in Australia relies largely on spring applications of sulphur **(e.g. Kumulus™ DF, or wettable sulphur) in high volume sprays during bud swell to woolly bud stage**. Sulphur sprays should not be used on Foch or *Vitis labrusca* varieties, as they are susceptible to leaf and fruit damage. There are no miticides currently registered for the control of grape leaf rust mite.

For additional information on grape leaf rust mite control, see '*Grapevine Pests and Their Management*, G. Dunn & B. Zurbo, 2014. Primefact , New South Wales Dept. Primary Industries, NSW Austalia. https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0010/110998/Grapevine-pests-and-their-management.pdf

Snailcase Bagworm

Apterona helix (Lepidoptera: Psychidae)

Identification



This introduced moth remains throughout most of its life within a snail-like case made from particles of soil and sand bound together with silken threads. When fully grown the coiled case is approximately 4 mm in diameter (4f). There are no males and the wingless female moths remain inside the case to deposit their eggs without having mated (parthenogenetic reproduction). Large aggregations often form on posts, tree trunks, or vine trunks in late summer.

Life Cycle and Damage

Young caterpillars overwinter within the case formed by the mother. They drop to the ground in spring, form C-shaped cases, and begin to feed on a wide range of weeds, native plants and cultivated crops. Feeding damage consists of small excavated holes on the leaf surface. As the larva grows it eventually expands its case into the typical snail-like, helical shape. In mid-summer the fully grown larvae will climb vines, posts or buildings, attach themselves firmly with silk, and pupate within the case. Attachment to overhead sprinkler rotators can occasionally cause them to malfunction. Several weeks later the females emerge, lay eggs, and then exit the case to die. The eggs hatch in late summer and the small first instar larvae spend the winter within the protective cases. There is only one generation per year.

Monitoring and Spray Thresholds

Larvae of the snailcase bagworm cause minimal feeding damage to leaves and they are not considered economic pests of wine grapes. The large aggregations are easily detected on buildings, posts, wires, and the trunks of vines. If contamination of table grapes is a concern, inspect vines and apply control measures before the overwintering aggregations form in late summer. The non-feeding overwintering stage, secure within the case, is not susceptible to insecticides.

Biological Control

Because it has not yet been adequately studied, natural enemies of this pest of grapes in BC are unknown. The protective case would provide some shelter from certain generalist predators, but predators, parasitoids and diseases undoubtedly take their toll.

Cultural Control

Snailcase bagworm prefer moist areas with thick vegetation. Avoid excessive irrigation and drain areas that puddle or remain damp. Bagworm are uncommon in vineyards planted on light soils with drip irrigation. Proper drainage will also help reduce grapevine root diseases. Frequent mowing of areas of the vineyard where bagworm are a problem can help reduce infestations.

Chemical Control

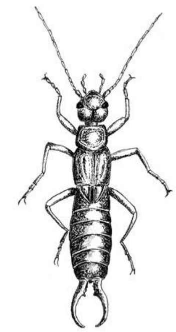
Dipel™ and Bioprotec CAF™ (*Bacillus thuringiensis*) are registered for snailcase bagworm control on grapes, and sprays applied for the control of other insects will provide protection. For this reason, they are more common in organic vineyards or conventional vineyards with low chemical inputs.

European Earwig

Forficula auricularia (Dermaptera: Forficulidae)
(Order Dermaptera)

The European earwig is both a beneficial insect on wine grapes and a pest of table grapes. All stages feed on small, soft-bodied insects such as small leafhopper nymphs and will scrape leafhopper eggs off of leaves. In fall they feed to some extent on damaged grapes and their presence in table grapes is not appreciated by some consumers. On grapes produced for wine they should be considered important generalist predators.

Identification



Adult earwigs are dark brown, about 1.5 cm long, with a pair of forcep-like appendages (cerci) at the rear of their elongate bodies. The anal forceps of females are long and straight, while those of males are curved. Earwigs seldom fly and the membranous hind wings usually remain folded under the short leathery forewings, exposing the abdomen. The four nymphal stages resemble the adults except that they are smaller and wingless. Earwigs are largely nocturnal and hide during the day, often in large aggregations, in cracks and crevices or under bark. When disturbed they move quickly.

Life Cycle and Damage

Adults overwinter in the ground in earthen cells. Clutches of eggs laid in cells in the top 5 cm of soil in the fall and spring are opened by females in spring to release the young nymphs. Adults are semi-social and tend their young for a period of time after birth; nymphs later disperse to secure locations under rocks, in crevices, or under bark. Adults develop by mid-summer and there is only a single generation per year. Earwigs are nocturnal and feed at night on damaged fruit, tender plant tissue, small soft bodied insects, and other foodstuffs. They rarely damage grape leaves.

Monitoring and Spray Thresholds

Rolled up newspaper or cardboard, or flat boards placed on the ground, can be used to monitor earwigs. It might be possible to use these same refuges to enhance their numbers in wine grapes.

Biological Control

Birds, large spiders, wasps and ground beetles prey on earwigs. **Earwigs, in turn, feed on the eggs and small nymphs of leafhoppers and**

on other soft bodied insects.

Cultural Control

Tillage in spring and fall will destroy some of the earthen cells. For table grapes, mowing, tillage, removal of loose bark from vine trunks, and sanitation will remove hiding places and help reduce earwig numbers. They can be kept out of small plantings of table grapes by applying sticky tape or commercial Stickum® around trunks and posts. Washing table grapes after harvest will help dislodge many earwigs. They are less likely to seek refuge in table grape varieties with loose, open fruit clusters.

Chemical Control

Earwigs are sensitive to most insecticides applied for the control of other pests of table grapes. For this reason, earwigs are a greater concern for organic table grape production. Commercial earwig baits are also available.

Root Weevils

Black Vine Weevil, *Otiorhynchus sulcatus*
Raucus Root Weevil, *O. raucus*
(Coleoptera: Curculionidae)

Life Cycle and Damage

Black vine weevil and raucus root weevil spend the winter in the soil as pale, legless larvae feeding on the roots of a wide range of plants. It is not known if they feed on the roots of grapevines to any extent.

Adult black vine weevils feed during late spring and summer on grape clusters and leaves and sometimes girdle fruit clusters. They are active only at night and remain hidden under plant debris or loose bark during the day, making detection difficult. Raucus root weevil adults, in contrast, can often be found feeding on the buds of grapes at twilight or on overcast days. Earlier emergence in spring of adult raucus root weevil coinciding with the development of grape buds accounts for the greater damage by this species as compared with the black vine weevil. Although localized and usually confined to the edges of vineyards, infestations of raucus root weevil have occurred occasionally in large numbers that required control. The raucus root weevil was reported from the Okanagan Valley for the first time in 1979 and there have been several localized outbreaks documented since that time. Damage by these pests has increased as of late.

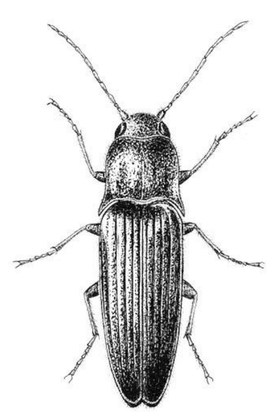
Identification

The flightless adults of both species have long, broad 'snouts' typical of weevils. The thick, roughened front wings are fused together. Adults range in size from 5.5-7.5 mm for the raucus root weevil and 7.5-10 mm for the black vine weevil. In addition to their slightly smaller size, raucus root weevil can be differentiated from black vine weevil by their generally lighter, patchy appearance and often a distinct difference in colour between the head/thorax and the elytra that cover the abdomen (1f).

Black vine weevil adults are a uniform black colour. Unlike adult raucus root weevil that damage buds, leaves with deeply notched edges not associated with damage from other chewing pests are an indicator of black vine weevil feeding. Traps for both species can be made from cardboard loosely wrapped around vine trunks where the weevils will hide during the day. Adults can also be collected on beating trays placed beneath canes and cordons that are hit sharply with a stick. Care needs to be taken, however, as adults often fall to the ground as they are approached.

Click Beetle

(Coleoptera: Elateridae)



Click beetles were formerly considered to be important pests of grapes in BC, however extensive study in Okanagan vineyards over a number of years has shown that most of the damage formerly attributed to click beetle adults was in fact caused by half grown cutworm larvae. Several species will feed occasionally on buds of grapes, but control is usually not warranted. Click beetles are also not considered pests of grape in Washington State.

Identification

Click beetle larvae, called wireworms, have long, slender, hard bodies that are a light tan to a light orange-brown in colour and appear somewhat shiny and polished. Their short legs and cylindrical slender bodies allow them to burrow through the soil to feed on the roots of plants. Adult beetles have elongate somewhat flattened bodies usually in shades of brown or black (1e). The segment behind the head has small projections that point backward on each side of the body. Adults of most species are around 1 to 1.5 cm in length but some are significantly larger. When adults are placed upside down in the palm of a hand or gently held between finger and thumb they will rapidly flex their bodies at both ends and attempt to right themselves or escape with a characteristic clicking action.

Life Cycle and Damage

Adults that have spent the winter under debris and leaves emerge with the arrival of warm weather in spring to feed on the tender buds and leaves of a wide range of plants, occasionally including grapes. They are often quite common on flowers where they feed on soft tissues and pollen. After feeding for a short time, females begin to deposit eggs into the soil. In two or three weeks the eggs hatch into larvae resembling small slender 'worms' that develop in the soil throughout the summer. Click beetles can persist for a long time without feeding and they often require more than one year to complete development to the adult stage.

Larvae are not known to damage the roots of grapes to any extent, preferring to feed on the roots of weeds or grasses. Click beetle adults are often seen feeding on sap from pruning cuts. As for cutworm larvae, feeding of click beetle adults causes death of developing buds, reduced yields, and delayed and uneven ripening of fruit. Little damage occurs after bud break.

Monitoring and Spray Thresholds

Adult click beetles feed on buds so infrequently that monitoring for these pests is generally not warranted. **The presence of adult click beetles in a vineyard does not indicate feeding or correlate with damage.** There are no established thresholds in BC relating click beetle numbers to bud damage. To determine if bud damage is due to click beetles or cutworm larvae, it is best to inspect vines with the aid of a flashlight after dark on warm spring nights.

Biological Control

Little information is available on the biological control of click beetles in BC vineyards.

Cultural Control

As for climbing cutworm, the presence of broadleaf weeds in spring helps reduce click beetle damage to grapes.

Chemical Control

Chemical control of click beetles is generally not warranted and none are registered specifically for adults on bearing vines. Sprays for cutworm larvae should help control adult click beetle.

Flea Beetles

(Coleoptera: Chrysomelidae)

An as yet unidentified species of flea beetle, *Altica* sp., has over the past several years been found feeding on the leaves and shoots of newly planted grapevines in the south Okanagan. Specimens sent to the Canadian National Collection of Insects, Arachnids and Nematodes, AAFC-Ottawa, **verified that it is not the grape flea beetle**, *Altica chalybea*, native to eastern North America. Larvae of that species develop on grape leaves, while the larval host for this new pest of grapes in BC is not yet known. Damage has been sufficiently high in some vineyards to warrant control. Interestingly, feeding is largely restricted to new vines during the year of planting.

Similar in appearance to the crucifer flea beetle, *Phyllotreta cruciferae*, adults are small (~2mm), shiny metallic-looking beetles with an overall dark blue-black colour. The hind legs of these active insects are enlarged for jumping. This new presumably invasive pest is becoming more common and widespread and it would be helpful to learn more about its biology, in particular its larval development. There are no insecticides registered for control of this species, however, sprays applied for the control of leafhoppers should also provide control of this pest.

Miscellaneous Insect Pests

In addition to the major and secondary grape pests described in previous sections, a number of insects attack grapes in BC only very rarely and are generally not of economic importance. Following are brief descriptions of a few of these occasional pests.

Grasshoppers

(Orthoptera: Acrididae)

Adults and nymphs of several species of grasshopper feed on grape leaves, usually beginning in late summer when preferred hosts begin to dry down. Feeding by these well-known, long-legged jumping insects consists of chewing damage to leaf margins, most often on lower leaves.

Grasshoppers suffer from pathogenic diseases when populations are high. Preying mantids, toads, and many species of birds feed on adults, while smaller nymphs are attacked by spiders and a number of predatory insects such as ground beetles. Maintaining the growth of drive row vegetation, particularly broadleaf plants, over the season reduces feeding damage to grapes. Grasshoppers will be affected by most sprays directed against other pests of grapes.

Whitefly

(Hemiptera: Aleyrodidae)

Several species of whitefly occasionally infest grapes. Overwintering whitefly are relatively rare in BC. Some sub-tropical and tropical species, such as the common greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood), infest outdoor plants each season from infested greenhouses, house plants, and vegetable and ornamental transplants. Adults are small, around 2 mm in length, with two pairs of wings that are covered with a fine, white powder (3h). They somewhat resemble small white moths. The minute crawlers are mobile for only a few hours until they settle and develop into nearly translucent, scale-like immobile nymphs. The 'scales' have a fringe of waxy material projecting from the bottom edge (3g); the distribution and numbers of the projections can assist in species identification. The pupal stage that develops inside the case on the underside of leaves is somewhat bulbous and appears segmented. There are several generations per year. Whitefly feed by sucking juices from the leaves, much as scale insects do, and they also produce large amounts of sugary honeydew. Populations are controlled by parasitic *Encarsia* wasps that turn the scales black, by several predatory insects, and by pathogenic fungi.

Minor Cicada

Platypedia minor (Hemiptera: Cicadidae)

Adult minor cicada are about 2 cm long with two pairs of large, transparent wings held roof-like over the body (3b). The pale, wingless nymphs have enlarged front legs that they use to dig through soil. Cicadas are mostly known from the loud buzzing or clicking noises that males produce on hot summer days. They are difficult to locate and will move around to the opposite side of trees or posts when approached. Damage to individual shoots occurs occasionally when females deposit eggs into canes with their long, saw-toothed ovipositor. Deposition of several eggs into a cane can weaken it or cause it to break. The oviposition damage is recognizable by the slivers of wood protruding from a series of punctures. Newly hatched nymphs drop to the ground to spend two to three years feeding on the roots of plants. It is not known if they feed on the roots of grapes.

Buffalo Treehoppers

Spissistilus bisonia and *S. Bsalis*
(Hemiptera: Membracidae)

Ongoing research being conducted in the Okanagan valley, BC, on potential vectors of Grapevine red blotch virus (GRBV) has helped clarify the treehopper species present in this area. The three-cornered alfalfa treehopper that is suspected of spreading GRBV in the U.S. has not been found here. Rather, two closely related species of buffalo treehopper have been identified in BC vineyards. Adult buffalo treehopper are green or brown in colour and about 5-6 mm in length. The 1st section behind the head (pronotum) is elongated to the sides and extends to the rear of the abdomen so that they look somewhat triangular when viewed from the front. It has a hump-backed appearance of the American Bison after which it is named when viewed from the side.

Damage to the lateral shoots of grapes caused by treehoppers can somewhat resemble virus infection or other diseases. In summer late instar nymphs will produce a series of feeding punctures around leaf petioles or stems (3a), resulting in decreased flow of water and nutrients and eventual reddening of leaves beyond the feeding site. The initial feeding punctures coalesce into a darkened band of sunken tissue encircling the stem or leaf petiole. Although damage is often restricted to lateral shoots and generally not of economic concern, growth of newly planted vines could be stunted in areas with lots of alfalfa or other suitable host plants. The economic status of the buffalo treehopper would change if it was shown to spread GRBV.

Brown Marmorated Stink Bug

Halyomorpha halys (Hemiptera: Pentatomidae)

The brown marmorated stink bug (BMSB) was first found in eastern North America in 2001 and in BC in 2015. It has been trapped at various locations throughout the Okanagan, with the largest populations occurring in downtown Kelowna. To date, BMSB has not been collected from any vineyards in BC. Native to southeast Asia, the BMSB feeds on a wide range of vegetables, field crops, ornamental trees and shrubs, and fruit crops including grapes. Damage results from feeding punctures and removal of fluids from the plant, resulting in shrunken, distorted buds, shoots and fruit. Fortunately, grapes are reportedly not a preferred host. Damage mostly occurs in late summer and fall when adults are congregating and moving to sheltered locations prior to winter. At high levels, contamination of fruit at harvest can lead to 'wine taint'* due to the foul odor produced from the defensive glands of these insects.

Similar in size and shape to some of our native stink bugs, first instar nymphs are bright red marked with black; while adults are dark brown with white banding on the antennae and legs. Adults are a little more than 1.5 cm in length. In areas where they have become established they are often found feeding in close proximity to one another. Adults aggregate in large numbers in the fall to spend the winter in protected areas or invade houses.

> For additional information see *Brown Marmorated Stink Bug (BMSB) Pest Alert*, BCMA, at https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/tree-fruits/brown-marmorated-stink-bug#:

*Wine Taint, Multicolored Asian Ladybeetles, and the Environment

Wine taint caused when multicolored Asian ladybeetles (MALB), *Harmonia axyridis*, contaminate fruit at harvest is a concern for Ontario growers. As the name suggests, MALB adults are variable in colour, ranging from black to light orange and with a variable number of spots. Distinguishing features are its large size and usually a dark 'M' (or 'W') on the white pronotum. It is the most common ladybeetle species in Ontario and also in the interior of BC. As for other ladybeetles that are also brightly coloured to warn off potential predators, ladybeetles produce a number of defensive compounds. One of several, isopropyl methoxy pyrazine, is higher in the hemolymph (blood) of MALB than in any other ladybeetle species.

MALB, intentionally introduced to North America for the biological control of aphids and scale, did not establish well or reach high numbers until the accidental arrival of its favorite aphid prey species, the soybean aphid. MALB populations in Ontario now increase over the summer in soybean fields, after which they move in large numbers to find food and to aggregate for the winter. After eliminating their preferred foods they will feed and aggregate on grape clusters and be included in the fruit at harvest. Lacking expansive soybean fields here, MALB has not become a pest of grapes in the southern interior of BC and remains a beneficial species helping to control leafhoppers, scale, and other grape pests.

Hard Scale

(Hemiptera: Diaspididae)

Two species of hard scale, the oystershell scale, *Lepidosaphes ulmi* L., and San Jose scale, *Quadraspidiotus perniciosus* Comstock, are infrequently found attacking two-year-old wood of weakened vines. Hard scale do not produce large amounts of honeydew and are currently of little importance to the BC grape industry.

The smaller hard scales (1-2 mm), which are longer than wide, do not produce any cottony material and remain firmly attached to the canes even after death.

June Beetles

(Coleoptera: Scarabaeidae)

June beetles can occasionally damage the roots of grapes newly planted in land previously in pasture. The following description of ten-lined June beetle damage to tree fruits contained in the BC Tree Fruit Production Guide (bctfpg.ca/pest_guide/info/ 74/) is applicable to grapes.

"*When grass or orchard land preparation for planting trees destroys food plants, white grubs will feed on the fine root hairs and smaller roots of the transplanted trees. The trees gradually weaken and eventually die from lack of water and attack by wood-boring insects.*"

Native to the western U.S. and Canada, adult ten-lined June beetles (*Polyphylla decemlineata*) are large (~3 cm) dark coloured scarab beetles boldly marked with ten whitish stripes. Adults produce a hissing sound when held gently between two fingers. Feeding of adults on foliage causes little damage. The large white grubs or chafers grow to a size of 3-4 cm over a 3-4 year developmental period while feeding on the roots of grasses and various other plants. Other species of June beetles (June bugs) occur in the southern interior of BC, but the C-shaped white larvae (white grubs) of these smaller brown coloured beetles do not cause any significant damage to grapevines.

There are no insecticides registered for the control of June beetles. Control is achieved through fallowing and preparation of land prior to planting a new vineyard.

Wood-Boring Beetles

(Coleoptera: Bostrichidae)

Several wood-boring beetle species, including the branch and twig borer (*Melalgus confertus*), can occasionally infest grapevines or cause damage to wine barrels. Depending on the species, adults are brown to black, cylindrical in shape, and from 5-10 mm in length. The head is largely hidden under the enlarged pronotum. They have hardened forewings typical of beetles and indistinct body sections. The white cylindrical larvae have enlarged brown-coloured heads. Adults burrow into the spurs and canes at the base of new shoots to feed, causing them to wilt or break. The pale larvae or grubs burrow through weakened living or dead vine tissues, most often directly above or below a bud. The perfectly round holes that they create are ~3 mm in diameter. Infestations most often occur on weakened or diseased vines. The lead cable borer (*Scobia declivis*) feeds on grapevines, but the greatest economic damage occurs from the holes that larvae create in wine barrels.

Control of these pests is best achieved through sanitation and good vine health. Vineyards need to be kept free of wooden debris, and diseased and weakened parts of vines should be removed. Higher levels of damage occur near wooded and riparian areas that provide alternate hosts. Insecticides applied in spring for cutworm control are likely to also reduce borer damage to some extent.

Western Grape Rootworm

Bromius obscurus (Coleoptera: Chrysomelidae)

The western grape rootworm is a widespread pest of grapevines in Europe and California, but damage to grapes in BC was not reported until recently when an outbreak occurred in the Kelowna area. Fully grown larvae are C-shaped white grubs about 7 mm long with yellowish brown heads and dark mouthparts. Adult beetles are about 4 mm long and somewhat hairy with nearly black heads and dark bodies (5d insert). Adults, which are all females, start emerging in May and feed on the expanding leaves of grapes, causing long slit-like holes (5d). Larvae initially feed on root hairs before tunneling into the roots of grapevines. Feeding by western grape rootworm larvae is known to cause the death of vines in California due to direct damage to the roots and entry of secondary pathogens.

For additional information on the western grape rootworm, please see: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/western_grape_rootworm.pdf

Termites

Reticulitermes sp. (Isoptera)

Native species of subterranean termites occur in the dry interior of BC where they occasionally consume woody heartwood tissue of old or weakened vines or untreated support posts, causing vines and trellises to collapse. Termites live in the soil in colonies comprised of various forms, including queens, kings, workers and soldiers. The eyeless workers are 3-5 mm long with creamy pale bodies, while the slightly larger soldiers have enlarged heads and black jaws. They are distinguished from ants by their dull, pale colour, bead-like antenna, and broad rather than constricted waist connecting the abdomen. Living deep in the ground and feeding on dead woody tissue makes termites difficult to control with insecticides. None are registered for this purpose in BC. There are no effective natural controls, but sanitation and removal of wooden debris prior to planting will help delay infestations. Termites do not eat the outer living tissue, so maintaining healthy vines is helpful. Old, heavily infested vineyard blocks may need to be replaced.

Prevention of New Grape Pests

Provincial Entomologists (currently Susanna Acheampong, Kelowna; Tracy Hueppelsheuser, Abbotsford), AAFC researchers, and Canadian Food Inspection Agency (CFIA) regulators and inspectors contribute to the prevention of the arrival of new invasive pests of grapevines into BC. Importation of host plant material from areas known to harbor these pests is regulated and plants are inspected upon arrival or at the source nursery. Information is provided to industry members and the general public through talks, identification factsheets and brochures. It is inevitable that new economically important pests of grapevines will arrive in our region from elsewhere. **Growers can help prevent the establishment of new alien pests by knowing the species currently found in BC and reporting new pests and unfamiliar damage to grapevines.** The list of potential grape pests that might arrive in BC from elsewhere is very long. Following is a list of a few economically important ones and sources for additional information.

Japanese Beetle

Popillia japonica (Coleoptera: Scarabaeidae)

Japanese beetles were found for the first time in BC in Vancouver in 2017. Efforts are now underway to try to eradicate this pest of lawns, gardens, parks and agricultural crops. These distinctive looking beetles are about 12 mm in length with a bright metallic green body and shiny brown forewings (elytra). Tufts of white hairs occur at the rear and along the edges of the abdomen. The C-shaped larvae are similar to those of June beetles and other members of the scarab beetle family. Feeding by larvae is largely restricted to the roots of grasses. Adults often feed in large aggregations on a wide range of plants, with grapevines being one of the preferred hosts. Adults skeletonize leaves by eating the tissue between the leaf veins. Considerable economic damage is caused to grapes in Ontario, particularly those that are managed organically.

Additional information on Japanese beetle damage to grapes is available at: *Notes on Grape Insects: Japanese beetle*, OMAFRA http://www.omafra.gov.on.ca/english/crops/pub360/notes/grapejapbtl.htm#top

Light Brown Apple Moth

Epiphyas postvittana (Lepidoptera: Tortricidae)

The light brown apple moth, which is native to the cooler, wetter coastal regions of Australia, was found in parts of California in 2007. As for other members of this moth family (Tortricidae), it has a wide host range that includes ornamentals, fruit trees, berries, and grapes. There likely would be two generations under our conditions. Larvae that grow to about 10-18 mm in length are pale to medium green with a tan coloured head. Adult moths are medium tan often with oblique markings of darker tan to brown. Partly grown overwintering larvae feed on grape buds in spring and continue to feed on developing shoots, tender leaves and flower clusters as they mature. Damage to fruit later in the season reduces the crop and allows the entry of disease organisms.

For additional information see, *Grape: Light Brown Apple Moth*, UC IPM Online, Statewide Integrated Pest Management Guidelines. http://ipm.ucanr.edu/PMG/r302303011.html

Grape Berry Moths

European grape berry moth, *Lobesia botrana*
American grape berry moth, *Paralobesia (=Endopiza) viteana*

The European grape berry moth and the American grape berry moth are similar in appearance and cause similar damage to grapes. The former was first reported in Napa County, California, in 2009, and reportedly eradicated from the state by 2016 following a statewide trapping and management program. The American grape berry moth, native to eastern North America, is now found in parts of western Colorado. The slender larvae reach a maximum size of 1 to 1.5 cm and are green to light purplish with a darker contrasting head and first thoracic segment. The adult moths are generally less than 0.75 cm long and of a medium brown colour mottled in patches of lighter or darker brown, dark grey or blue depending on the species. Both are best identified by the damage caused by larvae feeding on flowers and fruit. Larvae of the 1st generation feed on developing buds, flowers and small berries and produce a significant amount of webbing. Larger 1st and 2nd generation larvae burrow into and feed on the fruit, leaving hollowed out skins and seeds. Grape bunches become contaminated with frass and webbing and are subject to fungal infections.

For information on the European grape berry moth see; *European Grapevine Moth*, UC IPM.

https://www2.ipm.ucanr.edu/Invasive-and-Exotic-Pests/Euopean-grapevine-moth/

For the American grape berry moth; *Grape Berry Moth Management*, Cornell University, CALS.
https://grapesandwine.cals.cornell.edu/newsletters/appellation-cornell/2011-newsletters/issue-6/grape-berry-moth-management/

Spotted Lanternfly

Lycorma deliculata (Hemiptera: Fulgoridae)

Native to southeast Asia, the spotted lanternfly was found in Pennsylvania in 2014. As of 2019 it has spread to New Jersey, Virginia, Maryland and Delaware, with additional detections in New York, Connecticut and Massachusetts. The spotted lanternfly has a wide host range that includes tree-of-heaven and grapes as preferred hosts. It is a serious threat to the production of tree fruits, grapes, ornamental trees and forestry. Feeding of nymphs and adults on the trunks, shoots and leaves of grapes removes large volumes of phloem which stresses the vines and causes reduced fruit set, increased winter injury, and death. Feeding sites on woody tissues are marked by weeping wounds. The large amounts of honeydew produced during feeding promotes the growth of sooty mold that fouls table grapes. In the northeastern U.S. adults will appear starting in July, with large numbers suddenly appearing in vineyards until frost

These large, colourful and active insects have a very distinctive appearance. Adults are 2-2.5 cm long with dark legs and a yellow abdomen marked by a central black stripe. The front portion of the greyish-brown front wing is marked with black spots and the rear section marked with dark broken fine lines. The front section of the hind wings is red with black spots; the rear section is white with black bands. Small nymphs are black with white spots; larger nymphs are boldly coloured in black, white and red.

The overwintering eggs that are laid in masses and initially covered in a wax-like covering account for the rapid spread of this pest. A preference for smooth vertical surfaces, such as the sides of cars, transport trucks, and trains, on which to lay eggs has resulted in eggs being transported widely. There is one generation per year.

For additional information see:

Spotted Lanternfly – Lycorma deliculata. CFIA website https://www.inspection.gc.ca/plant-health/plant-pests-invasive-species/insects/spotted-lantern-fly/eng/1433365581428/1433365581959

Spotted Lanternfly Management in Vineyards, Penn State Ext., 2019. https://extension.psu.edu/spotted-lanternfly-management-in-vineyards

Additional Resources:

Note!! Environmental conditions, the grape pest complex, and registered pesticides differ for BC as compared to other grape-producing regions.

Pacific Northwest Pest Management Handbooks> Small Fruit Crops> Grape Pests. 2020. Skinkis, P., V. Walton, and B. Edmunds. https://pnwhandbooks.org/sites/pnwhandbooks/files/insect/chapterpdf/insect20-i-small-fruits.pdf

How to Manage Pests: Grape. UC IPM Online, Statewide IPM Program, UC Agr. & Nat. Res. http://ipm.ucanr.edu/PMG/selectnewpest.grapes.html

2019 Pest Management Guide for Wine Grapes in Oregon. Oregon State Univ. Skinkis, P.A., J.W. Pscheidt, M.L. Moretti, V.M., Walton, K.C. Achala, and C. Kaiser. 2019 https://ir.library.oregonstate.edu/concern/technical_reports/0c483r698

2017 Pest Management Guide for Grapes in Washington. WSU Ext. EB0762. D. Walsh, Section Coordinator: Insects. https://research.libraries.wsu.edu/xmlui/bitstream/handle/2376/6488/EB0762.pdf

Information for Commercial Grape Growers in Ontario. 2020. Ont. Min. Agr. Food & Rural Affairs. http://www.omafra.gov.on.ca/english/crops/hort/grape.html