Crop Profile for Grape in Canada, 2022

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Preface

National crop profiles are developed by the Pest Management Program of Agriculture and Agri-Food Canada (AAFC). The crop profiles provide baseline information on production and pest management practices and document growers' needs to address pest management gaps and issues for specific crops grown in Canada. This information is developed through extensive consultation with stakeholders and data collected from reporting provinces. Reporting provinces are selected based on their acreage of the target crop (>10 percent of the national production) and provide qualitative data on pest occurrence and integrated pest management practices used by growers in those provinces. For grape production, the reporting provinces are British Columbia, Ontario, Quebec and Nova Scotia.

Information on pest issues and management practices is provided for information purposes only. For detailed information on growing grape, the reader is referred to provincial crop production guides and provincial ministry websites listed in the Resources Section at the end of the profile. For guidance about crop protection products registered for pests on grape, the reader is referred to provincial crop production guides and Health Canada's Pesticide label database.

Every effort has been made to ensure that the information in this publication is complete and accurate. Agriculture and Agri-Food Canada does not assume liability for errors, omissions, or representations, expressed or implied, contained in any written or oral communication associated with this publication. Errors brought to the attention of the authors will be corrected in subsequent updates.

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Grapes (*Vitis* spp.) are long-lived woody perennial vines, the fruit of which grows in bunches or clusters on the vine, and can be green, red, pink or purple. Grapes are eaten fresh, dried into raisins, preserved as jelly and are used for wine and juice. Grapes grown in Canada are primarily used for the making of wine, juice and for sale on the fresh market. Grapes destined for use in wines are judged based on their level of brix (sugar), titratable acids and anthocyanin content.

The genus *Vitis* belongs to the botanical family Vitaceae, which is composed of 11 genera and 600 species and is the only food-bearing genus in the family. Bunch grapes (*Vitis lubrusca*), originated in North America and make up most of the fresh market grape varieties. *Vitis riparia*, also indigenous to North America, can be used in the making of wine but is mainly used as a hardy rootstock due to its cold hardiness and resistance to phylloxera, an insect pest. *Vitis vinifera* is used in the making of wine and is often referred to as the "Old World" or "European" grape. This species originated in the region south of the Caspian Sea in Asia Minor, from where it has been disseminated worldwide.

Early European settlers in North America had limited success cultivating *V. vinifera* grapes due to its lack of winter hardiness. As a result, they relied on native grape species, *Vitis labrusca* and *V. riparia* for wine. However, the end result was wine of an inferior quality to the European wines made at the time.

The first commercial wineries and vineyards of *V. labrusca, V. riparia* and *V. vinifera* were established in the mid 1800's in Ontario and British Columbia. By the 1890's, vineyards were also established in Quebec. However, the lack of winter hardiness continued to be a problem with *V. vinifera* grapes. Improvements in varieties and viticulture practices, as well as a shift in consumer demand for dry table wines, led to an expansion of the grape and wine industry in the 1980's. In the late 1980's, a federal replant program accelerated the move to *V. vinifera* varieties.

Nova Scotia's first commercial vineyard was planted in 1978. There, the industry relies primarily on hybrid varieties for their cold hardiness. However, the industry continues to grow, evolve and experiment with *V. vinifera* varieties as well.

Crop Production

Industry Overview

In 2022, the total farm gate value for fresh grapes (table and wine) was $195.8 million (Table 1); fresh grapes continued to rank third in farm gate value among all fruits grown in Canada.

Wine grape production totaled 86,307 metric tonnes on 13,004 hectares for a farm gate value of $189.6 million. Table grape production totaled 2,703 metric tonnes on 331 hectares for a farm gate value of $6.2 million (Table 1).

Canadian exports of fresh grapes, grape juice and wines were $0.3 million, $12.4 million and $109.9 million, respectively, for a grand total of $122.6 million for all Canadian grape related exports in 2022. For the same period, Canadian imports of fresh grapes, grape juice and wine exceeded $3.6 billion, with imported wines accounting for $2.9 billion of total imports (Table 1).

The Canadian Grapevine Certification Network (CGCN), a national not-for-profit organization, was created in 2017 to support and advance the Canadian grape and wine industry. In 2018, CGCN received federal Agri-Science Program Cluster funding to develop a Grape and Wine Science Cluster. Twenty-two research activities were funded from 2018 to 2023.

Table 1. General production information in Canada, 2022

	Grapes, fresh (total)	Vinifera grapes (wine), fresh	Labrusca grapes (table), fresh
Canadian Production[1]	89,010 metric tonnes	86,307 metric tonnes	2,703 metric tonnes
	13,335 hectares	13,004 hectares	331 hectares
Farm Gate Value[1]	$195.8 million	$189.6 million	$6.2 million
Availability[2]	Fresh: 4.39 kg/person		
	Juice: 2.30 kg/person		
	Wine: 15.71 L/person, 15 years old and over		
Exports[3]	Fresh: $0.3 million		
	Juice: $12.4 million		
	Wine: $109.9 million		
Imports[3]	Fresh: $644.7 million		
	Juice: $79.5 million		
	Wine: $2.9 billion		

[1]Source: Statistics Canada. Table 32-10-0364-01 - Area, production and farm gate value of marketed fruits (Accessed: 2023-05-20).
[2]Source: Statistics Canada. Table 32-10-0054-01 - Food available in Canada (Accessed 2023-06-20).
[3]Source: Statistics Canada. Canadian International Merchandise Trade Web Application. Fresh: HS # 8060.10 - Grapes, fresh. Juice: HS # 2009.61 - Grape juice/grape must,Brix value <= 30,unferm,not cont spirit,w/n add sug/sweet; HS # 2009.69 - Grape juice/grape must, Brix value > 30,unferm,not cont spirit,w/n add sug/sweet. Wine: HS # 2204.10 - Grape wines, sparkling; HS # 2204.21 - Grape wines,nes,incl fortified & grape must,unfermented by add alc,in ctnr <=2 l; HS # 2204.22 - Grape wine,fresh,nes;grape must,ferm prevented/arrested by alc,in ctnr >2l <=10l; HS # 2204.29 - Grape wine,fresh,nes; grape must, ferm prevented/arrested by alc, in ctnr > 10 l (Accessed: 2023-06-20).

Production Regions

Grapes are produced in Ontario (7,168 hectares or 54% of national acreage), British Columbia (4,848 hectares or 36% of the national acreage), Quebec (848 hectares or 6% of the national acreage) and Nova Scotia (391 hectares or 3% of the national acreage) (Table 2).

In Ontario, the majority of production occurs within the Niagara Peninsula along the southern shore of Lake Ontario. The remainder is mostly along the northern shore of Lake Erie and on Pelee Island and in Prince Edward County on the north-east shore of Lake Ontario. In British Columbia, the majority of the production occurs in the Okanagan Valley, with adjacent areas of the interior and the coastal region producing the balance of the commercial grapes in BC. In Quebec, the Eastern Townships are the main area of production. There are four main production areas in Nova Scotia including Annapolis Valley, South Shore, Gaspereau Valley and Malagash peninsula.

Table 2. Distribution of grape production in Canada in hectares (ha), 2022[1,2]

Production Regions	Grapes, fresh (total)	Vinifera grapes (wine), fresh	Labrusca grapes (table), fresh
	Cultivated Area (national percentage)		
British Columbia	4,848 ha (36%)	4,771 ha (37%)	77 ha (23%)
Ontario	7,168 ha (54%)	6,940 ha (53%)	228 ha (69%)
Quebec	848 ha (6%)	823 ha (6%)	25 ha (8%)
Nova Scotia	391 ha (3%)	390 ha (3%)	1 ha (<1%)
Canada	**13,335 ha**	**13,004 ha**	**331 ha**

[1]Source: Statistics Canada. Table 32-10-0364-01 - Area, production and farm gate value of marketed fruits (Accessed: 2023-06-20).
[2]Cultivated area includes bearing and non-bearing area.

Cultural Practices

There are significant production differences in terms of pruning, training, fertilization and irrigation for fresh market grapes and grapes grown for the production of wine and juice, often referred to as processing grapes. The focus of this profile will be on processing grapes, since the vast majority of grapes produced in Canada are for this purpose.

The choice of planting site for grapes requires careful consideration, as a minor difference in geography may represent a major difference in the local climate and can significantly affect the viability of the vineyard. An ideal site has a slope of 3 to 4 percent, with maximum sunlight exposure. South- and west-facing slopes are more suitable than north- and east-facing slopes, as they receive higher solar radiation. In some areas, south-facing slopes may be too warm for some grape varieties, making variety selection and site selection inter-dependant.

Grapes are grown in a variety of different soil types, such as course textured sands, fine gravels and imperfectly drained clay soils, but grapevines grow best in well drained soils. Tile drainage is essential for grape growing areas in Eastern Canada due to the high levels of soil moisture typically encountered in the spring and the frequent rainfall experienced during the growing season.

Growing regions with extreme winter temperatures (below -22 °C for *V. vinifera* grapes and below -30 °C for more hardy species) are generally avoided. Snow cover, which serves as a good insulator, is an important consideration in vineyard establishment in many regions in Quebec. Winter protection systems, such as burying the vines with soil to a depth of 30 to 60 cm or positioning the vines along the ground and covering each row with a geotextile, may be used to facilitate the growing of grape varieties outside their hardiness zones.

Depending on grape variety, grape vines require a minimum of 140 to 165 days of consecutive frost-free conditions, with sunshine exceeding 1,250 hours and an accumulation of at least 1000 growing degree days during the growing season. Low areas and frost pockets are not suitable for production. The risk of damage from spring and fall frosts can be mitigated by planting site selection, the use of overhead sprinklers, the use of inversion wind machines or cold air drains. Few practical means are available to protect against the abiotic risk of hail which occurs in most Canadian growing regions.

Growers are advised to use certified virus-free nursery stock when establishing a new vineyard as viruses are easily spread by propagation. Soil moisture can be preserved by practicing minimal tillage approaches and/or the use of thick organic mulches. Black plastic mulches can also be used and have the advantage of increasing soil temperature and helping to control weeds.

Grapevines require three years before they produce a crop and do not produce a full crop until the fourth or fifth year. Vines are trained on an ascending or descending vertical plane with the help of wires, which are often mobile, allowing producers to shape the vines in a manner that facilitates their management and maintenance. Canes are spread along a trellis to allow for movement of equipment throughout the vineyard and to facilitate management activities, air circulation and exposure of the vines, foliage and clusters to light. Pruning is used to develop and maintain the shape and vigour of a grapevine, to select buds that are needed to produce fruitful shoots and a balanced yield and to regulate the number of potential shoots. If required, shoot-thinning and bunch thinning are done to achieve optimal vine balance as well as improve air circulation and spray penetration. Commercial grape varieties are self-pollinated but wind and insect activity on blossoms does help to increase fruit set and yield.

Grapes grow best when springs are mild and dry, followed by long, warm, dry summers. The amount of water needed by a vineyard varies depending on the weather, soil type, age of the plants, grape variety and harvest date. Irrigation systems can be used to alleviate problems due to insufficient moisture.

A schedule for cultural and pest management practices for growing grapes in Canada is presented in Table 3.

Table 3. Grape production and pest management schedule in Canada

Time of Year	Activity	Action
November to March (plants are dormant)	Plant care	Winterize vines (hilling or use of geotextile fabric) to protect the graft point in colder climates. Check vines for signs of winter damage. Prune vines and tie to desired training system.
	Insect / mite control	Monitor overwintering European red mite, mealybug and scale populations.
April (bud swelling stage)	Plant care	Removal of winter protection measures, if necessary. Finish tying vines. Continue pruning vines (Quebec and Nova Scotia). Thin clusters, especially of French hybrid wine grapes.
	Soil Care	Sample soil to determine fertility requirements. May occur later in the month depending on growing region. Plough under fall planted green manure crop; apply lime as needed.
	Disease control	Apply early season fungicide applications for *Phomopsis* diseases and/or anthracnose, if needed.
Late-April (bud burst)	Plant care	Irrigate as needed.
	Soil care	Cultivation for and/or planting of new cover crop.
	Disease control	Apply first fungicide spray, if needed.
	Weed control	Mechanical tillage, in some areas. Apply early systemic and pre-emergent herbicides, if needed.
May (bud growth)	Plant care	Finish pruning and tying (Quebec and Nova Scotia).
	Soil care	Apply fertilizers to the soil as needed, including first split application of nitrogen. Remove hill from around the base of vines. If applicable to production system, sow cover crops.
	Disease control	Apply control for early season disease management.
	Insect / mite control	Apply mating disruption products for grape berry moth. Monitor and apply oils for phylloxera. Monitor for grape flea beetles and mites.
	Weed control	Apply weed controls, if needed.
June (shoot growth)	Soil care	Plant cover crops, if necessary.
	Plant care	Apply foliar nutrients as needed according to leaf analysis. Shoot thinning and the start of shoot positioning/tucking into the trellis. Sample tissues for nutritional management of bloom.
	Disease control	Survey for diseases and apply preventative or curative fungicide treatments as needed according to weather conditions.
	Insect / mite control	Begin monitoring for leafhoppers and spring feeding caterpillars. Apply controls, if needed.
	Weed control	Apply controls if needed or work soil mechanically.
Mid-June (pre-bloom, less than 5% cap fall)	Plant care	Irrigate as needed if dry, hot spring; position shoots.
	Disease control	Apply controls for black rot, powdery mildew, downy mildew, anthracnose and bunch rot if wet during bloom.
	Insect control	Continue monitoring for leafhoppers, phylloxera, first generation grape berry moth and rose chafer; apply controls, if needed.

… continued

Table 3. Grape production and pest management schedule in Canada (continued)

Time of Year	Activity	Action
late June (80% cap fall, berry set)	Soil care	Apply second split application of nitrogen fertilizer.
	Plant care	Shoot positioning.
	Disease control	Apply controls for diseases (e.g., *Botrytis*), as necessary
	Insect / mite control	Monitor for leafhopper species.
	Weed control	Mechanical tillage, in some regions, as required.
July (berry set and pea size growth)	Plant care	Irrigate as needed; continued shoot positioning as required. Sample tissues for nutritional management of bloom. Initiate leaf stripping for varieties susceptible to powdery mildew.
	Soil care	Maintenance and mowing between rows and of cover crops to maintain good air circulation at the vineyard floor.
	Disease control	Apply controls for disease, if needed.
	Insect / mite control	Monitor for leafhoppers and Japanese beetles (Ontario and Quebec) and apply controls if needed; apply insecticides as soon as the second generation of grape berry moth hatches.
July (pre-bunch closure)	Plant care	Final shoot positioning and early hedging if growth is vigorous. Remove leaves in fruit-bearing area of the vine.
	Disease control	Apply controls for diseases (e.g., *Botrytis*, sour rot, powdery and downy mildew), if needed.
late July (post-bunch closure)	Plant care	Further hedging if needed; further leaf removal around bunches. Foliar fertilization if deficiency is indicated by leaf analysis.
	Soil care	Continue to manage and mow between rows and cover crops to maintain airflow across vineyard floor.
	Disease control	Apply controls for powdery and downy mildew, if needed.
Mid-August (change of berry colour)	Plant care	Estimate yield; reduce yield by removing a number of clusters per vine. Install bird netting as required. Sample tissues for nutritional management at veraison.
	Disease control	Apply controls for diseases, if needed.
Mid-August to September / October (veraison to harvest)	Plant care	Monitor sugar, acid and pH development. Harvest fruit.
	Disease control	Apply controls for bunch rot, sour rot, powdery mildew, and downy mildew, if needed.
	Insect / mite control	Monitoring and implementation of controls of spotted wing drosophila, multicoloured Asian lady beetle and wasps, if needed.
September to November (post-harvest)	Plant care	Visually inspect vineyard wood quality. Irrigate as needed.
	Soil care	Take soil samples; apply lime following leaf drop if indicated.
	Disease control	Apply copper sprays, if needed.
	Weed control	Mowing of green manure crop, if necessary and manage perennial weeds to discourage rodents from wintering in vineyard.
November	Plant care	Pre-pruning in some regions; install winter protection, if used.
December to February	Ice wine harvest	Hand and machine picking when temperatures reach -8 °C.

Abiotic Factors Limiting Production

Millerandage

Adverse weather conditions during flowering can result in poor pollination of grape flowers, resulting in millerandage (shot berries), a condition characterized by the uneven development and maturation of berries within a fruit cluster. This can result in “green flavours” in the wine of some varieties.

Water Limitations and Excesses

Optimizing moisture levels is important during vineyard establishment and throughout the life of the crop. Excess moisture can suffocate roots leading to poor vine performance, poor fruit and poor brix and can contribute to decreased winter hardiness. Hotter and drier summers and insufficient irrigation can result in poor fruit quality at harvest (low brix and low acids) as well as poor winter hardiness.

Diseases

Key Issues

- There is significant concern about the development of resistance to available fungicides, particularly in the case of powdery mildew, *Botrytis*, black rot, anthracnose and downy mildew. There is a need to educate growers on resistance management to prolong the efficacy of fungicides with single modes of action. In addition, a national program to monitor resistance development of powdery mildew, downy mildew and *Botrytis* populations would provide vulnerable growing regions with data to assist in managing resistance. A spore sensor system developed in Quebec could be used to monitor the development of resistance and the use of this and other new technologies should be encouraged.

- Many disease prediction models have been investigated under Canadian growing conditions, however there is a need for easier access to these models for regional climates and situations to optimize timing of fungicide sprays for the management of black rot, *Botrytis* bunch rot, downy mildew, Phomopsis cane and leaf spot, powdery mildew and anthracnose.

- Trunk wood diseases like Black Foot Disease (*Campylocarpon* spp.), Esca, Botryosperacae dieback and eutypiosis are being observed in grape production and little information is known about their distribution, epidemiology and methods of control. Research efforts to understand these diseases in Canadian grape production are required. Resistant rootstocks, clean nursery stock and the use of mycorrhizal fungi are all areas that require further examination.

- Support of the Canadian Grapevine Certification Network's mandate to ensure a sustainable, domestic supply of certified virus-free propagative material is available to Canadian grape growers by grape growers and nurseries must continue. To complement this program, there is an immediate need to mitigate sourcing propagation material (domestic or imported) from possible virus infected vines/blocks.

- Following recent fungicide label re-evaluations on Mancozeb-based products and length re-entry intervals on many Group 3 and captan-based fungicides, proper management against black rot, downy mildew, Phomopsis and anthracnose is becoming more challenging. There is a need to register efficacious, sustainable and multi-site fungicides that can be used pre-bloom against these diseases with short re-entry intervals for hand labour.

- There is a need to continue surveying all cultivars (vinifera, hybrid and labrusca) in grape growing regions for the presence of major grapevine viruses. A management strategy needs to be established for asymptomatic cultivars, and continued research is needed to determine potential insect vectors of grapevine red blotch virus and grapevine pinot gris virus in Canadian production areas.

…continued

Key Issues (continued)

- There is a need for both conventional and non-conventional fungicides suitable for use in organic production systems. Even though newer biological-based fungicides are available to organic growers, additional organically acceptable, non-copper based fungicides would be welcomed for downy mildew control as copper toxicity in tissues and soils is a major concern for organic growers.

- Given the lack of products available for management of bacterial diseases, there is a need to investigate the use of antagonistic bacteria, antibiotic materials and mycorrhizae for controlling crown gall.

- There is a reluctance by growers to use gibberellic acid sprays to reduce *Botrytis* and sour rot pressure due to concerns about return fruitfulness the following year. Additional trials to confirm optimal application rates and application timing are needed.

- Continued research is required to determine potential vector(s) for grapevine red blotch virus. Once determined, a survey of each major growing region would be required to determine presence and distribution of the vector in order to generate effective management solutions to mitigate the impact.

- Continued grower education on fungicide resistance results with respect to powdery mildew and *Botrytis* is needed. Currently, Group 11 fungicides have shown high levels of resistance to powdery mildew and *Botrytis* fungicides are currently being investigated.

- For provincial evaluations of disease occurrence by species, see Table 4.

Table 4. Occurrence of diseases in grape production in Canada[1,2]

Disease	British Columbia	Quebec	Ontario	Nova Scotia
Angular leaf scorch	[black]	[yellow]	[black]	[grey]
Anthracnose	[black]	[red]	[blue]	[yellow]
Black rot	[white]	[red]	[red]	[yellow]
Botrytis bunch rot	[orange]	[red]	[red]	[orange]
Downy mildew	[black]	[red]	[red]	[red]
Eutypa die-back	[black]	[yellow]	[blue]	[grey]
Phomopsis cane and leaf spot	[white]	[orange]	[orange]	[yellow]
Powdery mildew	[red]	[red]	[red]	[orange]
Crown gall	[white]	[orange]	[yellow]	[red]
Vine decline (esca)	[white]	[yellow]	[blue]	[white]
Sour rot	[white]	[yellow]	[red]	[white]
Grapevine leafroll virus	[orange]	[yellow]	[red]	[orange]
Tomato ringspot virus	[black]	[orange]	[grey]	[grey]
Grapevine red blotch virus	[yellow]	[yellow]	[red]	[yellow]
Grapevine pinot gris virus	[yellow]	[yellow]	[orange]	[yellow]
Nematodes	[white]	[white]	[blue]	[yellow]

- [red] Widespread yearly occurrence with high pest pressure.
- [orange] Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.
- [yellow] Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.
- [white] Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pest pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.
- [blue] Pest is present and of concern, however, little is known of its distribution, frequency and pressure.
- [black] Pest not present.
- [grey] Data not reported.

[1]Source: Grape stakeholders in reporting provinces (British Columbia, Ontario, Quebec and Nova Scotia). The data reflect the 2020, 2021 and 2022 production years.
[2]Refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

Table 5. Adoption of integrated disease management practices in grape production in Canada[1]

Practices	Botrytis bunch rot	Downy mildew	Phomopsis leaf and cane spot	Powdery mildew	Viruses
Avoidance:					
Varietal selection / use of resistant or tolerant varieties					
Planting / harvest date adjustment					
Rotation with non-host crops					
Choice of planting site					
Optimizing fertilization for balanced growth and to minimize stress					
Minimizing wounding and insect damage to limit infection sites					
Use of disease-free propagative materials (seed, cuttings, transplants)					
Prevention:					
Equipment sanitation					
Canopy management (thinning, pruning, row or plant spacing, etc.)					
Manipulating seeding / planting depth					
Irrigation management (timing, duration, amount) to minimize disease infection periods and manage plant growth					
Management of soil moisture (improvements in drainage, use of raised beds, hilling, mounds, etc.)					
End of season or pre-planting crop residue removal / management					
Pruning out / removal of infected material throughout the growing season					
Removal of other hosts (weeds / volunteers / wild plants) in field and vicinity					
Monitoring:					
Scouting / spore trapping					
Maintaining records to track diseases					
Soil analysis for the presence of pathogens					
Weather monitoring for disease forecasting (regional and on-farm)					
Use of precision agriculture technology (GPS, GIS) for data collection and mapping of diseases					

…continued

Table 5. Adoption of integrated disease management practices in grape production in Canada[1] (continued)

Practices	Botrytis bunch rot	Downy mildew	Phomopsis leaf and cane spot	Powdery mildew	Viruses
Decision making tools:					
Economic threshold					
Use of predictive model for management decisions					
Crop specialist recommendation or advisory bulletin					
Decision to treat based on observed disease symptoms					
Use of portable electronic devices in the field to access pathogen / disease identification / management information					
Suppression:					
Use of diverse product modes of action for resistance management					
Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pathogen populations					
Use of biopesticides (microbial and non-conventional pesticides)					
Controlled atmosphere storage					
Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)					
Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms					
Crop specific practices:					
Vertical shoot positioning (VSP)					
This practice is used to manage this pest by at least some growers in the province.					
This practice is not used by growers in the province to manage this pest.					
This practice is not applicable for the management of this pest.					

[1]Source: Grape stakeholders in reporting provinces (British Columbia, Ontario, Quebec and Nova Scotia); the data reflect the 2020, 2021 and 2022 production years.

Angular Leaf Scorch (*Pseudopezicula tetraspora*)

Pest Information

Damage: Early symptoms of angular leaf scorch are light yellow spots on the leaves. The spots are delimited by leaf veins, become reddish-brown and develop yellow or reddish margins as they mature. Severe infections result in leaf death and drop. Infections may also develop on fruit stems resulting in shrivelling of fruit.

Life Cycle: During wet weather in the spring, spore producing bodies (apothecia) are produced in the fallen leaves remaining from the previous season. The apothecia release spores that infect new leaves. Leaf symptoms appear three to four weeks after infection. There is usually only one infection cycle in the spring.

Pest Management

Cultural Controls: The destruction of overwintered leaf litter prior to bud break and the removal of susceptible wild species near the vineyard will reduce the potential for disease development in the spring. Pruning to improve air circulation in the vineyard will facilitate drying of the foliage and will help to prevent infections.

Resistant Cultivars: Susceptibility to disease varies greatly among cultivars.

Issues for Angular Leaf Scorch

1. This disease is present in Quebec. There is a need for effective products for both organic and conventional production systems as no products are currently registered for angular leaf scorch.

Anthracnose (*Elsinoe ampelina*)

Pest Information

Damage: Anthracnose causes circular spots on leaves, petioles, fruit stems, young shoots and berries of grape. Young leaves may become deformed if infection occurs before they are fully expanded. Lesions on fruit can cause fruit cracking. Anthracnose reduces fruit quality, vine vigour and yield.

Life Cycle: The fungus overwinters in infected shoots as resting bodies called sclerotia. Sclerotia germinate in the spring to produce conidia that cause new infections when they are spread by splashing rain to new tissues. Asexual spore producing structures called acervuli develop in infected tissues and give rise to conidia that serve to further spread the disease.

Pest Management

Cultural Controls: The removal of affected plant tissues while the canes are dormant and the removal of wild grapes in the vicinity of the vineyard will reduce sources of infection. Pruning to open and facilitate the drying of the canopy will result in conditions less favourable for disease development.

Resistant Cultivars: The susceptibility to this disease varies with variety.

Issues for Anthracnose

1. There is a need for the registration of protectant products that can be used early in the season when *Elsinoe ampelina* infection typically occurs and are safe to use on susceptible hybrid cultivars (i.e., do not cause foliar burning). This disease is more prevalent in eastern Canada (Quebec and Nova Scotia) where susceptible hybrid cultivars are being grown.
2. There continues to be a need for new, efficacious, sustainable and multi-site fungicides that can be used in a resistance management program pre-bloom against anthracnose in susceptible hybrid varieties. There is also a particular need for organic products targeting anthracnose.

Black Rot (*Guignardia bidwellii*)

Pest Information

Damage: Infected berries initially turn brown and become covered with black, pin-head size spherical spore producing structures called pycnidia. Eventually the berries become mummified, remaining attached to the fruit cluster stems. Young leaves may develop small brown spots up to 10 mm in diameter that are encircled by a ring of pycnidia. Lesions may also develop on shoots.

Life Cycle: The pathogen has a limited host range. It overwinters as pycnidia and pseudothecia (sexual spore producing bodies) on infected canes and mummified berries. Spores produced within cane lesions can cause infection starting at bud break. Spores produced within mummified fruit on the ground are a greater source of disease in the spring; these spores are present two to three weeks after bud break and reach peak levels one to two weeks before bloom. Mummified fruit in the trellis release both rain-splashed conidia (asexual spores) and airborne ascospores (sexual spores) throughout the summer. Infections need a minimum 6 hour period of wetness with temperatures between 10 and 21 °C. Berries and leaves are very susceptible to infection for the first two to three weeks after bloom and become less susceptible over time.

Pest Management

Cultural Controls: The removal of infected, mummified fruit during pruning is very important. Management of cane vigour and the canopy can impact berry-to-berry spread by reducing the duration of wetness.

Resistant Cultivars: V. vinifera cultivars are very susceptible to this disease.

Issues for Black Rot

1. Following recent fungicide label re-evaluations on Mancozeb-based products and lengthy re-entry intervals on many Group 3 fungicides, proper management against black rot is becoming challenge. There is a need to register efficacious, sustainable and multi-site fungicides that can be used pre-bloom against black rot with short re-entry intervals for hand labour.
2. There are few organic materials available with acceptable efficacy against black rot. There is a need for organically suitable materials, which are acceptable under all organic certification programs.

Botrytis Bunch Rot (*Botrytis cinerea*)

Pest Information

Damage: Botrytis cinerea causes blight on blossoms, leaves and shoots, as well as fruit rot, which can result in significant economic loss particularly on tight-clustered cultivars. *Botrytis cinerea* predisposes fruit to infection by secondary organisms, such as *Penicillium* spp. and *Acetobacter* spp., which can attract secondary insect problems.

Life Cycle: The pathogen has a wide host range. It overwinters in debris on the vineyard floor or on the vine. Prolonged periods of wetness and high humidity with moderate temperatures (18 to 24 °C) favour spore production and infection in the spring. Berries may be infected in the spring with infections becoming latent until fruit starts to ripen in the fall. Ripe berries are susceptible to direct attack and are particularly susceptible to infection through wounds caused by insects, hail or cracking. Wounds caused by the grape berry moth are common sites of *B. cinerea* infection.

Pest Management

Cultural Controls: Any practice that improves air circulation and reduces humidity in the canopy will significantly reduce the development of bunch rot. Canopy management by positioning shoots, thinning, hedging and removing leaves will modify the microclimate around bunches and reduce Botrytis bunch rot. These practices also promote better fungicide coverage. When planting new vineyards, it is important to avoid heavily wooded areas and sites prone to fog. Fertilizer applications in quantities that do no cause excessive vegetative growth will result in less disease development. The use of clones or viticulture techniques that provide loose flower and fruit clusters may also reduce the development of this pathogen. Refer to *Table 5* for practices used by growers to manage botrytis bunch rot.

Resistant Cultivars: There are no resistant varieties, but some are less susceptible.

Issues for Botrytis Bunch Rot

1. The registration of new products with different and modes of action and the development of resistance management strategies for Botrytis bunch rot control are required. It is important that new products have pre-harvest intervals that are feasible under current production systems.
2. Continued research into cultural practices (e.g., basal leaf removal, post-bloom floral debris removal and cluster thinning) that could reduce the incidence of Botrytis bunch rot remains an important need for both conventional and organic grape growers. Additional organically acceptable *Botrytis* control products are also in demand.
3. Further studies investigating products (such as calcium, plant extracts or phospholipid products) or practices that strengthen berry skins, reduce berry split and subsequent *Botrytis* infections are required in all growing regions.
4. There continues to be some reluctance by growers to use gibberellic acid sprays to reduce *Botrytis* pressure due to concerns about return fruitfulness the following year. Additional trials to confirm optimal application rates and application timing are needed. Trials conducted in Ontario have shown no significant response on cluster morphology with registered rates.

5. Field research on how to integrate new, non-conventional control products, including biofungicides, into current production programs is needed. Areas of focus include tank mix compatibility, product residual length and resistance to climatic conditions (e.g., wash off potential) and better understanding of yeast and/or bacterial population dynamics following application of biofungicides.

Downy Mildew (*Plasmopara viticola*)

Pest Information

Damage: Downy mildew attacks leaves, shoots, fruit and fruit stems. Early symptoms develop as yellow spots on leaves. Infected shoot tips and fruit clusters become twisted, and infected tissues eventually become covered with a fluffy white growth of fungal mycelia and spores. Infected fruit of red cultivars colour prematurely while fruit of white cultivars become mottled. Infected fruit does not mature properly, remaining hard while uninfected fruit softens. When foliar infections are severe, the disease can cause direct fruit loss, uneven fruit maturity, reduced sugar content and reduced plant vigour.

Life Cycle: The pathogen overwinters as oospores (sexual spores) in infected tissues and soil on the vineyard floor. The oospores germinate in the spring producing sporangia that are blown by wind to susceptible tissue where they release zoospores (motile spores) that cause primary infections. Primary infections require 10 mm of rain and temperatures above 10 °C for 24 hours to occur. Infected leaves develop yellow, oily appearing spots (oil spots) with sporangia within seven to 14 days of infection, which then act as a source of secondary spread. The disease develops quickly at temperatures between 20 and 25 °C and can reach epidemic proportions in a very short period of time under these conditions. Young leaves are more susceptible than older leaves.

Pest Management

Cultural Controls: Practices that improve air circulation and hasten drying within the vine will help reduce downy mildew. These practices also improve the penetration of fungicide sprays into the canopy. Cultivation can be used to bury fallen infected leaves from previous years and will help reduce early season disease pressure. Refer to *Table 5* for practices used by growers to manage downy mildew.

Resistant Cultivars: Although there are varietal differences in terms of susceptibility, all varieties require fungicide applications to prevent infection.

Issues for Downy Mildew

1. Following recent fungicide label re-evaluations on Mancozeb-based products and lengthy re-entry intervals on captan fungicides, there is a need for new, efficacious, sustainable and multi-site fungicides that can be used in a resistance management program pre-bloom against downy mildew in both conventional and organic production systems. Compatibility with oil products would be important as this has become a common tank-mix partner in recent years.
2. Models for improved timing of fungicide treatments for downy mildew (e.g., DMCast, Dmodel, RIMpro) are available but need to be validated for Canadian growing conditions.
3. Growers are interested in investigating compounds with post-infection or anti-sporulant properties to provide new downy mildew management options when an infection event takes place.
4. Additional organically acceptable, non-copper based fungicides are required for downy mildew control as copper toxicity in tissues and soils is a major concern for organic growers.

5. Two strains (strain A and B) of downy mildew have been identified in Canadian vineyards. As management of the two strains is different, research is needed to determine the efficacy of control products against both strains.

Eutypa Dieback (*Eutypa lata* and other Diatrypacaea spp.)

Pest Information

Damage: Symptoms of Eutypa dieback include small, shortened internodes and stunted shoots with chlorotic leaves. Fruit either fails to develop completely or are small and misshapen. Shoot symptoms include a wedge-shaped staining internally. It is important to note that symptoms often appear many months or years after the initial infection. Damage is observed in mature vineyards (> five to six years old). Eutypa dieback, along with vine decline (esca), Botrytosphaeria dieback and Phomopsis dieback are a group of trunk diseases caused by different wood-infecting fungi.

Life Cycle: The pathogen invades perennial shoots through existing wounds (e.g., retraining or mechanical damage). The pathogen infects the xylem forming a canker. Cankers are embedded in the bark and contain perithecia. The spores mature in the cankers in late winter through early spring and are released during wet weather or irrigation events (> one mm water) during the spring and summer and germinate in wood cells. Eutypa dieback pathogens release toxins that are translocated via the vascular system causing symptoms in different parts of the plant.

Pest Management

Cultural Controls: Vineyard sanitation is important; burning or removing pruned vines from the vineyard will help to reduce inoculum. Remedial surgery including the elimination of the infected part of the vine and subsequent vine re-training is an option. Another option is to delay pruning in the spring; however, this strategy will only be successful in regions with dry springs. For regions with wet springs, late pruning will not help manage infection.

Resistant Cultivars: There are no known resistant cultivars.

Issues for Eutypa Dieback

1. Eutypa dieback has been detected in both Eastern and Western Canadian vineyards. There is a need for information on the presence and epidemiology of the disease and possible methods of control.

Phomopsis Cane and Leaf Spot (*Phomopsis viticola*)

Pest Information

Damage: Petioles, rachises (central fruit stems), shoots and fruit can be affected by *Phomopsis viticola*, which causes small dark spots with yellow margins on the leaves. Rachis infection restricts the movement of water and nutrients to developing berries, resulting in withered fruit clusters. Fruit infection is sporadic but can cause serious losses. Infected canes may be more susceptible to winter kill. Girdled shoots can break off easily and fewer new shoots and bunches are produced as plant vigour is reduced.

Life Cycle: The pathogen has a narrow host range. It overwinters as pycnidia in infected one- and two-year old canes. In the spring, spores ooze from the pycnidia and are dispersed to susceptible, young green tissue through rain-splashing. The severity of subsequent infections depends on temperature as cool weather delays the maturity of plant tissue, making plants susceptible for longer periods of time. Fruit infection requires extended periods of rain and wetness during bloom and early post-bloom, combined with cooler temperatures (23 °C). Spores are released only in early spring and once the initial flush of spores is exhausted there is no further spread of the disease for the season.

Pest Management

Cultural Controls: Pruning and removal of infected shoots will reduce disease incidence. Refer to *Table 5* for practices used by growers to manage Phomopsis cane and leaf spot.

Resistant Cultivars: There are no resistant cultivars.

Issues for Phomopsis Cane and Leaf Spot

1. Following recent fungicide label re-evaluations on Mancozeb-based products and lengthy re-entry intervals on captan fungicides, there is a need for new, efficacious, sustainable and multi-site fungicides that can be used in a resistance management program pre-bloom against *Phomopsis*. Compatibility with oil products would be important as this has become a common tank-mix partner in recent years.
2. With more hybrid grape cultivars grown across Canada, there is interest in validating available American *Phomopsis* predictive models for the cultivars, their respective susceptibilities and growing conditions associated with Canadian production areas.
3. Better tools for accurate early spring disease identification are needed. Confusion between early symptoms of anthracnose and *Phomopsis* is possible.

Powdery Mildew (*Erysiphe necator*)

Pest Information

Damage: Powdery mildew symptoms can be seen on foliage, fruit, flowers and canes. Mildew usually appears first as whitish or greenish-white powdery patches on the undersides of basal leaves. It may cause mottling or distortion of severely infected leaves, as well as leaf curling and withering. Lateral shoots are very susceptible. Infected blossoms may fail to set fruit. Berries are most susceptible to infection during the first three to four weeks after bloom but shoots, petioles and other cluster parts are susceptible all season. Infected berries may develop a netlike pattern of russet, crack open and dry up or never ripen at all. Old infections appear as reddish-brown areas on dormant canes. Early powdery mildew infections can cause reduced berry size and reduced sugar content. Scarring and cracking of berries may be so severe that fruit are unsuitable for any purpose. Winemakers have a low tolerance for powdery mildew on grapes. Research has shown that infection levels as low as three percent can taint the wine and give off-flavours.

Life Cycle: Powdery mildew fungus overwinters as chasmothecia (tiny, round, black fruiting bodies) in bark, canes, left-over fruit and on leaves left on the ground. Ascospores from the overwintering chasmothecia are released in the spring after a rainfall of at least 2.5 mm. For primary infection to occur the spores require at least 12 to 15 hours of continuous wetness at 10 to 15 °C to infect developing plant tissue. Once primary infection has occurred the disease switches to its secondary phase. Patches of white powdery mildew develop in seven to 10 days. Millions of spores are spread by wind causing more infections. Disease spreads quickly in early summer when temperatures are moderate. The time between infection and the production of spores can be as short as five to six days under optimal temperatures. High temperatures and sunlight inhibit powdery mildew. Extended periods of hot weather (>32 °C) will slow the reproductive rate of grape powdery mildew, as well as reduce spore germination and infection.

Pest Management

Cultural Controls: Disease development is favoured by low light conditions, so pruning to facilitate air circulation and light penetration will help to reduce powdery mildew development. Irrigation and fertilization must be managed to avoid excessive vegetative growth, which also favours disease development. Disease prediction models have been developed in California, which have been modified and validated in different American states, and also in Germany and Australia. In Quebec, the CIPRA Disease prediction model has been linked to a high risk index for powdery mildew when grapes have reached 600 to700 degree days. Refer to *Table 5* for practices used by growers to manage powdery mildew.

Resistant Cultivars: Cultivars vary in their susceptibility to powdery mildew.

Issues for Powdery Mildew

1. Resistance management is of great concern. Strains of powdery mildew resistant to sterol inhibiting (DMI) and strobilurin fungicides have been well documented. There is a continued need for new, broad spectrum fungicides with different modes of action to continue the battle against resistance development.
2. It is important to provide growers with information on resistance management so that they may select use patterns that prolong the efficacy of fungicides with single sites of action.

3. An effective management strategy that includes non-conventional products, including biofungicides is required for powdery mildew control in organic vineyards.
4. Disease prediction models developed in California (adapted for west-coast climates) need to be validated for growing regions in British Columbia.

Crown Gall (*Agrobacterium vitis*)

Pest Information

Damage: This bacterial disease results in fleshy galls on the lower trunk near the soil line and at budding and grafting sites. Gall formation on the aerial part of the vines is the most common symptom associated with crown gall. Although galls on grape roots are not typical, the bacteria can induce a localized necrosis of infected root tissue. The surface becomes open and the texture becomes moderately hard and very rough. Young galls are soft, creamy to greenish in colour, with no bark or covering, and as they age the tissue darkens to brown. Galled canes produce inferior shoot growth and surface tissue of the galls turns black as it dies, but the bacteria remain alive in the vine. Galls can prevent graft and bud healing.

Life Cycle: Although the pathogen can survive in the soil and on infected root material it is generally not present in areas where grapes have not previously been grown. *Agrobacterium vitis* is systemically present in the majority of grape vines but remains latent unless the vine is injured. Budding and grafting injuries can occasionally elicit disease development but cold injury is by far the most important predisposing factor. Most grape cultivars are susceptible to crown gall. The occurrence of crown gall from year to year appears to be related to the severity of the preceding winter and vine maturity.

Pest Management

Cultural Controls: Avoiding replanting in old vineyards where crown gall was present for at least two years following grape vine removal will minimize the risk of crown gall becoming established in the new vineyard. This is important because crown gall bacteria can survive in the remnants of the old grape plants until the debris decomposes. Hot water treatment of vines is effective in reducing crown gall infection levels in planting materials and it is required for vines imported from France and Germany for the prevention of phytoplasma diseases. There is little that can be done to control this disease once it is established in the vineyard. However, suckers can be removed when shoots are small (3 to 6 cm) to reduce trunk damage and promote rapid healing. Removing larger shoots before they harden will also result in clean and small scars. Hilling young vines with 30 cm or more of soil or other material can protect them from cold temperatures. Galls can be removed by pruning below the affected tissue. Management practices that minimize the risk of cold injury are currently the only practical technique for managing the disease. The use of multiple trunk vines and the yearly replacement of dead trunks with renewal vines help to keep the disease at tolerable levels.

Resistant Cultivars: V. vinifera varieties are generally more susceptible to crown gall than *V. labrusca* due to their relatively higher susceptibility to cold damage. Varieties that are less susceptible to winter injury will be less susceptible to the disease. Certain rootstocks such as Courderc 3309, 101-14 Mgt and Riparia Gloire are resistant, whereas Teleki 5C and 110 Richter are susceptible.

Issues for Crown Gall

1. The development of management practices that reduce physical damage to vine trunks and contribute to increased winter hardiness of vines, thereby minimizing the risk of crown gall injury is required. It is important that information on best management practices (i.e., site

selection, adequate drainage, clean nursery material) be made available to minimize problems due to crown gall.

2. There is a need to maintain strict heat treatment regulations for nursery producers to ensure vines are not weakened, which makes them more susceptible to crown gall infections.

Vine Decline (Esca) (various fungi)

Pest Information

Damage: Symptoms of esca are slow to develop with damage often observed in mature vineyards (> five to six years old). External symptoms include shortened internodes, reduced leaf size and foliage, interveinal chlorosis and necrosis of leaves. Infected fruit have necrotic areas called 'black measles', which are caused by toxins produced by the various pathogenic fungi. Cross sections through cordons and trunks reveal dark vascular streaking throughout the xylem. Severe forms of esca lead to vine apoplexy, a sudden collapse of the shoots often observed in the middle of the growing season. Esca, along with Eutypa dieback, Botrytosphaeria dieback and Phomopsis dieback are a group of trunk diseases caused by different wood-infecting fungi.

Life Cycle: A number of diverse fungi are associated with esca, including species of both ascomycete and basidiomycete fungi. Biology of the causative fungi vary slightly but in general, overwintering structures (e.g., perithecia, pycnidia) embedded in diseased parts of woody vines produce spores that are released in the spring that can cause new infection sites.

Pest Management

Cultural Controls: Cutting infected vines below rotted and discoloured wood, and wound protection will offer some protection. Avoiding large wounds during pruning is also important. Vineyard sanitation including removing all dead or diseased vines will help to reduce inoculum. Avoid planting poor quality vines or vines with weak or spindly growth.

Resistant Cultivars: None available.

Issues for Vine Decline

1. Isolated cases of esca and other trunk diseases have been detected in Canadian vineyards. There is a need for more information on the epidemiology of vine decline, best management practices, thresholds and appropriate methods of control.

Sour Rots (yeasts and bacteria)

Pest Information

Damage: Sour rot results in a soft, watery breakdown of fruit close to harvest. Breakdown products include acetic acid and ethyl acetate. Entire clusters can be destroyed. The use of berries affected by sour rot for wine making can result in an off-flavour in the finished product.

Life Cycle: Sour rot is caused by secondary rot organisms that invade fruit damaged by disease, insects, hail and other physiological factors. Fruit produced in tight clusters on vigorous grape vines are also susceptible. Warm temperatures and rain during the pre-harvest period favour disease development. Fruit flies are attracted to healthy and damaged fruit and can spread the sour rot pathogens. Under favourable conditions of moisture and temperature, severe disease outbreaks can develop rapidly.

Pest Management

Cultural Controls: To minimize the chances for sour rot development, it is important to minimize wounding and to control fruit damaging diseases and insects. Pruning to thin the canopy and promote drying of foliage will result in a crop microclimate that is less suitable for sour rot development. The removal of infected clusters will help reduce further spread of the disease.

Resistant Cultivars: None available.

Issues for Sour Rot

1. There is a continued need to investigate and register new products that have a negative impact on the organisms identified in the sour rot complex. Using an effective 'sterilizing' material in combination with fruit fly control has provided good results in reducing incidence of sour rot in susceptible cultivars. It is important that any new products have a short pre-harvest interval to allow application near harvest without impacting the wine making process.
2. Different cultural practices and/or the use of gibberellic acid sprays should be investigated to determine if they have any effect on the incidence and severity of sour rot infections.
3. In British Columbia, weather conditions around bunch closure heavily influence the development of sour rot. Monitoring weather conditions during this time and applying an effective 'sterilizing' material should be considered for susceptible cultivars.

Grapevine Leafroll Virus (GLRaV, genus *Closterovirus*) and Grapevine Red Blotch Virus (GRBaV, family Geminiviridae)

Pest Information

Damage: Leaves of grape cultivars susceptible to grapevine leafroll (GLRaV) turn red or purple (red grape varieties) or light-green to yellow (green grape varieties) in the late summer, with the discolouration often accompanied by a downward rolling of the leaf margins. Both red blotch (GRBaV) and leafroll virus cause basal leaves in red varieties to turn red in late August through September. Leafroll symptoms include veins remaining green while the rest of the leaf turns red and rolls downward. Red blotch does not cause leaves to roll, the red discolouration is blotchy and irregular and the smaller veins turn red. Fruit maturity is delayed and sugar content of fruit is reduced in virus infected plants. Infection reduces brix accumulation in grapes in warm climates, but the impact in cool climates is not known at this time. Infected vines are weakened, eventually reaching the point that they are no longer fit for production. Some varieties can be infected yet show no negative symptoms until they are grafted to a susceptible rootstock and die.

Life Cycle: Both GLRaV and GRBaV are spread primarily through the movement of infected propagation material. GLRaV can be also transmitted locally from plant to plant by mealybugs and soft scale insects.

Pest Management

Cultural Controls: The removal of an infected vineyard is an economic decision, particularly if the virus is present and significantly reducing brix. To minimize contamination, the removed vines should be burned at the vineyard rather than being moved elsewhere. When establishing new vineyards, the use of certified virus-free vines is critical to prevent the introduction of viral diseases. In established plantings monitoring for grapevine leafroll virus is most effective in the late summer when foliar symptoms are present. Suspect plants can be confirmed as infected through laboratory testing and then removed to prevent further spread of the disease. Control of insect vectors, including soft scale insects and mealybugs, will help limit spread of the virus. Refer to *Table 5* for practices used by growers to manage viruses.

Resistant Cultivars: None available.

Issues for Grapevine Leaf Roll Virus & Grapevine Red Blotch Virus

1. Continued awareness of clean propagation materials and methods are important to ensure this is an adequate supply of nursery stock which is free from GLRaV and GRBV.
2. Continued support of all grape growers and nurseries is required for the Canadian Grapevine Certification Network’s mandate to ensure a sustainable, domestic supply of certified virus-free propagative material is available to Canadian grape growers.
3. There is a need to continue comprehensive virus surveys in all major production areas to establish baseline information on the presence of viruses in vineyards.
4. There is a need for continued research to identify insect vectors of GRBaV in all Canadian growing regions.
5. There is a need for better understanding of the expression of virus symptoms for all major grape cultivars grown in Canada, best management practices and the level of resistance

rootstocks can provide. There are few solutions available when a field is affected by viruses.

Grapevine Pinot Gris Virus (GPGV, genus *Trichovirus*)

Pest Information

Damage: Grapevines infected with grapevine pinot gris virus (GPGV) may be symptomatic or asymptomatic. General symptoms include chlorotic mottling, leaf deformation, stunted growth, delayed budburst, poor quality grapes and low yields.

Life Cycle: GPGV is spread through propagative materials and graft transmission. Research is pending on whether the eriophyid mite transmits the virus through feeding.

Pest Management

Cultural Controls: When establishing new vineyards, the use of certified virus-free vines is critical to prevent the introduction of viral diseases. Sanitation and removal of affected vines and replanting with clean material is an option in vineyards displaying symptoms. Refer to *Table 5* for practices used by growers to manage viruses.

Resistant Cultivars: None available.

Issues for Grapevine Pinot Gris Virus

1. Continued support of all grape growers and nurseries is required for the Canadian Grapevine Certification Network's mandate to ensure a sustainable, domestic supply of certified virus-free propagative material is available to Canadian grape growers.
2. There is a need to continue comprehensive virus surveys in all major production areas to establish baseline information on the presence of viruses in vineyards and to understand the impacts on production by grape variety.
3. There is a need for research to identify potential insect vectors of GPGV in all Canadian growing regions. Bud and blister mites (erineum mites) have been identified as potential vectors in other regions.

Nematodes: Dagger nematode (*Xiphinema americanum*), other *Xiphinema* spp., Northern root-knot nematode (*Meloidogyne hapla*) and Root lesion nematode (*Pratylenchus penetrans*)

Pest Information

Damage: Nematodes feed on vine roots by piercing plant cells with their needle-like mouthparts and sucking-out cell contents. Feeding can reduce vine vigour, growth and yield. Root-knot nematodes induce the formation of galls at their feeding sites, which reduce the uptake of water and nutrients by the plant. Dagger nematodes are vectors of viral diseases. Nematode damage usually appears in patches throughout the vineyard although entire blocks of vines can be uniformly affected.

Life Cycle: In general, most plant pathogenic nematodes develop from eggs, through four larval stages to become adults. Adult nematodes mate and lay eggs within the host or in soil in the vicinity of host roots. Some nematodes such as *Xiphinem*a spp. feed and develop completely external to the plant. Others, including *Pratylenchus* spp. and *Meloidogyne* spp., spend a part of their life cycle within plant roots.

Pest Management

Cultural Controls: Soil testing may be carried out prior to planting a new vineyard to determine whether plant parasitic nematodes are present.

Resistant Cultivars: Nematode resistant rootstocks are available.

Issues for Nematodes

1. The impact of nematodes on early vine development, potential virus transmission and on long-term productivity, especially as vineyards expand into areas with different soil textures and slopes, needs to be investigated.
2. Environmentally sustainable products are needed for nematode management. Currently there are no products registered for nematodes in grapes.

Insects and Mites

Key Issues

- Effective integrated management strategies need to be developed for leafhoppers, soft scales, mites and climbing cutworms. Such strategies should incorporate various tactics such as the use of sticky traps, beneficial insects and mites, vegetation management, companion planting, and attract and kill approaches.

- Access to efficacious, sustainable and multiple site mode of action pest management products that are economical and can be used as resistance management tools is critical.

- With concerns about the development of resistance and bee health, there is a continued need to register new conventional and non-conventional pest control products, including options compatible with organic production systems. In particular, products compatible with pollinators with efficacy against spotted wing drosophila, grape mealybug, soft scales, mites, leafhopper, rose chafer, Japanese beetle and grape phylloxera are needed.

- Due to the heavy reliance on two active ingredients registered to control and repel multicoloured Asian lady beetle, there are concerns surrounding the development of resistance, especially to cypermethrin. There is a need for new effective pest control products with short pre-harvest intervals for management of lady beetles, primarily the multicoloured Asian lady beetle. Most commercial wineries have taken a conservative zero tolerance approach to the presence of this pest in harvested grapes.

- Research is needed to better understand the environmental factors that allow for a fourth generation of grape berry moth late in the season. In hot growing seasons, Ontario has observed late season (mid-late September) grape berry moth larval activity.

- Spotted wing drosophila and other *Drosophila* spp. have been linked to the establishment and spread of the sour rot complex near harvest. An effective management strategy has been established in Ontario; however, additional control options with short pre-harvest intervals are needed for resistance management. Given the short reproductive cycle of spotted wing drosophila and the frequency of insecticide applications, it is important to monitor for the development of pesticide resistance.

- Grape mealybug presence in grape production has increased as producers have stopped using broad spectrum organophosphorus insecticides. This insect is a major vector of grapevine leafroll virus, which negatively impacts fruit quality and vigor of affected vines. There is a need to establish economic thresholds and monitoring protocols to better identify and quantify mealybug presence in the spring. There is a need for fully systemic pest control products that effectively target mealybug nymphs feeding under bark that are also safe around pollinators.

…continued

Key Issues (continued)

- Further investigation of the possible role erineum mites may have as a vector of grapevine pinot gris virus is needed.

- Although not confirmed to be present in Canada as of fall 2022, the spotted lantern fly is a significant potential threat to grape production in Canada. Best management practices should be developed following US research and experiences. Careful monitoring must continue so control strategies can be quickly implemented once presence of spotted lantern fly is confirmed.

- For provincial evaluations of insect occurrence by species, see Table 6.

Table 6. Occurrence of insect and mite pests in grape production in Canada[1,2]

Insect/Mite	British Colombia	Quebec	Ontario	Nova Scotia
Grape berry moth	Black	Orange	Red	Black
Spotted wing drosophila	Yellow	Yellow	Red	White
Brown marmorated stinkbug	White	Black	White	Black
Grape mealybug	White	White	Orange	White
Potato leafhopper	Black	Orange	Red	Yellow
Grape leafhopper	Black	Orange	Red	White
Three-banded leafhopper	Black	Orange	Red	White
Virginia creeper leafhopper	Orange	Orange	Orange	Black
Tarnished plant bug	Black	Yellow	White	Yellow
Multicoloured Asian lady beetle	Black	Red	Red	Yellow
Sevenspotted lady beetle	Black	Yellow	Orange	Yellow
European red mite	White	White	Yellow	White
Two-spotted spider mite	White	White	Yellow	White
Grape erineum mite	White	Yellow	Orange	Orange
Grape phylloxera	White	Red	Orange	Red
Grape flea beetle	Black	Yellow	White	Yellow
Redheaded flea beetle	Black	Orange	White	Yellow
Japanese beetle	Black	Orange	Orange	White
Rose chafer	Black	Orange	White	Black
Cutworms	Orange	White	White	White
European earwig	Orange	Yellow	Blue	Yellow
European fruit lecanium	White	Yellow	Black	Yellow
Cottony maple scale	Black	White	White	White
Wasps	Orange	Red	Orange	Yellow

- Red: Widespread yearly occurrence with high pest pressure.
- Orange: Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.
- Yellow: Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.
- White: Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pest pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.
- Blue: Pest is present and of concern, however, little is known of its distribution, frequency and pressure.
- Black: Pest not present.

[1]Source: Grape stakeholders in reporting provinces (British Columbia, Ontario, Quebec and Nova Scotia). The data reflect the 2020, 2021 and 2022 production years.
[2]Refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

Table 7. Adoption of integrated insect pest management practices in grape production in Canada[1]

Practices	Grape berry moth	Leafhoppers	Lady beetle complex	Flea beetles	Mites
Avoidance:					
Varietal selection / use of resistant or tolerant varieties					
Planting / harvest date adjustment					
Rotation with non-host crops					
Choice of planting site					
Optimizing fertilization for balanced growth					
Minimizing wounding to reduce attractiveness to pests					
Reducing pest populations at field perimeters					
Use of physical barriers (e.g., mulches, netting, floating row covers)					
Use of pest-free propagative materials (seeds, cuttings, transplants)					
Prevention:					
Equipment sanitation					
Canopy management (e.g., thinning, pruning, row or plant spacing)					
Manipulating seeding / planting depth					
Irrigation management (timing, duration, amount) to manage plant growth					
Management of soil moisture (e.g., improvements to drainage, use of raised beds, hilling, mounds)					
End of season or pre-planting crop residue removal / management					
Pruning out / removal of infested material throughout the growing season					
Tillage / cultivation to expose soil insect pests					
Removal of other hosts (weeds / wild plants / volunteer crops) in field and vicinity					

…continued

Table 7. Adoption of integrated insect pest management practices in grape production in Canada[1] (continued)

Practices	Grape berry moth	Leafhoppers	Lady beetle complex	Flea beetles	Mites
Monitoring:					
Scouting / trapping					
Maintaining records to track pests					
Soil analysis for pests					
Weather monitoring for degree day modelling					
Use of precision agriculture technology (GPS, GIS) for data collection and mapping of pests					
Decision making tools:					
Economic threshold					
Use of predictive model for management decisions					
Crop specialist recommendation or advisory bulletin					
Decision to treat based on observed presence of pest at susceptible stage of life cycle					
Use of portable electronic devices in the field to access pest identification / management information					
Suppression:					
Use of diverse pesticide modes of action for resistance management					
Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pest populations					
Use of biopesticides (microbial and non-conventional pesticides)					
Release of arthropod biological control agents					
Preservation or development of habitat to conserve or augment natural controls (e.g., preserve natural areas and hedgerows, adjust crop swathing height)					
Mating disruption through the use of pheromones					
Mating disruption through the release of sterile insects					

…continued

Table 7. Adoption of integrated insect pest management practices in grape production in Canada[1] (continued)

Practices	Grape berry moth	Leafhoppers	Lady beetle complex	Flea beetles	Mites
Trapping					
Targeted pesticide applications (e.g., banding, spot treatments, use of variable rate sprayers)					
Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms					
This practice is used to manage this pest by at least some growers in the province.					
This practice is not used by growers in the province to manage this pest.					
This practice is not applicable for the management of this pest.					
Information regarding the practice for this pest is unknown.					

[1]Source: Grape stakeholders in reporting provinces (British Columbia, Ontario, Quebec and Nova Scotia); the data reflect the 2020, 2021 and 2022 production years.

Grape Berry Moth (*Paralobesia viteana*)

Pest Information

Damage: First generation grape berry moth larvae feed on flowers and newly set fruit. Damaged berries wither and often drop to the ground before they reach pea size. Later generation larvae bore into fruit and feed internally. A larva can complete its development in a single fruit but it typically moves between many berries in a cluster causing greater crop loss. Some berries may drop, shrivel or rot depending on the extent of the larval feeding. Wound sites are ideal for the entry of other insects and pathogens. Late season infestations are often the most serious as they lead to *Botrytis* infection, resulting in serious yield losses.

Life Cycle: Grape berry moth is native to eastern North America where it feeds exclusively on wild grape, cultivated wine grape and juice grape. The insect overwinters as pupae in debris on the vineyard floor. Adults emerge in the spring, mate and lay eggs on buds, stems and newly forming berries. Eggs hatch and larvae feed on the fruit. When larvae are mature, pupal chambers are constructed on leaves or in fruit clusters where the larvae had been feeding. Following pupation, newly emerged adults lay eggs of the next generation on the fruit. There can be two to four generations per season, depending on the growing region.

Pest Management

Cultural Controls: The removal of wild hosts near a vineyard will reduce a source of grape berry moth migration into vineyards in the spring. Spring cultivation to bury leaves from the previous season will reduce the number of moths emerging. Low temperatures in winter help reduce overwintering populations, especially in the absence of snow. Records of injury levels in specific areas of a vineyard or on specific cultivars can assist in determining control measures in subsequent years. Mating disruption technology is available. Pheromone traps are effective tools for timing conventional insecticide use and providing an early alert as to the effectiveness of mating disruption technology. Refer to *Table 7* for practices used by growers to manage grape berry moth.

Resistant Cultivars: Varieties with tighter bunches may have more severe infestations.

Issues for Grape Berry Moth

1. There is a need to re-examine the effectiveness of pheromones in trapping grape berry moth under Quebec and Nova Scotia growing conditions as there is concern that they do not effectively attract this insect.
2. Additional research is needed on the environmental factors that favour the development of a partial fourth generation late in the season. In hot growing seasons, Ontario has observed grape berry moth larval activity late in the season (mid-late September).
3. Grape berry moth developmental models developed at Michigan State University need to be validated under growing conditions in Nova Scotia and Quebec.

Spotted Wing Drosophila (*Drosophila suzukii*)

Pest Information

Damage: Spotted wing drosophila (SWD) has become a chronic pest in most berry and tender fruit growing regions of Canada. Early detection and management are required to limit economic damage. SWD is a serious pest of soft fruit, berries and grape. Unlike other fruit flies, SWD attack sound fruit. Larvae feed within fruit causing softening and breakdown of flesh that makes the fruit unmarketable. Wounds caused by SWD egg-laying also serve as entry points for disease causing pathogens. Grapes are at greatest risk of attack from when they start to ripen until harvest.

Life Cycle: The insect overwinters as an adult fly. In the spring, flies mate and lay eggs under the skin of ripening fruit. Larvae feed and develop within the fruit. The entire life cycle (egg to adult) can occur in as few as seven days depending on temperatures. Due to the short generation time and extended period of egg laying there can be several, overlapping generations each year (e.g., three to nine generations in Ontario). The insect is spread short distances by wind and can be carried to new areas through the movement of infested fruit.

Pest Management

Cultural Controls: Regular monitoring with baited traps, especially near harvest, will assist growers to make informed decisions about pest control applications. The frequent harvest of all ripe fruits and removal of unmarketable fruit culls help to reduce the chances of the fly infesting the fruit and reduces sources of continued infestations. A SWD Growing Degree Day Model has been developed by researchers at Oregon State to predict early season activities in the Pacific Northwest however, the tool needs to be validated in Canadian growing regions.

Resistant Cultivars: None identified.

Issues for Spotted Wing Drosophila

1. There is a need to continue monitoring the potential effects of SWD on table grape production. Pest management strategies for table grapes including monitoring, trapping and post-harvest assessments need to be developed. Experience in Ontario has shown that SWD appears to have little effect on table grapes harvested at maturity. Pressure increases with more over-mature and degrading fruit present.
2. Spotted wing drosophila and other *Drosophila* spp. have been linked to the establishment and spread of the sour rot complex in susceptible cultivars. An effective management strategy has been established in provinces where *Drosophila* spp. are present; however, additional conventional and non-conventional products with short pre-harvest intervals, including products for organic production are needed to develop better resistance management programs.
3. Given the short reproductive cycle of SWD and the frequency of insecticide applications, it is important to monitor for the development of pesticide resistance.

Brown Marmorated Stinkbug (*Halymorpha halys*)

Pest Information

Damage: Brown marmorated stinkbug (BMSB) has a broad host range including tree fruit, berries, grapes, ornamentals, grain crops, tomatoes, peppers and sweet corn. Injury is caused by feeding of adults and nymphs. The insect injects saliva with digestive enzymes into the plant and ingests the liquefied plant material. Each feeding puncture results in crop injury. The presence of only a few adults at crushing time can taint wine.

Life Cycle: The insect spreads through natural means and also as a “hitchhiker” in cargo and vehicles. In the spring, adults mate and lay eggs on host plants. Both nymphs and adults feed on host plants. Each female can lay up to 400 eggs throughout the summer on host plants, resulting in overlapping nymph stages. Eggs hatch in four to five days; nymphs mature in approximately five weeks depending on temperature. In the fall, the adults move back to protected overwintering sites. They have frequently entered structures in the fall where they are a nuisance pest.

Pest Management

Cultural Controls: Monitoring for BMSB may be done through aggregation pheromones and by scouting. Although thresholds have not been established, small numbers of nymphs and adults can cause considerable damage in a growing season.

Resistant Cultivars: None available.

Issues for Brown Marmorated Stinkbug

1. To-date, there have not been any issues due to the presence of BMSB during harvest; however, it remains a potential threat to juice taint. Monitoring BMSB movement into grape production areas is of high importance.
2. The registration of conventional and non-conventional control products for BMSB management on grape is needed as only one active ingredient is currently registered. In addition, an effective integrated pest management strategy for BMSB in grape would be welcomed.

Lady Beetle Complex: Multicoloured Asian Lady Beetle (*Harmonia axyridis*) and Seven-spotted Lady Beetle (*Coccinella septempunctata*)

Pest Information

Damage: Lady beetles migrate into the vineyard during the fruit ripening and harvesting periods. The beetles do not cause physical damage to bunches but will feed as a secondary pest after berry splitting or after bunch breakdown caused by grape berry moth, Botrytis bunch rot or bird damage. The presence of beetles during harvest and the wine making process can lead to the release of methoxypyrazine, a chemical that imparts a serious sensory taint to wine making it unmarketable. There is zero tolerance for these insects in juice and wine grapes.

Life Cycle: Aphids are the primary food source of these beetles. The beetles are opportunistic and both adults and larvae feed on aphids in field crops (e.g., soybean aphids), ornamental plants, grasses and other crops. The beetles overwinter as adults in protected areas. They can travel over 70 km and may congregate in vineyards, orchards or berry crops in the fall before moving to overwintering sites. Reasons for their congregation in these areas are not well understood but could be due to the late-season food source (i.e., fruit sugars) or the presence of volatile chemicals such as terpenes.

Pest Management

Cultural Controls: Grape bunches kept healthy and intact and free of injury from other insects, birds and diseases are less prone to damage from lady beetles. Harvesting by hand and mechanically separating beetles from harvested grapes can be done. Refer to *Table 7* for practices used by growers to manage lady beetles.

Resistant Cultivars: Some varieties tend to be more attractive to the beetles than others, possibly due to their susceptibility to Botrytis bunch rot and the production of volatiles that attract beetles during the ripening process.

Issues for Lady Beetles

1. Due to the potential impact on wine quality, the presence of lady beetles at harvest is a great concern. Pest control products with short pre-harvest intervals that control and repel lady beetles during the harvest period are required by growers.

Grape Mealybug (*Pseudococcus maritimus*)

Pest Information

Damage: The grape mealybug feeds by sucking plant sap from leaves, shoots and fruit. The insect produces a liquid waste called honeydew, which supports the growth of sooty molds and stains the fruit. Mealybugs transmit some strains of the leafroll virus.

Life Cycle: In the fall, females lay eggs under cottony masses in protected areas of the bark of grapevines. Mealybugs overwinter as eggs or as dormant crawlers. In the spring, the crawlers disperse to new shoots to feed. They mature by mid-summer and a second generation is produced.

Pest Management

Cultural Controls: Crawler activity can be monitored with the use of sticky tapes on vines. It is particularly important to monitor vigorous vines with thick canopies as these are preferred mealybug sites. Avoiding fertilizer applications at levels that stimulate lush growth will result in canopy conditions that are less favourable for mealybug populations.

Resistant Cultivars: None available.

Issues for Grape Mealybugs

1. Due to the fact grape mealybug is a major vector of grapevine leafroll virus, regional monitoring programs should be enforced around budbreak to determine mealybug presence in the spring. This will aid growers in developing an appropriate mealybug management plan in blocks with confirmed presence.
2. In addition to the systemic control product we already have available for mealybug control (Movento), there is a need to register additional control products that are non-toxic to bees and can be used early in the season for small population control or as a maintenance application against mealybugs. Additional research is needed on the effects of horticultural oils on maintaining mealybug populations following Movento applications.

Potato Leafhopper (*Empoasca fabae*)

Pest Information

Damage: The potato leafhopper feeds by sucking plant juices from leaves and young stems of grape vines. While feeding, the insect injects a toxin that blocks the plant's vascular system reducing movement of nutrients, photosynthesis and plant vigour. Leaves turn yellow and curl upwards, with severe infestations causing leaves to turn brown and die. The effects of the potato leafhopper are most severe in newly planted vineyards; however, leaf symptoms do occur in plantings older than five years under moisture stress, leading to a reduction in the brix levels and quality of grapes.

Life Cycle: Potato leafhopper has a wide host range of more than 200 different species of plants, including grape, apple, strawberry and potato. It does not overwinter in Canada. It is blown in each year from the United States, arriving in early June. Leafhoppers move into the vineyard with the harvest of other hosts. Females lay eggs in the upper canopy. There can be up to four generations per year.

Pest Management

Cultural Controls: Yellow sticky traps and visual inspection of shoots can be used to detect potato leafhopper. Practices that prevent or reduce vigorous shoot growth, a preferred food source of leafhoppers, will indirectly reduce leafhopper populations. Stresses due to diseases, other pests and the environment must be taken into account when deciding whether to treat, as these factors could affect the grape plant's susceptibility to leafhopper feeding. Refer to *Table 7* for practices used by growers to manage leafhoppers.

Resistant Cultivars: There are some indications that this pest prefers certain varieties.

Issues for Potato Leafhopper

1. There is a need to establish thresholds to determine when control treatments are required in vineyards under both non-stressful and stressful growing conditions.
2. The development of alternative, non-chemical control approaches to leafhopper management is required for use in organic vineyards, including the use of anti-feedants and repellents, biological controls, sticky traps and companion plantings.

Grape Leafhopper (*Erythroneura comes*) and Three-banded Leafhopper (*E. tricincta*)

Pest Information

Damage: Grape and three-banded leafhoppers feed on the underside of leaves by sucking sap. The tissue around the punctures that are created during feeding turns pale white and eventually dies. Feeding injury is first seen along veins but eventually spreads to the entire leaf. Heavy feeding can result in premature leaf drop, lowered sugar content, increased acidity and poor colouring of the fruit, and reduced growth the following season. Ripening fruit is often stained by the sticky excrement of the leafhoppers, which affects appearance and supports the growth of sooty molds. Damage to the vine can be serious if infestations are allowed to persist for two or more years.

Life Cycle: Overwintering adults emerge from hibernation in mid-spring and begin feeding on various host plants such as strawberry and other berries, catnip, Virginia creeper, burdock, beech, and sugar maple. They mate and migrate into the vineyard where they lay eggs under the epidermis of the lower surface of leaves. Both grape and three-banded leafhoppers are found in the vineyard into the fall, with migration to overwintering sites beginning in late October and continuing into December.

Pest Management

Cultural Controls: Cultivation in the fall and clean-up of adjacent weedy land eliminates favourable overwintering sites. Cold and wet weather in the spring and fall are damaging to pest populations, as are wet winters. The presence of natural enemies can result in higher treatment thresholds. Leafhoppers have several natural enemies, including birds, spiders, insect predators, parasites and diseases. Refer to *Table 7* for practices used by growers to manage leafhoppers.

Resistant Cultivars: None available.

Issues for Grape Leafhopper and Three-banded Leafhopper

1. There is a need to establish thresholds to determine when control treatments are required in vineyards under both non-stressful and stressful growing conditions.
2. The development of alternative, non-chemical control approaches to leafhopper management is required for use in organic vineyards, including the use of anti-feedants and repellents, biological controls, sticky traps and companion plantings.

Virginia Creeper Leafhopper (*Erythroneura ziczac*)

Pest Information

Damage: Adults and nymphs feed by piercing leaves and sucking sap. Light feeding results in stippling of the leaves, while heavy feeding causes the leaves to become brown and dry and to fall prematurely resulting in yield losses and reduced fruit quality. Table grapes, particularly light-coloured varieties can become spotted and unsightly with excreta. Adult Virginia creeper leafhoppers can be a nuisance during harvest; they are primarily a mesophyll feeder but may also feed in the xylem.

Life Cycle: Virginia creeper leafhopper has two generations per year. Adults overwinter in plant debris in and around the vineyard. With warm temperatures in the spring, adults move to grape vines where eggs are laid on lower leaf surfaces. First generation nymphs are present from early summer to the end of July and second generation nymphs appear in August.

Pest Management

Cultural Controls: Fall or spring disking between rows destroys overwintering adults. Removing leaves in the fruiting zone when eggs of the first generation are present can reduce populations. Maintaining moderate vigour with irrigation and fertilization is important. Estimates of the number of overwintering adults can be obtained from monitoring with yellow sticky traps in the spring, allowing for the identification of potential problem areas for monitoring throughout the season. Established grapevines can tolerate early season feeding by leafhoppers due to their rapid growth; however, insecticide applications may be required when populations exceed 20 to 25 nymphs per leaf later in the season. The presence of natural enemies can result in higher treatment thresholds. Leafhoppers have several natural enemies including birds, spiders, insect predators, parasites and diseases. A small egg parasite, *Anagrus daanei* can effectively control Virginia creeper leafhopper in some vineyards, with parasitism of the second brood approaching 100 percent. Refer to *Table 7* for practices used by growers to manage leafhoppers.

Resistant Cultivars: None available.

Issues for Virginia Creeper Leafhopper

1. Virginia creeper leafhopper is becoming more prevalent in British Columbia, especially during warm and wet growing seasons. Research is needed on the effect of climate change on this insect, as well as the impact on established economic thresholds.
2. The effects of canopy damage can be variable depending on overall vigour and plant health. Under heavy feeding pressure, low vigour and late ripening red vinifera cultivars are most at risk from the damaging effects of leafhopper feeding. The development of alternative, non-chemical approaches to leafhopper control is required for use in organic vineyards. Approaches such as the use of anti-feedants and repellents, biological controls, sticky traps and companion plantings require investigation.
3. The registration of new conventional and non-conventional pest control products is required for conventional and organically managed vineyards.

Tarnished Plant Bug (*Lygus lineolaris*)

Pest Information

Damage: The tarnished plant bug (TPB) is a general feeder, feeding on many wild and cultivated herbaceous plants. It feeds by piercing plant tissue and sucking sap. On grape, feeding on buds and developing fruits in early spring can result in fruit drop.

Life Cycle: Adult TPBs overwinter under bark, plant debris and in other protected sites. With the onset of warm weather in the spring, overwintering adults become active and begin to feed. The adults move to herbaceous plants in late spring and lay eggs. Following hatch, TPB nymphs develop through five stages to become adults.

Pest Management

Cultural Controls: The management of weeds in and around the vineyard will eliminate feeding sites for the TPB. The elimination of crop debris in the fall will help to reduce overwintering sites.

Resistant Cultivars: None available.

Issues for Tarnished Plant Bug

None identified.

Grape Phylloxera (*Daktulosphaira vitifoliae*)

Pest Information

Damage: Grape phylloxera feed by sucking sap from leaves, stems and roots. While feeding, phylloxera inject a toxin that induces the formation of galls on leaves and roots. Root galls interfere with the uptake of moisture and nutrients by the vine. Severe infestations cause defoliation, reduced shoot growth, delayed fruit ripening and a reduction in the winter hardiness of the vine. Affected fruit may have reduced sugar levels at harvest. Galls may be invaded by root diseases, which further contribute to the decline of the grape vine. Affected vines may eventually die.

Life Cycle: Two 'forms' of grape phylloxera are recognized, the leaf form and the root form. The leaf form overwinters as an egg under the bark of the grapevine. Eggs hatch in the spring and the young nymphs move to expanding leaves where they feed and induce gall formation. When mature, female phylloxera lay eggs within the galls. Leaf-form phylloxera can have as many as seven generations per year. The second or 'root form' of phylloxera overwinters as first instar nymphs on roots. These nymphs feed, mature and lay their eggs on the roots. There may be as many as nine generations per season of the root form. In early summer, some adult root form phylloxera move to the soil surface. Eggs laid by mature females in the vines give rise to male and female phylloxera. Following mating, the next generation females lay the overwintering eggs of the leaf form phylloxera.

Pest Management

Cultural Controls: The best line of defense against phylloxera is rootstocks developed from grapes native to North America, which are resistant to grape phylloxora. Planting vines certified free from grape phylloxera is an important practice in the prevention of introducing this pest into non-infested areas. Dormant, well-matured grape cuttings and grape plants may be treated against the pest by washing all soil from the cuttings and/or roots and treating them with hot water. Monitoring the leaf feeding cycle of the pest depends on timely visual observations. Common predator species including lacewing nymphs, minute pirate bugs and predatory fly larvae help to control populations.

Resistant Cultivars: The genetic make-up of hybrid grape varieties must be taken into account when managing this insect as some hybrid cultivars have a large proportion of *V. vinifera* in their genetic composition, which could increase their vulnerability to grape phylloxera. Vinifera grapes are especially susceptible to phylloxera. Varieties highly susceptible to leaf feeding forms include: DeChaunac, Foch, Ventura, Baco Noir, Villard Noir, Le Commandant and Chelois.

Issues for Grape Phylloxera

1. Additional systemic and non-systemic pest control products that can provide a quick knockdown of this pest and are safe for pollinators are required. Additional investigation is needed for the use of summer horticultural oil products in a season long program and the impact on phylloxera populations.
2. A predictive model for grape phylloxera developed at the University of Arkansas to help time treatment decisions needs to be validated for use under Canadian growing conditions.

3. With more phylloxera sensitive cultivars being planted (e.g., Marquette and Frontenac), there is a need to update action thresholds for highly susceptible cultivars. These cultivars typically require at least one additional control spray each season compared to moderately susceptible cultivars.

Mites: European Red Mite (*Panonychus ulmi*), Twospotted Spider Mite (*Tetranychus urticae*) and Grape Erineum Mite (*Colomerus vitis*)

Pest Information

Damage: Adult and immature mites feed on plant sap. Light infestations result in small, chlorotic spots on leaves. Heavy infestations cause bronzing of the leaves and premature leaf drop. The grape erineum mite produces white, felt-like galls on lower leaf surfaces and can be a major stress to young vines. Severe stress can result in early drop of heavily infested leaves and slow establishment of new plantings.

Life Cycle: Mites overwinter on grapevines, the European red mite overwinters as eggs, twospotted spider mite as fertilized females and the erineum mites as adults under bud scales. Mites become active in the spring and feed on young foliage. All species have several generations per season. Hot and dry conditions are conducive to the rapid build-up of mite populations.

Pest Management

Cultural Controls: Predatory mites and natural insect enemies play an important role in the natural control of all mites. The careful selection and use of pesticides is important to minimize their impact on natural enemies. Mixed ground covers in the vineyard will reduce dust levels that favour mite populations and provide a habitat for beneficial insects and predaceous mites. Irrigation to alleviate drought stress will result in conditions less favourable to the build-up of mite populations. Refer to *Table 7* for practices used by growers to manage mites.

Resistant Cultivars: None available.

Issues for European Red Mite, Twospotted Spider Mite and Grape Erineum Mite

1. There is a need for control products that are compatible with beneficial mite species. Studies to develop criteria for the selection of pesticides that do not adversely affect beneficial mite species are required.
2. There is concern over the rapid development of miticide resistance in mite populations. Miticides, with short pre-harvest intervals and new modes of action are required.
3. There is a need for additional research to understand the role of dormant oil applications, beneficial organisms and ground cover management in mite management.
4. There is a need for additional control options for grape erineum mite. Sulphur and horticultural oil are currently used successfully at low-moderate pressure locations; however, more efficacious materials are required for full control under high pest pressure conditions.
5. Further investigation of the possible role erineum mites have as a vector of grapevine pinot gris virus is needed.

Soft Scale Insects: European Fruit Lecanium (*Parthenolecanium corni*) and Cottony Maple Scale (*Pulvinaria vitis*)

Pest Information

Damage: Scale adults and nymphs feed by sucking plant fluids from shoots and vines. Under heavy infestations, fruit, leaves and vines can become covered with honeydew excreted by the soft scale insects. The honeydew supports the growth of black sooty molds and together can render the fruit unmarketable. Feeding by scale insects weakens shoots and vines.

Life Cycle: Scale insects overwinter as immature scales on grape canes. Females mature in early summer and lay eggs beneath the scale covering. Crawlers that hatch from the eggs disperse to leaves where they feed until the fall, after which they move back to the current year's canes and secrete the hardened shell covering to overwinter.

Pest Management

Cultural Controls: As healthy vines are less attractive to scale insects, following good cultural practices that minimize vine stress will reduce the likelihood of a scale infestation. The presence of scale insects can be detected through the use of sticky tape when crawlers are active.

Resistant Cultivars: None available.

Issues for Soft Scales

1. Soft scales are a concern for all growing regions in Canada as these insects have been identified as a vector of grapevine leafroll virus. Monitoring procedures, action thresholds, rate of virus spread, distribution and efficacy of pest control products need to be evaluated to better manage this pest.

Flea Beetles: Grape Flea Beetle (*Altica chalybea*) and Redheaded Flea Beetle (*Systena frontalis*)

Pest Information

Damage: In the spring, adult grape flea beetles bore into swelling buds and hollow out the inside. Buds become less susceptible to attack as they elongate. Flea beetle larvae and summer adults feed on tender leaf tissues but avoid the leaf veins. Feeding on the primary buds causes more serious damage, resulting in yield loss and stunted growth from secondary or tertiary buds. There is no fruit development on canes where the primary and secondary buds are destroyed. Injury is more severe in years when bud development is prolonged by unfavourable weather conditions. Little information is available on redheaded flea beetle damage in grapes; however, it is assumed to be similar to grape flea beetle damage.

Life Cycle: Grape flea beetles overwinter as adults in protected locations in and around the vineyard. In the spring, females lay eggs on the canes of the grapevine. After hatching, larvae feed on leaves and when fully grown drop to the ground to pupate. Adults emerge and feed on grape leaves until the fall when they seek overwintering sites.

Pest Management

Cultural Controls: The elimination of plant debris from the vineyard and surrounding area will reduce overwintering sites. It is important to monitor the vineyard as buds swell in the spring for signs of grape flea beetle damage. Disking to control weeds between grape rows can expose pupae to desiccation. Refer to *Table 7* for practices used by growers to manage flea beetles.

Resistant Cultivars: None identified.

Issues for Grape Flea Beetle and Redheaded Flea Beetle

1. Insecticides already registered on grapes should be investigated as potential candidates for flea beetle control in vineyards to target grape flea beetle, redheaded flea beetle and the corn flea beetle (*Chaetocnema pulicaria*), a pest which is increasing in prevalence in southwestern Ontario.
2. The development of economic thresholds to assist in treatment decisions in both young and mature vineyards is required.

Rose Chafer (*Macrodactylus subspinosus*)

Pest Information

Damage: Rose chafer feeds on flowers, fruit and foliage of many plants including grape. In the spring, adult rose chafers feed on buds, flowers and foliage of grape resulting in the destruction of blossoms, the skeletonization of leaves and limited to no fruit set. Larvae are found in the soil and feed on the roots of a variety of plant species. Rose chafers are more prevalent in areas with sandy soils.

Life Cycle: Rose chafers overwinter as larvae in the soil. Pupation and adult emergence occurs in the spring. Adults live for only a few weeks. Following mating, adult females lay eggs in the soil and hatching larvae (white grubs) feed on roots of grasses and weeds. There is one generation per year.

Pest Management

Cultural Controls: Cultivation of the soil between rows will help destroy pupae. Visual monitoring for this pest can be done in late May through June.

Resistant Cultivars: None available.

Issues for Rose Chafer

1. The rose chafer is a pest of concern in Quebec vineyards. There is a need for the development of a management strategy that includes chemical (conventional as well as organically acceptable) and non-chemical approaches.

Japanese Beetle (*Popillia japonica*)

Pest Information

Damage: Japanese beetle adults are generalist feeders that attack over 300 different plant species. They feed on the tender leaf tissues of grape, leaving a network of veins and causing browning of severely affected leaves. The impact of the feeding injury on grape is dependent on its severity and the health of the vine.

Life Cycle: The Japanese beetle has a one-year life cycle. Adult beetles emerge from the soil in early summer, feed on plant foliage and mate and lay eggs in the soil. Following egg hatch, the larvae, known as white grubs, feed on plant roots in the upper 10 to 12 cm of soil. The larvae continue to feed on plant roots into the fall, overwinter and resume feeding the following spring.

Pest Management

Cultural Controls: Monitoring for adult Japanese beetles and beetle damage can be done by visual inspection of plants from late June through August or by using traps baited with attractants. There are some concerns that the baited trap approach may attract beetles into the area.

Resistant Cultivars: None available.

Issues for Japanese Beetle

1. With the recent loss of phosmet (Imidan), the registration of additional conventional and non-conventional pest control products (including biopesticides) is needed for resistance management against Japanese beetles in high pressure areas.
2. Validation of alternative management strategies should also be investigated (e.g., repellents, nets, mass trapping).

Climbing Cutworms: Noctuidae (*Peridroma saucia* and *Xestia c-nigrum*)

Pest Information

Damage: A number of species of climbing cutworms feed on buds and young leaves in the spring. Many buds on a single shoot may be destroyed.

Life Cycle: Climbing cutworms overwinter as eggs or young larvae. In the spring these cutworms feed on weeds and other vegetation. If weeds are destroyed from mid-May to mid-June, climbing cutworms will move to grapevines in the absence of any other food source. When mature, larvae pupate in soil with adult moths emerging in the summer. Female moths are attracted to tall weeds and grasses where they lay their eggs in the soil. There is one generation per year.

Pest Management

Cultural Controls: Proper vegetation management will discourage egg-laying by adult moths and deprive young climbing cutworms of food hosts; however, destroying weeds during the period from mid-May to mid-June can result in grapevine feeding by cutworms due to limited food sources. Weed control in the fall, before new vineyards are planted will help to minimize problems due to these cutworms the following spring.

Resistant Cultivars: None available.

Issues for Climbing Cutworm

1. Approaches to determining the need for treatment for climbing cutworms, including economic thresholds requires further development.
2. The evaluation and registration of non-conventional controls, including biopesticides, as groundcover and grape foliage sprays, and as bait are needed for climbing cutworm control.
3. There is a need for continued work on till versus no-till along with vegetation management focusing on the use of different ground cover crops for management.

European Earwig (*Forficula auricularia*)

Pest Information

Damage: European earwig can cause damage to soft fruits such as grapes by chewing into ripening and overripe fruit. The presence in harvested berries has been reported to taint the wine in wine growing regions including Australia.

Life Cycle: This insect overwinters as an adult and has one generation per year. Females lay eggs in the spring and care for the nymphs for one to two weeks. Adults are brownish black, about 14 mm long, have short feathery front wings and a pair of forceps at the rear. European earwigs are sensitive to low humidity; at 25 to 30 percent relative humidity earwigs survive only three to six days.

Pest Management

Cultural Controls: European earwigs are nocturnal, feeding at night and hiding during the day. Traps made from crumpled paper in tubes or cans and rolled cardboard can be used to detect their presence and to collect individuals. Fumigation of shipments can help to reduce the frequency of accidental introduction. Growers can minimise the risk of introduction by ensuring that all machinery, vehicles and equipment arriving on their property have been cleaned. Earwigs can be found in large numbers under boards, tree holes, decaying bark or wherever it is moist and dark. The first step to controlling them is to eliminate these and other breeding and nesting sites. IPM practices seem to be well suited to control damage caused by earwigs while still benefiting from their capacity as biological control agents for other insect pests.

Resistant Cultivars: None available.

Issues for European Earwig

None identified.

Wasps (*Vespula* spp.)

Pest Information

Damage: Wasps produce slits (~0.2 mm long) in the berry skin with their mouthparts, then sap leaks from the berry. Prolonged feeding results in multiple wounds and eventually mining of a cavity can extend into the grape. Wasps feed on ripe and damaged berries and are occasionally present in such large numbers that they can seriously affect yield. In other cases, they are just a nuisance when mechanically harvesting. For hand harvesting, wasps can be a dangerous and disruptive pest for workers.

Life Cycle: Wasps are social insects. They live in colonies consisting of a queen, female workers and males. Each colony starts out the year with a single, mated female queen, the only life stage that is able to survive the winter. In the spring, the queen emerges from a protected site and begins the process of nest building and laying several dozen eggs. Larvae mature and become infertile females, which continue the work of expanding the nest, foraging for the colony's food, and defending the colony. The queen continues to lay eggs, never leaving the nest again. Once the colony reaches upwards of a thousand wasps some of the eggs that are laid will develop into what will become future reproductive queens and males. In the fall, future queens and males leave the colony to mate. Mated females seek out places to stay alive during the cold months.

Pest Management

Cultural Controls: To discourage wasp feeding, grape clusters should be picked as soon as they ripen. Minimize injury to grapes caused by birds, insects or diseases. Remove any overripe or damaged fruit from the grapevines. Insecticides are not an effective management option for controlling wasps. Trapping wasps later in the season may help lower the damage on grapes but trapping needs to be started early and maintained through harvest. Trapping will not eliminate all wasps in the area. Early season bait should be fresh meat or fish but later in August sweet liquids are best. When yellow jackets are plentiful, just about any sweet liquid will attract dozens to funnel traps each hour, so traps need to be serviced daily or they will lose effectiveness.

Resistant Cultivars: None available.

Issues for Wasps

1. Wasps are often present, along with fruit flies / spotted wing drosophila, during the pre-harvest period feeding on damaged areas of clusters which can lead to problems with sour rot. It is important to maintain labels on registered insecticides that are efficacious against fruit flies, spotted wing drosophila and yellow jackets / wasps which short pre-harvest intervals. Repellants and exclusion methods should also be considered.

Weeds

Key Issues

- There is a need for registration of broad-spectrum contact herbicides with different modes of action in order to slow or prevent the development of resistance and to mitigate the impacts of glyphosate resistant weed species including Canada fleabane, field bindweed and thistle.
- There is a need to investigate additional pre-emergent residual herbicides, which are safe to use around young plantings and vines that are retaining suckers for trunk re-establishment.
- Weed management in slow growing, semi-hardy varieties of grapes grown in Quebec is difficult given the sensitivity of the vines to herbicides. There is a need to develop protection strategies around young vines to reduce the negative impact select herbicides may pose.
- There is a need for the development and assessment of the efficacy, economics and environmental impact of non-chemical methods of weed control such as steam treatment, flaming, electrification, development and use of mulch application, and mechanical weed removal. Assessments need to include efficacy, economics and environmental impacts of these methods.
- There is a need to investigate the long-term effects of pre-emergent herbicides that have multi-season residual weed control. There is concern among the grower community that areas treated with these long lasting pre-emergent herbicides are compromised for future plantings.
- For provincial evaluations of weed occurrence by species, see Table 8.

Table 8. Occurrence of weeds in grape production in Canada[1,2]

Weeds	British Colombia	Quebec	Ontario	Nova Scotia
Annual broadleaf weeds				
Annual grass weeds				
Perennial broadleaf weeds				
Perennial grass weeds				
Widespread yearly occurrence with high pest pressure.				
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.				

[1]Source: Grape stakeholders in reporting provinces (British Columbia, Ontario, Quebec and Nova Scotia). The data reflect the 2020, 2021 and 2022 production years.
[2]Refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

Table 9. Adoption of integrated weed management practices in grape production in Canada[1]

Practices	Annual broadleaf weeds	Annual grass weeds	Perennial broadleaf weeds	Perennial grass weeds
Avoidance:				
Varietal selection / use of competitive varieties				
Planting / harvest date adjustment				
Crop rotation				
Choice of planting site				
Optimizing fertilization for balanced crop growth				
Use of weed-free propagative materials (seed, cuttings, transplants)				
No till or low disturbance seeding to minimize weed seed germination				
Use of physical barriers (e.g., mulches)				
Prevention:				
Equipment sanitation				
Canopy management (thinning, pruning, row or plant spacing, etc.)				
Manipulating seeding / planting depth				
Irrigation management (timing, duration, amount) to maximize crop growth				
Management of soil moisture (improvements in drainage, use of raised beds, hilling, mounds)				
Weed management in non-crop lands				
Weed management in non-crop years / the year prior to planting				
Monitoring:				
Scouting / field inspection				
Maintaining records of weed incidence including herbicide resistant weeds				
Use of precision agriculture technology (GPS, GIS) for data collection and mapping of weeds				
Decision making tools:				
Economic threshold				
Crop specialist recommendation or advisory bulletin				

…continued

Table 9. Adoption of integrated weed management practices in grape production in Canada[1] (continued)

Practices	Annual broadleaf weeds	Annual grass weeds	Perennial broadleaf weeds	Perennial grass weeds
Decision to treat based on observed presence of weed at susceptible stage of development				
Decision to treat based on observed crop damage				
Use of portable electronic devices in the field to access weed identification / management information				
Suppression:				
Use of diverse herbicide modes of action for resistance management				
Soil amendments and green manuring involving soil incorporation as biofumigants to reduce weed populations				
Use of biopesticides (microbial and non-conventional pesticides)				
Release of arthropod biological control agents				
Mechanical weed control (cultivation / tillage)				
Manual weed control (hand pulling, hoeing, flaming)				
Use of stale seedbed approach				
Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)				
Selection of herbicides that are soft on beneficial insects, pollinators and other non-target organisms				
Crop specific practices:				
Roll-chopping between rows				
This practice is used to manage this pest by at least some growers in the province.				
This practice is not used by growers in the province to manage this pest.				
This practice is not applicable for the management of this pest.				

[1]Source: Grape stakeholders in reporting provinces (British Columbia, Ontario, Quebec and Nova Scotia); the data reflect the 2020, 2021 and 2022 production years.

Annual and Perennial Broadleaf and Grass Weeds

Pest Information

Damage: Weeds compete with grapevines for moisture and nutrients, may harbour disease pathogens and insect pests, and can provide shelter for problematic rodents. New vines can lose a year's growth if there is significant weed competition and may die if water or nutrients are a limiting factor. For older vines, weed competition can result in crop loss through the production of smaller fruit and reduced fruit bud set the following growing season.

Life cycle: Annual weeds complete their life cycle, from seed germination through vegetative growth and flowering to seed production, in one year. Annual weeds produce a large number of seeds that can remain viable in the soil for many years, germinating when conditions are suitable. Perennial weeds are plants that live for many years. They spread through seeds as well as through the expansion of various types of root systems and other vegetative means.

Pest Management

Cultural Controls: The cultivation, fallowing or mowing of surrounding fields, ditches and road areas will prevent weeds from flowering and producing a weed seed bank that could potentially be blown into the vineyard. In the vineyard, biodegradable plastic or straw mulches can be used for weed control in the planting strip. A green manure crop of rye-grass or Sudan grass planted the year before vineyard establishment, combined with fallow periods, can stimulate weed seed germination and deplete the weed seed bank in the soil. Mulch and manure used in the vineyard, which is free from weed seeds will prevent the introduction of new weeds. Planting grapevines into established sod that has been chemically killed before planting will also reduce the need for herbicides in the year of planting. Although helpful, mowing alone will not eliminate weeds. Establishing vigorous sod between rows reduces weed pressure. Hand removal of new weed species or resistant biotypes may be an important method of stopping new problem weeds from becoming established. Refer to *Table 9* for practices used by growers to manage weeds.

Issues for Weeds

1. There is a need for registration of broad-spectrum contact herbicides with different modes of action in order to slow or prevent the development of resistance and to mitigate the impacts of glyphosate resistant weed species, including Canada fleabane and thistle.
2. Additional pre-emergent residual herbicides that are safe to use around young plantings and vines retaining suckers for trunk re-establishment would be welcomed by growers.
3. Although acetic acid-based herbicides are now available to organic growers, there continues to be a need for the development and communication of organic practices for weed control.
4. The use of low growing, semi hardy grape varieties in Quebec and Nova Scotia make the use of herbicides for weed control difficult. There is a need for new herbicides and control strategies (including mechanical weed control) that are not toxic to grape plants.
5. Mechanical weed control has become more popular in recent years. This method is more difficult to implement when tomato ringspot virus and nematode vectors are present. There is a need for the development and assessment of the efficacy, economics and environmental impact of non-chemical methods of weed control such as steam treatment, flaming,

electrification, development and use of mulch application along with mechanical weed removal.

6. Growers in British Columbia need better information on how to identify and stop the spread of puncture vine and long spine sandbur.
7. There is a need to investigate the long-term effects of pre-emergent herbicides that have multi-season residual weed control. There is concern among the grower community that areas treated with these long lasting pre-emergent herbicides are compromised for future plantings.
8. Further investigation is needed in the feasibility of using autonomous robots for weed control procedures or applications.

Resources

Integrated Pest Management / Integrated Crop Management Resources for Production of Grape in Canada

British Columbia Ministry of Agriculture. *Grapes.* https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/crop-production/grapes

British Columbia Wine Grape Council. *Best Practices Guide for Grapes: For British Columbia Growers (2010 Edition)* https://bcwgc.org/best-practices-guide

Ontario Ministry of Agriculture, Food and Rural Affairs. *Crop Protection Guide for Grapes 2021*. Publication 360C. http://omafra.gov.on.ca/english/crops/pub360/pub360C.pdf

Ontario Ministry of Agriculture, Food and Rural Affairs. *Information for Commercial Grape Growers in Ontario.* www.omafra.gov.on.ca/english/crops/hort/grape.html

Perennia. *Grape Production Guide*. https://www.perennia.ca/wp-content/uploads/2022/05/Grape-Production-Guide-2022-MAY-web.pdf

Provincial Contacts

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	AgriService BC www2.gov.bc.ca/gov/content/industry/agriservice-bc		Caroline Bédard Caroline.Bedard@gov.bc.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs omafra.gov.on.ca	Wendy McFadden-Smith Wendy.Mcfadden-Smith@ontario.ca	Joshua Mosiondz Joshua.Mosiondz@ontario.ca
Quebec	Ministère de l'Agriculture, Pêcheries et de l'Alimentation du Québec www.mapaq.gouv.qc.ca	Karine Bergeron Karine.Bergeron@mapaq.gouv.qc.ca	Mathieu Côté Mathieu.Cote@mapaq.gouv.qc.ca
Nova Scotia	Nova Scotia Department of Agriculture novascotia.ca/agri		Deney Augustine Joseph Deney.AugustineJoseph@novascotia.ca
	Perennia www.perennia.ca	Francisco Diez fdiez@perennia.ca	

National and Provincial Grape Growers and Wineries Organizations

British Columbia Grape Growers Association: www.grapegrowers.bc.ca

British Columbia Wine Institute: winebc.com

British Columbia Wine Grape Council: www.bcwgc.org

Canadian Grapevine Certification Network: www.cgcn-rccv.ca

Fruit and Vegetable Growers of Canada: fvgc.ca

Grape Growers Association of Nova Scotia: ggans.com

Grape Growers of Ontario: grapegrowersofontario.com

Ontario Fruit and Vegetable Growers Association: www.ofvga.org

Quebec Wine Council: vinsduquebec.com

VQA Ontario: www.vqaontario.ca

Wine Growers Canada (formerly Canadian Vintner's Association): www.winegrowerscanada.ca

Wine Growers Ontario: www.winegrowersontario.ca

Wines of Nova Scotia: winesofnovascotia.ca

Appendix 1

Definition of terms and colour coding for pest occurrence table of the crop profiles.

Information on the occurrence of disease, insect and mite and weed pests in each reporting province is provided in Tables 4, 6 and 8 of the crop profile, respectively. The colour coding of the cells in these tables is based on three pieces of information, namely pest distribution, frequency and pressure in each province as presented in the following chart.

<table>
<tr><th>Presence</th><th colspan="4">Occurrence information</th><th rowspan="2">Colour Code</th></tr>
<tr><td rowspan="15">Present</td><td rowspan="13">Data available</td><th>Frequency</th><th>Distribution</th><th>Pressure</th></tr>
<tr><td rowspan="6">Yearly - Pest is present 2 or more years out of 3 in a given region of the province.</td><td rowspan="3">Widespread - The pest population is generally distributed throughout crop growing regions of the province. In a given year, outbreaks may occur in any region.</td><td>High - If present, potential for spread and crop loss is high and controls must be implemented even for small populations.</td><td>Red</td></tr>
<tr><td>Moderate - If present, potential for spread and crop loss is moderate: pest situation must be monitored and controls may be implemented.</td><td>Orange</td></tr>
<tr><td>Low - If present, the pest causes low or negligible crop damage and controls need not be implemented.</td><td>Yellow</td></tr>
<tr><td rowspan="3">Localized - The pest is established as localized populations and is found only in scattered or limited areas of the province.</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="6">Sporadic - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="3">Widespread - as above</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>Yellow</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="3">Localized - as above</td><td>High - see above</td><td>Yellow</td></tr>
<tr><td>Moderate -see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="2">Data not available</td><td colspan="3">Not of concern: The pest is present in commercial crop growing areas of the province but is causing no significant damage. Little is known about its population distribution and frequency in this province; however, it is not of concern.</td><td>White</td></tr>
<tr><td colspan="3">Is of concern: The pest is present in commercial crop growing areas of the province. Little is known about its population distribution and frequency of outbreaks in this province and due to its potential to cause economic damage, is of concern.</td><td>Blue</td></tr>
<tr><td>Not present</td><td colspan="4">The pest is not present in commercial crop growing areas of the province, to the best of your knowledge.</td><td>Black</td></tr>
<tr><td>Data not reported</td><td colspan="4">Information on the pest in this province is unknown. No data is being reported for this pest.</td><td>Gray</td></tr>
</table>

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