Crop Profile for Raspberry in Canada, 2022

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Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Canada

Fifth Edition – 2024
Crop Profile for Raspberry in Canada, 2022
Catalogue No.: A118-10/18-2022E-PDF
ISBN: 978-0-660-49373-2
AAFC No.: 13172E

Fourth Edition – 2021
Crop Profile for Raspberry in Canada, 2019
Catalogue No.: A118-10/18-2019E-PDF
ISBN: 978-0-660-35264-0
AAFC No: 13070E

Third Edition – 2019
Crop Profile for Raspberry in Canada, 2016
Catalogue No.: A118-10/18-2016E-PDF
ISBN: 978-0-660-29359-2
AAFC No: 12889E

Second Edition – 2016
Crop Profile for Raspberry in Canada, 2013
Catalogue No.: A118-10/18-2013E-PDF
ISBN: 978-0-660-04528-3
AAFC No.: 12483E

First Edition – 2007
Crop Profile for Raspberry in Canada
Catalogue No.: A118-10/18-2007E-PDF

Electronic version available at publications.gc.ca

Paru également en français sous le titre: « *Profil de la culture de la framboise au 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 % of the national production) and provide qualitative data on pest occurrence and integrated pest management practices used by growers in those provinces. For raspberry production, the reporting provinces are British Columbia, Ontario and Quebec.

Information on pest issues and management practices is provided for information purposes only. For detailed information on growing raspberries, 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 raspberry, 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.

Agriculture and Agri-Food Canada gratefully acknowledges the contributions of provincial crop specialists, industry specialists and growers in the gathering of information for this publication.

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Raspberries (*Rubus* spp.) are members of the Rosaceae (rose) family. Raspberries have been cultivated for many centuries, and by the 19th Century, there were more than 20 cultivars of red raspberries in cultivation in North America. Although raspberry species produce fruit of various shades of red, black, yellow and purple, red raspberries (*Rubus idaeus* L.) make up the major portion of the commercial crop. Raspberries are consumed fresh, frozen, or processed in jam, juice, yogurt and wine. Individually quick-frozen raspberries are a premium quality and priced product, and consumer demand for quick-frozen raspberries continues to grow.

Raspberries have a perennial crown and root system. In the spring, buds on the roots give rise to new canes called primocanes. There are two main types of raspberries, floricane-fruiting (summer bearing) and primocane-fruiting (fall bearing or everbearing). In floricane-fruiting varieties, primocanes remain vegetative throughout the first season. In the second year, the primocanes of summer bearing raspberries become floricanes, as they produce flower buds and fruits. Primocane-fruiting varieties bear fruit on the top half of the primocanes late in the first year. In the second year of these varieties, a summer crop is produced on the lower half of the cane, now a floricane. In the same season, the primocanes of everbearing varieties produce a fall crop on the top half of the primocanes. In some everbearing fields, the floricanes are cut back in the fall or winter to eliminate the summer crop and to ensure a larger fall crop. The average lifespan of a raspberry planting is six to 10 years.

Crop Production

Industry Overview

Canada is a minor raspberry producer, responsible for less than 2 percent of world production. Canada produced 6,700 metric tonnes of raspberries in 2022 with a farm gate value of $32.4 million (Table 1). This was a 23 percent decrease in production since 2016. Most raspberries are exported frozen to the American market. Both summer and fall bearing raspberries are grown in Canada. The latter are grown in a high-tunnel production with adapted cultivars. High tunnel production is gaining in popularity as it enables an extended production season, and shows some promise for reduced use of pest management products. Organic production is on the rise representing about 10 percent of the total Canadian raspberry acreage.

Table 1. General production information, 2022

	Raspberries
Canadian Production[1]	6,700 metric tonnes
	1,499 hectares
Farm Gate Value[1]	$32.4 million
Availability[2]	Frozen: 0.30 kg/person
Exports[3]	Fresh: $0.8 million
	Frozen: $29.8 million
Imports[3]	Fresh: $486.6 million
	Frozen: $128.9 million

[1]Source: Statistics Canada. Table 32-10-0364-01 - Area, production and farm gate value of marketed fruits (Accessed: 2023-06-28).
[2]Source: Statistics Canada. Table 32-0054-01 - Food available in Canada (Accessed: 2023-06-28).
[3]Source: Statistics Canada. Canadian International Merchandise Trade Web Application. Fresh: HS # 0810.20 - Raspberries, blackberries, mulberries and loganberries, fresh. Frozen: HS # 0811.20 - Raspberries,mulberries,etc,uncooked,steamed or boil in water,sweet or not,frozen (Accessed: 2023-06-28).

Production Regions

Raspberries are produced commercially in all provinces of Canada. The largest cultivated production area is in British Columbia (53 percent of national area of production) followed by Quebec (26 percent) and Ontario (12 percent) (Table 2). British Columbia produces a disproportionately high share of the marketed production (72 percent or 4,799 metric tonnes in 2022).

Table 2. Distribution of raspberry production by province, 2022[1]

Production Regions	Cultivated Area[2] (national percentage)	Marketed Production (national percentage)	Farm Gate Value
British Columbia	801 hectares (53%)	4,799 metric tonnes (72%)	$17.1 million
Ontario	185 hectares (12%)	503 metric tonnes (8%)	$4.1 million
Quebec	385 hectares (26%)	1,206 metric tonnes (18%)	$9.5 million
Canada	**1,499 hectares**	**6,700 metric tonnes**	**$32.4 million**

[1]Statistics Canada. Table 32-10-0364-01 - Area, production and farm gate value of marketed fruits (Accessed: 2023-06-28).
[2]Cultivated area includes bearing and non-bearing area.

Cultural Practices

Raspberries do best on loam or sandy-loam soils that are slightly acidic (pH 5.5 to 6.5). Raspberries can also be grown on sandy or gravelly soils but careful management of water and nutrients is required as these types of soils do not hold water or nutrients well. Roots are highly susceptible to drought stress during dry periods and to overwatering and flooding which can predispose them to root rot, resulting in poor yields and a shortened lifespan of the planting. Thus, drainage is important for optimum production of the planting, and a sub-surface drainage system is recommended. Raspberries can be planted on 25 to 30 cm raised beds to improve drainage and reduce the risk of root rots.

Soil testing for nutrients, pH and nematodes, conducted the year prior to planting, will ensure sufficient time to implement necessary corrective measures such as amendments or cover crops for deficiencies. If used, some cover crops may be disced into the soil in time to allow for decomposition before planting in the spring. Alleyway cover crops, which may be used for soil health and weed management, are typically mowed in the spring. Limestone may be broadcast in the fall prior to cover crop planting, or in the spring before planting, if the soil pH is lower than 5.5.

Certified planting stock is used in new plantings to reduce the risk of introducing nematodes, viruses, root rot and other pests and diseases into the field. Varieties are selected based on fruit quality, disease resistance, harvest maturity time, suitability for hand or mechanical harvest and suitability for the fresh or processing market. Raspberry planting stock is sold as green tissue culture (TC) plants, dormant TC plants (i.e., overwintered TC plants) or bare root plants.

The utility and interest in high tunnels for raspberry production continues to grow. High tunnels are large hoop houses covered with plastic, the ends and sides of which can be raised or lowered to regulate temperature. Raspberry plants may be planted directly in the ground or in large pots or bags under the tunnels. High tunnels provide the benefit of extending the growing season for raspberries resulting in improved fruit yields and quality. High tunnels create a microclimate for the raspberry canes, thus, the spectrum of diseases and pests under the tunnels vary from that observed in the field. There is also a growing interest in long-cane raspberry production systems, involving raspberries grown in pots that can be moved in and out of cold treatment for scheduled production.

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

Table 3. Summer and fall bearing raspberries production and pest management schedule in Canada

Time of Year / Plant Stage	Activity	Action
January Dormancy	Plant care	Prune canes (BC).
February Dormancy; Roots becoming active (BC)	Plant care	Top canes, if necessary. Chop prunings. Set out new plantings (BC).
	Soil care	For new plantings, spring soil test and prepare soil (BC).
	Weed management	Apply herbicide for weeds within rows (BC).
March Bud swell, new canes and fruiting laterals (BC); Dormancy (QC, ON)	Plant care	Complete all pruning (including chopping of prunings) and topping of canes. Start planting (BC). Remove first flush of primocanes by "shoot burning" (BC).
	Soil care	Spring soil test for established plantings (BC).
	Disease management	If field has history of spur blight, apply pre-bloom fungicide (ON, QC). Apply delayed dormant spray for cane diseases and yellow rust. Apply spray for bacterial blight control.
	Insect / mite management	Drench crowns for crown borers, as needed (ON, QC). Monitor for clay coloured weevils. Apply controls as needed (BC).
April – early May New canes and fruiting laterals (BC); Roots becoming active, bud swell (QC, ON)	Plant care	Continue planting (BC). Apply granular fertilizer. Continue hand pruning or mowing (ON). Remove first flush of primocanes by "shoot burning" by mid-April (BC).
	Soil care	Fertilize new plantings, as necessary (BC, QC). Prepare land for planting and plant as soon as possible (ON, QC).
	Disease management	Monitor for diseases. If field has history of spur blight, apply pre-bloom fungicide. Apply copper for bacterial blight, as needed. Apply fungicide as needed (BC). Apply early season treatments for anthracnose with dormant sprays of lime sulfur or Bordeaux mixture (ON, QC)
	Insect / mite management	Continue monitoring for climbing cutworms and clay coloured weevils. Monitor for leafrollers and raspberry fruitworm. If insecticides are needed, apply before bloom to protect bees. Drench or soak crowns for crown borers, as needed (ON, QC).
	Weed management	Cultivate between rows. Apply herbicides, as needed (BC). Apply pre-emergent herbicide (ON).
May Flowering (BC); New canes and fruiting laterals (QC, ON); Flowering (QC); Bud swell (ON)	Plant care	Apply foliar micronutrients (e.g., boron, magnesium) and irrigate as needed. Place honeybees in field at the start of flowering, if applicable.
	Disease management	Continue monitoring for yellow rust, spur blight and Botrytis fruit rot; apply fungicides, as needed. Prune-out canes affected by anthracnose and spur blight (QC). Apply delayed dormant spray for cane diseases (ON).
	Insect / mite management	Continue monitoring for clay coloured weevils, leafrollers, strawberry blossom weevils (BC) and raspberry fruitworm. Begin monitoring for black vine weevil, mites, spotted wing drosophila and predators. Apply insecticides, as needed. Remove canes affected by mites and borers (QC).
June Bloom to Harvest	Plant care	Foliar feed and irrigate, as required. Begin harvest (BC). Suppress primocanes in biennial systems (ON). Install post and wire trellises in new plantings.
	Disease management	Monitor for cane wilt. Apply fungicides for cane wilt and fruit rot, as needed (BC).
	Insect / mite management	Continue monitoring for insects. Apply insecticides, particularly if harvest contamination is a concern, as needed. Observe required pre-harvest intervals (PHI).

…continued

Table 3. Summer and fall bearing raspberries production and pest management schedule in Canada (continued)

Time of Year / Plant Stage	Activity	Action
Late June to early August Harvest	Plant care	Harvest fruit. Irrigate, if necessary. In fall-bearing raspberries, place honeybees in field at the start of flowering (BC).
	Disease management	Continue fruit rot sprays, as needed. Monitor primocanes for spur blight. Monitor for cane wilt and spot mould (fruit) during rainy seasons.
	Insect / mite management	Continue monitoring for mites, leafrollers, weevils, spotted wing drosophila and arthropod predators. Apply insecticide controls if harvest contamination is a problem, observing required PHI.
August Harvest	Plant care	Irrigate to maintain growth in new canes. Apply foliar sprays (e.g., boron), as needed. Test soil for nitrates post-harvest. Begin harvest in fall-bearing raspberries (BC).
	Soil care	Loosen soil compaction that may have occurred during harvest. Prepare soil for cover crop, if using.
	Disease management	Remove floricanes to improve air circulation. Implement cultural controls if root rot was problematic. Apply fungicides for spur blight, as needed.
	Insect / mite management	Continue monitoring for mites and predators; apply controls, as needed.
September Post-harvest for summer bearing, harvest for fall bearing (BC)	Plant care	Irrigate, as needed. Start pruning floricanes (QC). Continue harvest in fall-bearing raspberries (BC).
	Soil care	Plant fall cover crops. Loosen compacted soil to improve winter drainage. Install drainage in new fields, as required. Collect soil samples for fall nutrient analysis.
	Disease management	Continue cultural controls for root rot, as needed. Fumigate new plantings.
	Insect / mite management	Continue monitoring for mites and predators; apply controls, as needed. Apply controls for crown borer, as needed.
	Weed management	Mow or cultivate, as needed.
October Pre-dormancy	Plant care	Begin pruning of floricanes.
	Soil care	Collect soil samples for fall nutrient analysis.
	Disease management	Apply fungicide for root rot and bacterial blight, as needed.
	Insect / mite management	Apply insecticide spray for crown borer, as needed.
	Weed management	Apply fall and early winter herbicides, as needed. Eliminate tall weeds and grass to discourage mice.
November & December Dormancy	Plant care	Continue pruning. Remove weak or unwanted primocanes. Mow fruiting canes in biennial systems once plants are dormant.
	Weed management	Apply early winter or pre-emergent herbicides, as needed.

Abiotic Factors Limiting Production

Moisture

Water management is a critical factor in raspberry production. Poor drainage and periodic flooding are major contributing factors to Phytophthora root rot disease. However, coarse, sandy soils suitable for raspberry production can also dry out quickly in the summer. Drought can lead to stressed plants, resulting in small berries and reduced yields, while overwatering may result in leaching of nutrients and root rot.

Frost

Frost injury increases the susceptibility of raspberries to cane and shoot dieback caused by *Pseudomonas* sp. As well, excess nitrogen in the fall increases the likelihood of frost injury and damage from bacterial blight (*Pseudomonas syringae* pv. *syringae*) in the spring. Severe frosts can also kill new primocanes in spring.

Nutrient Imbalance

Magnesium, boron and calcium levels are often low in coarse, sandy soils. Magnesium deficiencies cause interveinal areas of leaves to become yellow and red, eventually resulting in leaf death, starting with older leaves. Symptoms of boron deficiency include uneven bud break in the spring, downward cupping of leaves, death of the terminal bud on new canes, crumbly fruit and narrowing of new leaves in late summer. Calcium deficiencies result in slow growth, dieback of the terminal growth and spotting of leaves. Phosphorus deficiencies can cause purpling and reddening of new leaves in early spring. This is more severe in cold, wet years but the plants generally overcome these symptoms as the weather warms up.

Diseases

Key Issues

- Substrate production (i.e., container production) of raspberries has the potential to reduce the development of soil diseases. This technique is promising and should be a research priority.

- The prevalence of Cladosporium fruit rot is increasing in some growing regions. There is a need for additional research on this pathogen in raspberry production.

- Phytophthora root rot is a serious disease affecting raspberry production in Canada. There is a need for the development of an integrated approach for the management of this disease. In addition, there is a need for the registration of conventional and non-conventional fungicides for resistance management, and for user-friendly fumigation products pre- and post-planting for the management of Phytophthora root rot.

- The development of new cultivars with resistance to Raspberry Ringspot Virus and Raspberry Bushy Dwarf Virus are required.

- There is a need for additional fungicides with multi-site activity for the management of Botrytis. Re-entry restrictions on currently used fungicides and the associated reliance on other products without similar restrictions could lead to resistance and compromise disease control. Surveys are needed to determine the extent of resistance in Canada and to track the efficacy of registered fungicides over time. In addition, growers need access to diagnostic tools to determine if fungicides used on-farm are still efficacious and to determine the impact of fungicides applied during bloom on fruit rot incidence at harvest.

- Cane pathogens responsible for various blights are challenging to control in raspberry production. Disease susceptibility varies by cultivar and type of raspberry (e.g., primocane/floricane). Registered fungicides do not provide adequate control. There is a need for research on the biology of spur blight and cane blight to facilitate the development of effective approaches to the management of these diseases.

- Anthracnose can cause losses during cane blight and fruit rot phases of the disease in some growing regions. There are no effective controls available. There is a need for the registration of conventional and non-conventional fungicides and the development of an integrated approach to anthracnose management.

- Nematodes are serious pests in raspberry production. There is a need for the development of an integrated approach for nematode management, including research and evaluation of cultural practices, cost-effective nematicides and different application techniques, including through drip irrigation lines.

- Incidence of *Cylindrocarpon* sp. infecting roots and crowns of raspberries and *Rhizoctonia* sp. infecting raspberry crowns is increasing in some growing regions.

…continued

Key Issues (continued)

- Fire blight (*Erwinia amylovora*) causes significant damage to some raspberry cultivars. It is important to better understand the cycle of this disease in raspberry to develop predictive models comparable to those used in apple.

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

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

Disease	British Columbia	Quebec	Ontario
Botrytis diseases			
Fruit rot			
Spur blight			
Cane blight			
Anthracnose or cane spot			
Powdery mildew			
Yellow rust			
Fire blight			
Bacterial blight			
Verticillium wilt			
Phytophthora root rot			
Crown gall; cane gall			
Raspberry bushy dwarf virus			
Tomato ringspot virus			
Raspberry mosaic			
Root lesion nematode			
Dagger nematode			
Sting nematode			
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.			
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.			
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.			
Pest is present and of concern, however, little is known of its distribution, frequency and pressure.			
Pest not present.			
Data not reported.			

[1]Source: Raspberry stakeholders in reporting provinces (British Columbia, Ontario and Quebec). 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 raspberry production in Canada[1]

Practices	Botrytis disease	Phytophthora root rot	Spur blight	Anthracnose (cane spot)	Rusts	Fire blight
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						

…continued

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

Practices	Botrytis disease	Phytophthora root rot	Spur blight	Anthracnose (cane spot)	Rusts	Fire blight
Monitoring:						
Scouting / spore trapping	[green]	[green]	[green]	[green]	[green]	[green]
Maintaining records to track diseases	[green]	[green]	[green]	[green]	[green]	[green]
Soil analysis for the presence of pathogens		[green]				
Weather monitoring for disease forecasting (regional and on-farm)	[green]		[green]	[green]	[green]	[green]
Use of precision agriculture technology (GPS, GIS) for data collection and mapping of diseases	[red]	[red]	[red]	[red]	[red]	[red]
Decision making tools:						
Economic threshold	[green]	[green]	[green]	[green]	[green]	[green]
Use of predictive model for management decisions	[red]	[red]	[red]	[red]	[red]	[green]
Crop specialist recommendation or advisory bulletin	[green]	[green]	[green]	[green]	[green]	[green]
Decision to treat based on observed disease symptoms	[green]	[green]	[green]	[green]	[green]	[green]
Use of portable electronic devices in the field to access pathogen / disease identification / management information	[green]	[green]	[green]	[green]	[green]	[green]
Suppression:						
Use of diverse product modes of action for resistance management	[green]	[green]	[green]	[green]	[green]	[green]
Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pathogen populations		[green]				
Use of biopesticides (microbial and non-conventional pesticides)	[green]	[green]	[green]	[green]	[green]	[red]
Controlled atmosphere storage						
Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)	[green]	[green]	[green]	[green]	[green]	[green]

...continued

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

Practices	Botrytis disease	Phytophthora root rot	Spur blight	Anthracnose (cane spot)	Rusts	Fire blight
Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms	[green]	[green]	[green]	[green]	[green]	[green]
Crop specific practices:						
Modified atmosphere storage	[green]	[red]	[red]	[red]	[red]	[red]
Protected culture (e.g., grown under protection)	[green]	[green]	[green]	[green]	[green]	[green]
Substrate production	[green]	[green]	[green]	[green]	[green]	[green]
[green] This practice is used to manage this pest by at least some growers in the province.						
[red] 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: Raspberry stakeholders in reporting provinces (British Columbia, Ontario and Quebec); the data reflect the 2020, 2021 and 2022 production years.

Botrytis Diseases: Gray mold, Fruit Rot, Blossom Blight and Cane Botrytis (*Botrytis cinerea*)

Pest Information

Damage: This fungus infects blossoms and fruit resulting in mouldy and dried berries and also causes primocane lesions known as cane botrytis. In wetter years, the disease can drastically reduce both fruit quality (grade) and marketable yield and even with fungicide use, losses can be up to 30 percent. The disease is less severe in raspberries grown under tunnels.

Life Cycle: Botrytis cinerea overwinters as resting bodies (sclerotia) on primocanes and as vegetative fungal strands (mycelia) on dead leaves and mummified fruit. These overwintering structures produce spores in the spring, which infect blossoms. The early blossom infections remain inactive (latent) until the fruit is nearly ripe. When conditions are favourable for fungal growth within the berry, the fungus sporulates on the berry surface, appearing as a distinctive gray mould. These spores contribute to secondary infection of fruit, primocanes and other green tissues. The infection and spread of the disease are favoured by high moisture and poor drying conditions.

Pest Management

Cultural Controls: Cultural practices that improve air circulation within the crop, such as pruning, elimination of weeds and increased plant spacing help to minimize the disease. Biennial crop production and primocane suppression help improve air movement and thus can help reduce the incidence of Botrytis, as will avoiding excessive nitrogen fertilization and timing overhead irrigation such that plants do not remain wet for prolonged periods. Refer to *Table 5* for practices used by growers to manage botrytis diseases.

Resistant Cultivars: Some cultivars (e.g., Meeker, Squamish, Chemanius) have shown some resistance to Botrytis rots.

Issues for Botrytis Diseases

1. Resistance to several commonly used fungicide groups is developing worldwide. Surveys are needed in some berry producing regions of Canada to track efficacy of fungicides and development of resistance. Registration of new control options, including biofungicides, and research into and adoption of bee vectoring technology would provide a valuable alternative control for Botrytis.
2. Growers need access to diagnostic tools to determine which fungicides are no longer useful due to the development of resistance in pathogen populations on their farm.
3. A focused effort on the development of best management practices to prevent or delay the development of fungicide resistance is needed, as are resource materials for growers about these best management practices.
4. Re-entry restrictions on currently used fungicides will result in reliance on other products, which might lead to resistance and compromise disease control.
5. There is a need to verify existing forecasting models for use by growers in the field.
6. There is a need to register new products with novel modes of action and short harvest intervals to minimize issues with resistance.

Fruit Rot (*Cladosporum* spp.)

Pest Information

Damage: Cladosporum spp. infects fruit, covering berries with green mycelium. Damage is most commonly observed in storage; however, pre-harvest infections have been observed and are often associated with Botrytis fruit rot infections.

Life Cycle: The pathogen can be found in indoor and outdoor environments (commonly found in soil). *Cladosporum* spp. are common in humid conditions, with optimal growth between 2 to 25 °C but may occur at lower temperatures within storage. They are considered dematiaceous molds (e.g., produce melanin in their cell walls) and are known to cause human infections.

Pest Management

Cultural Controls: Cultural practices that include sanitation and moisture management within the crop will reduce inoculum levels. Some early research indicates a relationship between spotted wing drosophila and fruit rot caused by *Cladosporum* spp.; therefore, spotted wing drosophila management may be an important management tactic.

Resistant Cultivars: None available.

Issues for Cladosporium Fruit Rot

1. The prevalence of this disease is increasing in some growing regions. There is a need for additional monitoring resources to differentiate *Cladosporium* spp. from other fruit rot infections.

Spur Blight (*Didymella applanata*)

Pest Information

Damage: Yield losses from this disease tend to be cumulative over the years. Infection causes dieback of leaves, shoots and fruiting spurs. The disease first appears in mid- to late summer as wedge-shaped lesions on leaves. As the disease progresses, infections travel down the leaf petiole, infecting the cane at the nodes. Primocane lesions can damage buds at the base of the infected leaf. Damaged buds are predisposed to winter injury and weak growth the following season, potentially reducing yield.

Life Cycle: The fungus overwinters on infected primocanes and in the spring produces ascospores (sexual spores) and conidia (asexual spores), which can be spread by wind or rain-splashing and infect new primocanes. Release of conidia continues throughout the growing season during wet weather.

Pest Management

Cultural Controls: Scouting for characteristic symptoms may be done throughout the season to determine the need for fungicide treatments. Practices that improve air circulation and facilitate drying of foliage will make conditions less suitable for infection. The removal of old floricanes and infected primocanes after harvest will reduce overwintering inoculum. Refer to *Table 5* for practices used by growers to manage spur blight.

Resistant Cultivars: None available.

Issues for Spur Blight

1. Cane diseases are very challenging to control in raspberry. Registered products do not provide adequate control.
2. There is a need for studies on epidemiology (environmental conditions and timing of infection, etc.) and effective management practices. As well, research to support new fungicide registrations are needed to reduce resistance development.

Cane Blight (*Diapleella coniothyrium*)

Pest Information

Damage: Cane blight causes purple-black cankers at sites of pruning, insect feeding and mechanical damage to raspberry canes, resulting in girdling of the canes and wilting of shoots. The fungus remains in the vicinity of the wound but toxins produced by the fungus move up the cane, killing vascular tissue and buds.

Life Cycle: The fungus overwinters on old cane stubs. Old, dead canes may produce spores for several years. Pycnidia (spore producing bodies) develop in the spring and release spores that are rain splashed and wind-blown to nearby canes where they cause new infections. Physical damage to the surface of the primocanes enables the fungus to enter the vascular tissue. Moist conditions are required for infection.

Pest Management

Cultural Controls: The disease can be controlled by removal of infected canes. Other important cultural techniques include reducing damage from mowing equipment, trellising and harvesting machinery (by adjusting the tension of catcher plates). Examination of suspect primocanes in the fall and early spring is recommended to confirm the presence of this disease. Fast cane growth promoted by high nitrogen levels is more susceptible to cane blight infection injury.

Resistant Cultivars: None available.

Issues for Cane Blight

1. Cane diseases are very challenging to control in raspberry. The products available do not provide adequate control. There is a need for research on the biology of the disease to facilitate the development of effective controls.
2. There is a need for a better understanding of which fungicides provide control and the registration of these products.

Anthracnose or Cane Spot (*Elsinoe veneta* and *Colletotrichum* spp.)

Pest Information

Damage: The first symptoms of anthracnose are small, purplish circular patches on the cane or petioles. The patches enlarge and canes may eventually be girdled, resulting in dieback and the potential for uneven fruit ripening. Considerable cane injury may result from anthracnose in years when weather remains wet into late May or early June but early infections are more damaging. Uneven berry ripening may result from infected canes and the disease also causes a fruit rot that can result in down-grading of the fruit.

Life Cycle: In the fall, the disease spreads via spores produced in small black fruiting bodies. In the spring, splashing rain carries the spores to new shoots, leaves or fruit, where infection takes place. Both *Elsinoe veneta* and *Colletotrichum* species resembling *C. gloeosporioides* have been associated with this disease in British Columbia. *E. veneta* is the most common species in eastern Canada.

Pest Management

Cultural Controls: Effective management practices include pruning out infected canes after harvest and avoiding the application of excessive nitrogen. Refer to *Table 5* for practices used by growers to manage anthracnose.

Resistant Cultivars: Some varieties of red raspberry have demonstrated resistance to anthracnose (e.g., Willamette, Nootka, Meeker and Heritage).

Issues for Anthracnose

1. Serious losses can result from both the cane blight and fruit rot phases of anthracnose as there are no effective control methods. Due to the loss of FERBAM, there is an urgent need for the registration of conventional and non-conventional fungicides with short pre-harvest and re-entry intervals that can be used in hand harvested and U-pick fields, and for the development of an effective integrated approach to the management of this disease.
2. There is a need for the registration of effective fungicides and for research, to identify effective fungicides.
3. There is a need for the development of weather-based prediction models for use in integrated approaches to anthracnose management.

Powdery Mildew (*Sphaerotheca macularis*)

Pest Information

Damage: Sphaerotheca macularis attacks a wide range of plants, including raspberries, strawberries, currants, gooseberries and weeds. The fungus produces a white powdery growth of spores and mycelium on leaves, shoots and fruit. Fruit infections result in discolouration cracking and rotting, which renders the fruit unmarketable. Severely infected plants may be stunted. The white/gray powdery growth first appears on leaves, green shoots and fruit, later becoming brown with black specks (fungal fruiting bodies).

Life Cycle: Asexual spores produced in infected tissues are wind-blown to new tissues where they cause new infections. Later in the season, sexual fruiting bodies (cleistothecia) are produced that overwinter on fallen leaves and fruit. New leaves and fruit are infected every year in late spring when bloom begins. Infection is caused by airborne spores and is favoured by warm, humid weather and late-season dew and fog.

Pest Management

Cultural Controls: Cultural practices that promote good air circulation, including pruning and weed control, help to minimize problems due to powdery mildew. In the fall, cultivation between rows will bury infected leaves and reduce inoculum sources in the following spring. Monitoring for early detection of powdery mildew and treatment decisions are best completed before and during bloom.

Resistant Cultivars: Resistant cultivars are available.

Issues for Powdery Mildew

1. Powdery mildew incidence is increasing with the adoption of new cultivars. There may be increased disease pressure in high tunnel production systems.

Yellow Rust (*Phragmidium rubi-idaei*)

Pest Information

Damage: Yellow rust infects both floricane and primocane foliage. In some years, it causes significant premature leaf death, reducing plant vigour and increasing the likelihood of winter injury.

Life Cycle: The fungus overwinters in old primocane leaf debris trapped in bundles of canes where they are tied to the trellis wire. Spores released by the fungus in the spring cause the initial infection of floricane leaves. The first visible symptom of disease is the appearance of yellow-orange pustules on older leaves. Spores from these lesions lead to the secondary spread of the disease and to the overwintering stage.

Pest Management

Cultural Controls: In infected fields, removal of leaves from primocanes before they are tied up in the fall or delaying tie up until after leaves have dropped can reduce sources of infection for the following year. Tilling leaves into the soil will help to remove infected leaves as an inoculum source. Scouting in late April and early May and after harvest can assist in decision-making on the application of dormant or pre-bloom fungicide sprays and post-harvest cultural practices to reduce winter carryover. Refer to *Table 5* for practices used by growers to manage rusts.

Resistant Cultivars: None available.

Issues for Yellow Rust

1. There is a need for better understanding of the impact of pruning and other cultural practices on the development and management of yellow rust.
2. There is a need for the registration of additional fungicides, from different chemical groups, for disease management and as resistance management tools.

Late Leaf Rust (*Pucciniastrum americanum*)

Pest Information

Damage: This rust attacks leaves causing premature leaf drop and greater susceptibility to winter injury. Fruit can also be infected, resulting in unsightly and unmarketable berries. Severe outbreaks usually occur at harvest (late July to mid-August) and are often linked to conditions favourable for the development of the disease earlier in the season on nearby white spruce.

Life Cycle: The pathogen requires two different host species to complete its life cycle. Spores are produced on an alternate host, mainly white spruce, in mid-June to early July and are windblown to raspberry where they infect the leaves, calyces and flowers. Rust pustules develop on the infected tissues and give rise to spores of a different type which cause new infections on raspberry throughout the growing season. In the fall, an overwintering spore type is produced on raspberry that gives rise to yet another spore type in the spring which re-infects white spruce.

Pest Management

Cultural Controls: The removal of white spruce in the vicinity of raspberry plantings may help to break the disease cycle and reduce the likelihood of disease development on raspberry. Practices that promote drying of the foliage including proper row and plant spacing and weed management will result in conditions less favourable for disease development. Refer to *Table 5* for practices used by growers to manage rusts.

Resistant Cultivars: Some varieties (e.g., Cultivars Nova and K81-6) are resistant to late leaf rust.

Issues for Late Leaf Rust

1. There is a need for the registration of fungicides having short pre-harvest intervals for the control of late leaf rust.

Fire Blight (*Erwinia amylovora*)

Pest Information

Damage: Fire blight infected tips and lateral branches of primocanes become wilted and blackened, frequently developing a characteristic shepherd's crook. Symptoms of water soaking and blackening can also develop on infected fruit or flower clusters, which eventually become hard and dry, remaining attached to the plant. Droplets of white or amber bacterial "ooze" may be produced in infected tissue.

Life Cycle: Bacteria overwinter in cankers on first-year canes and survive on living tissue. In the spring, they spread to healthy tissues by rain splash or wind. Adverse weather conditions such as high winds, driving rains or hail can result in tiny wounds which provide entry sites for the bacteria. Insects such as tarnished plant bugs, earwigs and ants can spread *Erwinia amylovora* and facilitate infection. Strains of *E. amylovora* causing fire blight on raspberries differ from those causing the disease in apples and pears, with the raspberry strain unable to infect apple/ pear and vice versa.

Pest Management

Cultural Controls: The removal and destruction of infected canes will eliminate a source of the bacterial infection. Minimizing the creation of potential infection sites, such as those caused by overhead irrigation on susceptible varieties, will help to reduce disease development. The control of insects, if necessary, will reduce a potential means of spread. Refer to *Table 5* for practices used by growers to manage fire blight.

Resistant Cultivars: Varieties with resistance (e.g., Heritage, Nova, Royalty) or partial resistance (e.g., Ruby, Avon) are available.

Issues for Fire Blight

1. There is a need for the registration of protectant products that prevent fire blight development.
2. There is a need for improved understanding of the epidemiology of fire blight on raspberries and to identify conditions that lead to infection as an aid to better time applications of fungicide products.
3. The development of an integrated approach for the management of fire blight which includes varietal resistance and a predictive model is required.

Bacterial or Pseudomonas Blight (*Pseudomonas syringae* pv*. syringae*)

Pest Information

Damage: Bacterial blight is seldom a problem but when present can cause severe losses in British Columbia.

Life Cycle: The bacterium survives on leaf surfaces, in healthy buds and on weeds. It may be spread by splashing rain, wind, insects and infected planting stock.

Pest Management

Cultural Controls: Practices which avoid late growth due to excessive soil nitrogen, summer drought followed by resumption of growth with fall rains, and refraining from topping of canes too early in the fall, will minimize the potential for development for this disease.

Resistant Cultivars: None available.

Issues for Bacterial Blight

None identified.

Verticillium Wilt (*Verticillium dahliae* and *V. albo-atrum*)

Pest Information

Damage: Verticillium wilt, also known as bluestem, affects the water conducting tissues of the plant, causing leaves to develop a dull green colour and eventually become brown and dry. Growth may be stunted and display symptoms of nutrient deficiency or wilt. Fruit production may be poor in the second or third and later years. A characteristic blue streak may develop on stems of red raspberry cultivars.

Life Cycle: These pathogens are soil-borne and enter through the roots, moving upwards in the vascular system and blocking water and nutrient movement. *V. albo-atrum* does not persist in the soil for more than one season but *V. dahliae* produces microsclerotia (resting bodies), which can survive and remain infective for many years. Both pathogens have a very wide host range.

Pest Management

Cultural Controls: As verticillium wilt can affect many plants, it is important that raspberries are not planted where strawberries, potatoes or other susceptible crops have been grown in the past if *V. dahliae* has been present.

Resistant Cultivars: There is no varietal resistance.

Issues for Verticillium Wilt

None identified.

Phytophthora Root Rot (*Phytophthora* spp.)

Pest Information

Damage: Under excessively wet and poorly drained soil conditions, *Phytophthora* spp. can invade and kill root and crown tissues. Above ground symptoms include poor growth, wilting, leaf scorch and foliar dieback. In summer, fruiting canes wither and dry as a result of root infections, which occur during wet seasons. Primocanes are killed and eventually whole bushes die. The disease increases in plantings from year to year.

Life Cycle: The pathogens can persist in the soil for many years by means of resting spores (oospores). Mycelia in infected roots produce sporangia (reproductive structures) in spring and fall that release zoospores that move in water and infect new root tips in wet conditions.

Pest Management

Cultural Controls: Cultural practices to prevent infection include avoidance of fields with a history of the disease, improvement of soil drainage, ridging or planting raspberries into raised beds, cleaning of cultivation equipment to avoid spreading the pathogen from infected to healthy fields and the use of certified, disease-free root stock. Fields can be scouted before or during harvest for symptoms. Refer to *Table 5* for practices used by growers to manage phytophthora root rot.

Resistant Cultivars: While some root rot tolerance has been observed, no resistance cultivars are available.

Issues for Phytophthora Root Rot

1. There is a need for the development of an effective, integrated approach for the management of Phytophthora root rot. The impact and potential benefits of soil amendments, such as organic matter and calcium sulfate, for the suppression of disease needs further study.
2. Further research into substrate production of raspberries to reduce root rot pressure is needed.
3. There is a need for additional fungicide products to manage resistance, and for user-friendly fumigation products pre- and post-planting for the management of Phytophthora root rot.

Crown Gall (*Agrobacterium tumefaciens*)

Pest Information

Damage: This bacterial disease can cause significant reductions in yield. The pathogen causes woody swellings on raspberry roots, crowns or canes at ground level. Infected raspberry plants develop short, weak fruiting canes with leaves that yellow and dry out in warm weather. Root and crown galls reduce nutrient uptake, resulting in yield loss and early decline of plantings. The long-term impact can be even more significant since fields remain infested for many years and the disease will affect a new crop when fields are replanted. This disease causes more damage under dry conditions. A related disease, caused by *Agrobacterium rubi*, attacks fruiting stems in Quebec.

Life Cycle: The bacterium is soil-borne and can be introduced in infected planting stock or be present in the soil if infected plants were grown there previously. The bacterium invades through wounds created by insects and mechanical damage, and causes the development of galls. As the galls age, they become woody and brown, eventually releasing bacteria into the surrounding soil, where the bacteria can persist for many years.

Pest Management

Cultural Controls: The introduction of the bacterium can be prevented by carefully checking planting stock for galls and using only certified planting stock. Other cultural controls include disinfecting pruning shears and minimizing mechanical plant injury by avoiding close cultivation and making sure that catch plates on mechanical harvesters are working properly. Effective control of root weevils and nematodes will help to prevent root damage and subsequent crown gall infection.

Resistant Cultivars: Resistant or tolerant varieties include Willamette and Meeker.

Issues for Crown Gall

1. There is a need for better management strategies, including use of clean propagation stock, biopesticides and sanitation practices during production. There is a need for more information on the susceptibility of different cultivars to crown gall.

Virus Diseases: Raspberry Bushy Dwarf Virus (RBDV), Raspberry or Tomato Ringspot Virus (ToRSV), Raspberry Mosaic Disease

Pest Information

Damage: Raspberry bushy dwarf virus (RBDV) causes a loss of yield and fruit quality, and a shortened lifespan of plantings. This virus, despite its name, does not cause bushy or dwarfed plants but rather crumbly fruit. Once a plant is infected, the plant will continue to produce a poor quality and reduced yield of fruit. Yield and fruit quality losses are estimated at 20 to 30 percent in infected plantings. Raspberry ringspot virus (ToRSV) causes reduced yield and vigor. This virus stunts raspberry plants and causes crumbly fruit, thus impacting both yield and fruit quality. Some varieties also develop leaf symptoms such as mottling, yellowing, ringspots, mosaic patterns or curling. The disease is only present in sandy soils. Raspberry mosaic disease causes leaf mottling, blistering, leaf distortion and stunting of plants with most damage observed in black raspberry plantings.

Life Cycle: Raspberry bushy dwarf virus is spread by infected pollen. Once infected with RBDV, plants remain infected for life. Raspberry ringspot virus is nematode-borne while raspberry mosaic disease, a complex of viruses, is transmitted by aphids.

Pest Management

Cultural Controls: Planting certified, disease-free stock and the use of resistant varieties (if available), will help reduce incidence of RBDV and ToRSV. In addition, control of the dagger nematode (*Xiphinema americanum*) and possibly other nematode species may be helpful in reducing incidence of ToRSV. Aphid management may help with the reduction of raspberry mosaic disease. Infected plants, regardless of causal agent, must be removed and replaced with healthy nursery stock. If growing susceptible varieties, removal of fruiting laterals from first year plantings before bloom can delay infection.

Resistant Cultivars: Willamette, Cowichan Nootka and Chilcotin are resistant to RBDV. Meeker and Willamette are susceptible to ToRSV.

Issues for Virus Diseases

1. There is a need for continued surveys and identification of viruses and virus vectors in raspberries in all growing regions of Canada.
2. Raspberry bushy dwarf virus (RBDV) is a major factor in poor fruit quality. Resistant varieties are the only effective control; there is a need for a more intensive breeding program for resistance to RBDV in varieties with good processing fruit and mechanical harvest qualities.
3. Improved, affordable and DNA-based diagnostic tools, virus-indexing and the establishment of phytosanitary requirements (or guidelines) for planting stock are required.
4. Plant growers need access to disease-free nursery stock for the propagation of virus-free transplants. Research to support sampling methods and diagnostics in plant production fields is needed.
5. Economic thresholds for vectors of raspberry viruses and tests to determine the proportion of vectors carrying the virus are also required.

Nematodes: Root Lesion (*Pratylenchus* spp.), Dagger (*Xiphinema* spp.), Sting (*Belonolaimus* spp.)

Pest Information

Damage: Nematodes feed on plant roots causing early decline of plantings and a gradual loss of vigour. The sandy soils where raspberries are grown are highly favourable for pathogenic nematodes. If left uncontrolled, root lesion nematodes will shorten the productive life span of an established field by two to three years. Root lesion nematodes weaken plants and reduce their ability to overcome other pest damage or stress. Dagger nematodes (*Xiphinema* spp.) transmit raspberry (tomato) ringspot virus. The impact of nematodes on a vigorous field is less pronounced than on a weak field. Damage may occur at lower nematode densities if plants are also stressed by root rotting diseases, insects or other factors.

Life Cycle: Plant-feeding nematodes can progress from the egg stage, through a number of juvenile stages, to egg-laying adults in as little as 21 to 28 days during warm summer months. Nematodes are believed to survive from season to season primarily as eggs in the soil. Adult females lay eggs in the soil or within roots depending on their species.

Pest Management

Cultural Controls: Cultural methods to reduce nematodes include good weed control and long rotations out of raspberries. Beneficial practices include the growing of non-nematode host crops or the growing of nematode-suppressing cover crops and the addition of soil amendments, including manure. Keeping fields fallow and weed-free for one year prior to planting raspberries will reduce but not eliminate nematode populations. Soil samples, to monitor for root lesion and dagger nematodes can be collected before field planting and to determine pre-plant fumigation needs.

Resistant Cultivars: None available.

Issues for Nematodes

1. There is a need for the registration of cost-effective nematicides.
2. There is a need for the development of new application methods for nematicides.
3. Further research is required on soil preparation and amendments, including the use of green manures that can reduce nematode populations before planting.

Insects and Mites

Key Issues

- Spotted wing drosophila has significantly changed the landscape of pest management in raspberry. Some control options are particularly harsh on beneficial mite species and thus negatively impact integrated pest management for other pests. There is an urgent need for conventional and non-conventional products with one- or two-day pre-harvest intervals, along with improved understanding of pest biology and the development of integrated management approaches to manage this serious pest.

- Improved management options for mites are required, particularly given the prevalence of mites in high tunnel growing systems. Available miticides have limited utility due to use patterns that do not allow for in-crop sprays, the development of pesticide resistance and the cost of some products. An early season ovicide would be beneficial to help prevent mite buildup. As well, the efficacy of beneficial species such as predator mites is under threat due to pesticide applications for spotted wing drosophila.

- Cane and crown borers continue to be serious problems in raspberry production. There is a need for the registration of additional conventional and non-conventional products with efficacious use patterns. There is a need to pursue insecticide label expansions.

- Sap beetles, weevils, earwigs, cutworms, caterpillars, lygus bugs and various aphids can be a problem at harvest, particularly in mechanical harvest operations. Conventional and non-conventional products with short pre-harvest intervals are needed.

- Raspberry fruitworms are a problem in all types of raspberry production. There is a need for research on the efficacy of monitoring and decision-making tools and the potential of mass-trapping. There is a need to pursue insecticide label expansions as there are currently no products registered for raspberry fruitworm.

- Japanese beetle and rose chafer are an increasing concern in some growing regions. There is a need to develop an effective management strategy for these pests.

- Leafhopper pressure and foliar damage is increasing in raspberries, particularly in high tunnel production systems. Nursery plants often arrive with the presence of leafhoppers. There is need for clean planting stock and additional leafhopper management tools.

- Raspberry horntail (*Hartigia cressonii*), a cane boring wasp, was recently found in raspberries in Ontario and Quebec. More information is needed to determine the economic impact of this newly emerging pest.

…continued

Key Issues (continued)

- Strawberry blossom weevil (*Anthonomus rubi*) was recently discovered in BC. Strawberry blossom weevil and other anthonomids (e.g., *A. signatus*) can cause significant damage, especially in organic raspberry fields. There is a need for economic thresholds and control solutions, particularly in organic production systems. It is important to monitor this insect to limit its spread.
- For provincial evaluations of insect occurrence by species, see Table 6.

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

Insect/Mite	British Columbia	Quebec	Ontario
Small raspberry aphid			
Large raspberry aphid			
Potato leafhopper			
Tarnished plant bug			
Brown marmorated stinkbug			
Two spotted spider mite			
McDaniel spider mite			
Obliquebanded leafroller			
Dusky leafroller			
Bertha armyworm			
Variegated cutworm			
Raspberry sawfly			
Raspberry fruitworm			
Western raspberry fruitworm			
Redheaded flea beetle			
Raspberry crown borer			
Red-necked cane borer			
Raspberry cane borer			
Raspberry cane maggot			
Raspberry bud moth			
Sap beetles			
Spotted wing drosophila			
Thrips			
Black vine weevil			
Strawberry root weevil			
Clay coloured weevil			
Obscure weevil			
Strawberry bud (clipper) weevil			
Rose chafer			
Japanese beetle			
Harvest contaminants			
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.			
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.			
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.			
Pest is present and of concern, however, little is known of its distribution, frequency and pressure.			
Pest not present.			
Data not reported.			

[1]Source: Raspberry stakeholders in reporting provinces (British Columbia, Ontario and Quebec). 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 raspberry production in Canada[1]

Practices	Mites	Caterpillars	Fruitworms	Raspberry cane borer	Raspberry crown borer	Spotted wing drosophila
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						

…continued

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

Practices	Mites	Caterpillars	Fruitworms	Raspberry cane borer	Raspberry crown borer	Spotted wing drosophila
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						
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						

…continued

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

Practices	Mites	Caterpillars	Fruitworms	Raspberry cane borer	Raspberry crown borer	Spotted wing drosophila
Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pest populations						
Use of biopesticides (microbial and non-conventional pesticides)	[green]	[green]	[red]	[red]	[green]	[green]
Release of arthropod biological control agents	[green]	[red]	[red]		[red]	[green]
Preservation or development of habitat to conserve or augment natural controls (e.g., preserve natural areas and hedgerows, adjust crop swathing height)	[green]	[green]	[green]	[green]	[green]	[green]
Mating disruption through the use of pheromones		[red]	[red]		[red]	[red]
Mating disruption through the release of sterile insects		[red]	[red]		[red]	[green]
Trapping		[red]	[red]	[red]	[red]	[green]
Targeted pesticide applications (e.g., banding, spot treatments, use of variable rate sprayers)	[green]	[green]	[green]	[green]	[green]	[green]
Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms	[green]	[green]	[red]		[green]	[green]
Crop specific practices:						
Shortened harvest intervals						[green]
[green] This practice is used to manage this pest by at least some growers in the province.						
[red] 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: Raspberry stakeholders in reporting provinces (British Columbia, Ontario and Quebec); the data reflect the 2020, 2021 and 2022 production years.

Aphids: Small Raspberry Aphid (*Aphis rubicola*) and Large Raspberry Aphid (*Amphorophora agathonica*)

Pest Information

Damage: Aphids are rarely responsible for direct feeding damage in raspberries, but they are contaminants in machine harvested fruit and also transmit viral diseases. They are usually found as colonies on new shoot growth, buds, undersides of leaves and near flower and fruit clusters.

Life Cycle: Aphids overwinter as eggs and hatch in May. Young aphids mature to be winged or wingless females, which give birth to live young during the summer. The winged form can fly and spread over great distances. Males are produced only in the fall and mate with females which then lay overwintering eggs. The development time and the number of generations depend on the host crop and weather conditions.

Pest Management

Cultural Controls: Aphids are controlled by a number of native predators and parasites including ladybird beetles, lacewings and syrphid fly larvae. Aphids may also be controlled by insecticide sprays for other insects.

Resistant Cultivars: Some varieties may have some aphid resistance; however, there is evidence that some varieties considered resistant in British Columbia are now susceptible to aphids.

Issues for Aphids

1. With the proposed restriction of Group 4 insecticides there is a need for conventional and non-conventional control products, and for new management tools for aphid control in raspberry.

Leafhoppers: Potato Leafhopper (*Empoasca fabae*)

Pest Information

Damage: Both nymph and adult leafhoppers feed on the underside of leaves, sucking sap and causing white flecks or spots on the upper leaf surfaces. Heavy infestations result in mottled leaves which can wither and curl downward in hot weather. Plants may show a lack of vigour and berries can remain small and become sticky with honeydew secreted by the leafhoppers. A black mould can develop on the honeydew. Potato leafhoppers also inject toxins into the plant while feeding, blocking the vascular system. This reduces plant vigour and prevents the normal movement of water and nutrients to the affected areas of the plant. Leafhoppers may also be present as fruit contaminants at harvest.

Life Cycle: The potato leafhopper does not overwinter in Canada. It is carried by wind currents from the southern United States, across the Great Lakes and into eastern provinces. The first adults arrive as early as mid-May and continue to arrive well into June. They often migrate to raspberry fields after the first cut of hay. Larvae and adults are found on the undersides of leaves and can have many generations between June and September. Other species overwinter as eggs laid under the bark of raspberry canes. In early May, first generation nymphs hatch and feed for a few weeks before becoming winged adults. Second generation nymphs hatch in late July and early August, mature and lay the overwintering eggs.

Pest Management

Cultural Controls: The presence of leafhoppers can be detected by monitoring the underside of leaves for nymphs, beginning in early May. Leafhoppers are often controlled by insecticide sprays for other insects. Avoiding planting raspberry fields in the proximity to alternate hosts like alfalfa and keeping plantings free of weeds can help to reduce the likelihood of damage from potato leafhoppers.

Resistant Cultivars: None available.

Issues for Leafhoppers

1. Additional pest management products are needed to help control potato leafhopper.

Tarnished Plant Bug (*Lygus lineolaris*) and other *Lygus* spp.

Pest Information

Damage: Adults and nymphs feed on flower buds and fruit by puncturing the fruit skin and sucking sap, resulting in fruit deformation.

Life Cycle: Adults overwinter under plant debris and in other protected places. They emerge when temperatures reach 8 °C. In spring, females lay eggs in the flower stalks and buds when temperatures rise. Nymphs hatch in seven to 10 days and develop through three to five stages (instars) to become adults. There can be several overlapping generations per year.

Pest Management

Cultural Controls: Tarnished plant bugs are attracted to fast growing weeds and cover crops, therefore, keeping fields free of weeds and mowing borders will help to keep pest numbers down. Threshold levels for control may vary between summer-bearing and fall-bearing raspberry varieties.

Resistant Cultivars: None available.

Issues for Tarnished Plant Bug

1. Additional studies are required to establish the impact and economic threshold of tarnished plant bug on raspberries.

Brown Marmorated Stinkbug (*Halyomorpha halys*)

Pest Information

Damage: The brown marmorated stinkbug (BMSB) has not yet been identified as a pest in raspberry crops in Canada but is a concern as the insect causes significant crop injury in other jurisdictions where it is established. This insect 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.

Life Cycle: BMSB spreads through natural means and also as a “hitchhiker” in cargo and vehicles. It has been intercepted in many provinces over the years and in 2012, an established population was identified in the Hamilton, Ontario area. It can move readily between host crops throughout the growing season. The BMSB overwinters as an adult. In the spring, adults mate and lay eggs on host plants. Adults are long-lived and females may lay several hundred eggs over an extended period of time. In the fall, 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 the insect 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 Stink Bug

1. There is a need to develop monitoring thresholds for BMSB on raspberries.

Thrips (*Thysanoptera*)

Pest Information

Damage: Although thrips feed on all cane fruits, they seldom cause extensive damage. However, their presence in the fruit can render berries unmarketable. Thrips can attack in the spring but are most abundant in July and August when the weather is hot and dry.

Life Cycle: Thrips overwinter in the soil at the base of canes. Eggs hatch in the spring and the nymphs develop through two or more stages before pupating and emerging as adults. The entire lifecycle is several weeks long and there are numerous generations per year.

Pest Management

Cultural Controls: Thrips populations build up on weeds, therefore, mowing borders may reduce populations. Larvae and adults of the minute pirate bug (*Orius* spp.) are predators of thrips.

Resistant Cultivars: None available.

Issues for Thrips

1. Studies are required to establish the impact and economic threshold of thrips on raspberries.

Spider Mites: Twospotted Spider Mite (*Tetranychus urticae*) and McDaniel Spider Mite (*T. mcdanieli*)

Pest Information

Damage: Mites feed on the underside of leaves by piercing and sucking plant sap causing a white stippling and bronzing of the foliage or, in the case of McDaniel spider mite, yellowish leaf spots or discoloured blotches. Feeding damage reduces plant vigour and may cause leaves to drop prematurely, contributing to the potential for winter injury and subsequent yield loss. If uncontrolled, excessive defoliation during and after harvest from twospotted spider mite feeding damage can reduce yield by 25 percent in the following season. Foliar symptoms associated with spider mite feeding differ between species.

Life Cycle: Spider mites overwinter as adult females in the soil in raspberry fields and begin to colonize the plants in early summer, moving upward on the canes. Each generation lasts about two weeks and there are four to six generations per year. Populations usually increase through June and July with potential for rapid increase after harvest in mid to late August. In September, populations decline as a result of predation by natural enemies and migration of overwintering females from the raspberry plants to overwintering sites.

Pest Management

Cultural Controls: Cultural practices, including irrigation and fertilization, help maintain vigorous plantings and reduce the impact of spider mite feeding. Most growers consider the degree of foliar damage, the vigour of the field and the time of the year to determine the need for spray programs. Predators, such as the naturally occurring predatory mite *Amblyseius fallacis*, play a major role in suppressing spider mites and can in some cases provide control equal to that of chemical products. Other spider mite predators include the minute pirate bug *(Orius tristicolor)* and the small black lady beetle (*Stethorus punctillum*), known as the "spider mite destroyer", a significant natural predator in British Columbia. In other growing regions, other naturally-occurring predatory mites and *Stethorus* species aid in managing phytophagous mites. Refer to *Table 7* for practices used by growers to manage mites.

Resistant Cultivars: None available.

Issues for Spider Mites

1. An increase in spider mites have been observed in fields treated with insecticide applications for spotted wing drosophila. An early season ovicide may help to prevent mite buildup. Mite pests are more prevalent in tunnel growing systems.

Caterpillars: Obliquebanded Leafroller (*Choristoneura rosaceana*), Cabbage Looper (*Trichoplusia ni*), Bruce Spanworm (*Operophtera bruceata*), Dusky leafroller (*Orthotaenia undulana*), Winter moth (*O. brumata*) and Alfalfa looper (*Autographa californica*)

Pest Information

Damage: Caterpillars feed on foliage, buds and fruit throughout the season and can contaminate harvested fruit. The timing of the development of these insects varies from year to year depending on weather conditions. There are more than 25 species of caterpillars that may attack raspberries. However, the obliquebanded leafroller (OBLR) is the most prevalent pest among leafrollers in raspberries, feeding on raspberry foliage during April and May. The foliar damage is rarely economically important, but the larvae of the second generation can contaminate hand-picked and machine-harvested fruit in July and August if not controlled prior to harvest.

Life Cycle: While most caterpillar pest species overwinter as eggs or pupae, the OBLR overwinters as larvae, usually within protected old foliage or cane bundles in the field. In the spring the larvae move to feed on developing foliage, pupate and emerge as adult moths.

Pest Management

Cultural Controls: Monitoring for caterpillars can be done by inspecting foliage for feeding damage and rolled leaves. Parasitoids are important contributors to the biological control of caterpillars. To help determine treatment timing, pheromone traps can be used to monitor flights of adult moths of some species. *Bacillus thuringiensis* var. kurstaki (Bt or Btk) biopesticides are available for use against some caterpillar species. Parasitic control with *Trichogramma minutum*, a parasitoid wasp has been reported to reduce pest numbers to below spraying thresholds in British Columbia. Refer to *Table 7* for practices used by growers to manage caterpillars.

Resistant Cultivars: None available.

Issues for Caterpillars

1. The development of integrated approaches is required for the management of caterpillars in raspberry. There is a need for new conventional and non-conventional control products, with research on application timings to target caterpillars that hatch during summer harvest, as well as products for use in machine-harvested raspberry production.
2. There is a need for control products suitable for use in organic production systems.

Climbing Cutworms: Bertha Armyworm (*Mamestra configurata*) and Variegated Cutworm (*Peridroma saucia*)

Pest Information

Damage: Cutworms feed on new growth and flower buds early in the season and can be a significant contaminant at harvest. Major fruit contamination occurs in years when the larval stage of cutworms coincides with harvest (from late June to early August).

Life Cycle: Bertha armyworms lay their eggs in masses of 50 to 500 eggs on the undersides of raspberry leaves. Peak larval emergence varies between July and September, depending on environmental conditions. Variegated cutworm larvae are present from April to October.

Pest Management

Cultural Controls: Bertha armyworms have several natural enemies, including *Trichogramma minutum*. Commercially available *T. minutum* applied to control leafrollers will also control Bertha armyworms, as the wasp parasitizes the eggs of many lepidopteran species. Pheromone traps are sometimes used for monitoring cutworm moths.

Resistant Cultivars: None available.

Issues for Climbing Cutworms

None identified.

Fruitworms: Raspberry Fruitworm (*Byturus unicolor*) and Western Raspberry Fruitworm (*Byturus bakeri*)

Pest Information

Damage: Raspberry fruitworm has the potential to become a very significant fruit contaminant if not controlled. Adult beetles feed on new leaves and flower buds in May but the main injury is caused by larvae which feed on the receptacle inside the fruit. There is a very low tolerance for this pest because of the effect on fruit quality.

Life Cycle: Overwintering fruitworm beetles emerge from the soil during April and May, feed in the early spring, mate and then lay eggs on flower buds and inside opening flowers. The emerging larvae move into the centre of the developing fruits where they feed for 30 days or more. Fully grown fruitworm larvae drop to the ground and burrow in the soil where they pupate and overwinter, emerging as adults the following spring.

Pest Management

Cultural Controls: Adult populations are monitored by direct examination of the earliest open flowers and/or with a beating tray from mid-April through early bloom. Refer to *Table 7* for practices used by growers to manage fruitworms.

Resistant Cultivars: None available.

Issues for Raspberry Fruitworm and Western Raspberry Fruitworm

1. There is a need for new conventional and nonconventional products, including organic solutions, to control fruitworms.
2. Further studies to develop monitoring tools, thresholds and management tools are required.
3. There is a need to pursue insecticide label expansion for the management of raspberry fruitworm.

Raspberry Sawfly (*Monophadnoides geniculatus*)

Pest Information

Damage: Large infestations of the raspberry sawfly can result in defoliation and loss of crop. Larvae feed on leaves causing large, interveinal holes or skeletonization. Vigorous raspberry plants are not seriously damaged by sawfly larvae unless populations are in outbreak numbers.

Life Cycle: Mature larvae overwinter in a cocoon on the ground. Adult sawflies lay eggs on leaves in May and June. When mature, sawfly larvae drop to the soil where they overwinter. There is one generation per year.

Pest Management

Cultural Controls: A number of predators and parasitoid wasps attack sawfly larvae. Cocoons left on the ground are easy prey for ground beetles helping to minimize populations for the following year.

Resistant Cultivars: None available.

Issues for Raspberry Sawfly

1. There is a need for new conventional and non-conventional control products for raspberry sawfly.

Raspberry Crown Borer (*Pennisetia marginata*)

Pest Information

Damage: The raspberry crown borer is more problematic in older, established plantings. Feeding damage in canes and crowns can weaken plants and kill infested canes. Infested areas often have uneven bud break in the spring and spindly canes, which break off at ground level. Damage caused by crown borer creates entry points to diseases, such as crown gall. Without controls, estimated yield loss could be as high as 50 percent. Crown borer is devastating and is often not noticed until significant crop losses have occurred.

Life Cycle: The raspberry crown borer has a two-year life cycle. Adult moths are present from late July through early October. Eggs are laid on the underside of leaflets and upon hatching, caterpillars crawl down to the base of the canes and form an overwintering cell beside the cane in a protected area. Larvae begin feeding in early March on cane buds around the plant crown and then burrow into crowns.

Pest Management

Cultural Controls: Weak areas within a field can be monitored for evidence of raspberry crown borer during pruning or cane tying. Infested canes or canes with galls can be pruned out close to the crown, immediately after harvest or when setting canes on wires. Monitoring for this pest is difficult as current techniques are destructive and involve digging up the plant. Refer to *Table 7* for practices used by growers to manage raspberry crown borer.

Resistant Cultivars: None available.

Issues for Raspberry Crown Borer

1. There is a need for new conventional and non-conventional control products for raspberry crown borer management.
2. Studies and subsequent grower education on how to integrate new products (e.g., chlorantraniliprole) into existing IPM systems are required.

Rednecked Cane Borer (*Agrilus ruficollis*)

Pest Information

Damage: Rednecked cane borer adults feed along leaf margins from May through early August. Young larvae tunnel up and down the cane in a spiral pattern. Older larvae develop in the pith. Infested canes develop galls at the site of the tunnelling. The galls weaken canes causing them to break near the swellings, while unbroken canes can wither and die. Swollen canes are usually first observed in July and August.

Life Cycle: Females deposit eggs on the bark of new growth near the bottom of the cane in May and June. Following hatch, larvae feed within canes and reach full size in the fall. Larvae overwinter in the canes and pupate then emerge as adult beetles in the spring.

Pest Management

Cultural Controls: The pruning out and removal of galled canes from the raspberry planting before buds break in the spring will reduce the insect population.

Resistant Cultivars: None available.

Issues for Rednecked Cane Borer

1. There is a rising concern of rednecked cane borer damage and it has become a more common pest within raspberry production.
2. There is a need to better understand rednecked cane borer and control options, both culturally and chemically. There are currently no products registered for this pest. There is a need to pursue insecticide label expansions for the management of rednecked cane borer.

Raspberry Cane Borer (*Oberea bimaculata*)

Pest Information

Damage: Damage caused by the raspberry cane borer, results from egg laying and larval tunnelling in the cane. Damage includes tip and floricane dieback.

Life Cycle: The female cane borer lays single eggs close to the tip of the cane and then girdles the cane both above and below the egg. This results in wilting and sometimes breakage of the tip of the cane. Following hatch, the larvae tunnel within the cane. The first winter is spent within the cane close to the soil surface. In the second year, the larva burrows into the crown below soil level, where it spends the winter. Following pupation, adults emerge in late spring.

Pest Management

Cultural Controls: Raspberry cane borer infestations can be reduced by pruning-out of infested canes in June, targeting the area below the characteristic double rings as well as any insect tunnelling. Burning infected prunings will destroy the larvae. Refer to *Table 7* for practices used by growers to manage raspberry cane borer.

Resistant Cultivar: None available.

Issues for Raspberry Cane Borer

1. There is a rising concern that raspberry cane borer will become a more common pest within raspberry production as more targeted products are used to control other pests.

Raspberry Cane Maggot (*Pegomya rubivora*)

Pest Information

Damage: The raspberry cane maggot adult closely resembles a small housefly. Newly hatched maggots bore into the pith and then turn outward and girdle the stem, causing the shoot to wilt and die.

Life Cycle: Pegomya rubivora has one generation per year. It lays eggs in the tips of shoots in early spring. When mature, the maggot bores down to the base of the plant to pupate and overwinter.

Pest Management

Cultural Controls: Removing and destroying infested shoots will help to keep populations of this pest down.

Resistant Cultivars: None available.

Issues for Cane Maggot

None identified.

Raspberry Bud Moth (*Lampronia corticella*)

Pest Information

Damage: The raspberry bud moth is a sporadic pest of raspberry in the Atlantic Provinces. Larvae tunnel into the buds and lateral shoots of fruiting canes in the spring.

Life Cycle: Larvae overwinter in the soil and move to fruiting canes in the spring.

Pest Management

Cultural Controls: The elimination of crop debris and pruning out of affected shoots will reduce the pest population.

Resistant Cultivars: None available.

Issues for Raspberry Bud Moth

None identified.

Sap Beetles (Coleoptera*: Nitidulidae*)

Pest Information

Damage: Sap beetles are a sporadic fruit contaminant in Eastern Canada. They are more prevalent in areas where field and sweet corn are grown. The beetles have been implicated in the transmission of rot pathogens.

Life Cycle: Sap beetles overwinter as adults in protected locations. They have generally one generation per year. Egg laying and larval development occurs in decaying organic matter. Adult beetles are attracted to and feed on over-ripe or decaying fruit.

Pest Management

Cultural Controls: The timely harvesting of fruit and elimination of damaged and over-ripe fruit in the field will help reduce problems due to sap beetles.

Resistant Cultivars: Fall-bearing varieties are more susceptible to these attacks.

Issues for Sap Beetles

1. Sap beetles are primarily a problem at harvest and for this reason, efficacious controls, including baits and non-conventional products, with short pre-harvest intervals, are needed.

Spotted Wing Drosophila (*Drosophila suzukii*)

Pest Information

Damage: Spotted wing drosophila (SWD) is a serious pest of soft fruit and berries. This fruit fly is known to infest raspberry, blackberry, blueberry, strawberry, cherry, peach, nectarine, apricot and plum, as well as numerous wild hosts. Unlike other fruit flies, SWD will attack sound fruit. Larvae feed within the fruit causing softening and breakdown of flesh which makes the fruit unmarketable.

Life Cycle: There can be as many as nine generations per year depending on the growing region. The insect overwinters as adult flies. Flies mate in the spring and lay eggs under the skin of ripening fruit. Wounds caused by egg-laying serve as entry points for disease. Larvae feed and develop within the fruit. Due to the short generation time and extended period of egg laying by adults, there can be several, overlapping generations each year. 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: Strict sanitation measures are important in the field and in processing areas. The frequent harvest of all ripe fruit and removal of unmarketable fruit culls from the field will help reduce the chance of the fly infesting the fruit and reduce sources of continued infestations. Keeping equipment and processing areas free of old fruit will also help. Flies can be monitored using apple-cider vinegar traps. Refer to *Table 7* for practices used by growers to manage spotted wing drosophila.

Resistant Cultivars: None identified.

Issues for Spotted Wing Drosophila

1. The spotted wing drosophila has significantly changed the landscape of pest management in raspberry. There remains a need for improved understanding of the biology of this insect, including, behavior, population dynamics and factors affecting the growth and decline of populations in order to develop more effective control strategies in this crop.
2. There is a need to develop an integrated pest management program for SWD. Effective monitoring tools and predictive models need to be developed. The potential for mass trapping, attract and kill approaches and repellents require further investigation.
3. The availability of efficacious products, including both conventional and non-conventional products with short pre-harvest intervals (one to two days) is required for the control of SWD. Products are also needed that can be used in organic production systems and are not injurious to beneficial insects and predatory mites.

Weevils: Black Vine Weevil (*Otiorhynchus sulcatus*), Clay Coloured Weevil (*O. singularis*), Strawberry Root Weevil (*O. ovatus*) and Obscure Weevil (*Sciopithes obscurus*)

Pest Information

Damage: The larvae of several species of weevil feed on the roots of raspberry. The bark of larger roots may be damaged and smaller roots may be completely eaten. Root injury may result in foliar wilt. Adults feed at night and cause notching on the leaf edges. Weevil adults can be serious fruit contaminants when the adult stage coincides with harvest.

Life Cycle: Black vine and strawberry weevils have one generation per year. They overwinter as grubs in the soil and resume feeding on plant roots in the spring. Weevil grubs pupate in April and emerge from the soil as adults during May and early June. These adults feed on above-ground plant parts during June and July. Newly emerged adults begin laying eggs in late June prior to the onset of harvest. The life cycle of the obscure weevil is similar to that of the black vine weevil. Adult clay coloured weevils begin emerging from the soil in mid-March.

Pest Management

Cultural Controls: Monitoring is used to identify the species that are present and provide an estimate of population density before and after treatment. Three-year cycle rotation between strawberry or raspberry and other non-host crops will reduce population levels. Ground beetles (Carabids) are known to feed on weevil grubs, pupae and adults; however, the contribution these natural enemies make to control weevil populations has not been determined.

Resistant Cultivars: None identified.

Issues for Root Weevils

1. As weevils are a harvest contaminant, particularly associated with mechanical harvesting, there is an immediate need for additional control products with short pre-harvest intervals.

Strawberry Bud (Clipper) Weevil (*Anthonomus signatus*)

Pest Information

Damage: Damage from the strawberry bud weevil results when females sever raspberry buds from their pedicel, preventing fruit formation.

Life Cycle: The strawberry bud weevil has one generation per year, with overwintering adults emerging early in the season from ground litter in wooded areas. They migrate to berry fields in late April. Females puncture unopened buds with their long beaks and deposit a single egg into the bud. Larvae develop in the buds, reaching maturity in three to four weeks. Adults emerge in June, feed on flower pollen and then move to overwintering sites in mid-summer, remaining inactive the rest of the season.

Pest Management

Cultural Controls: Damage caused by the strawberry clipper weevil is readily apparent and can be detected by scouting. Threshold levels are available for timing of control products. Removal of weeds in and around raspberry fields, particularly pollen-producing plants will reduce infestation.

Resistant Cultivars: None identified.

Issues for Strawberry Bud (Clipper) Weevils

1. There is a need for research on the economic impact of strawberry bud weevil on raspberries. Products are needed that can be used to control this pest in organic production systems.

White Grubs: Japanese Beetle (*Popillia japonica*), European Chafer (*Rhizotrogus majalis*) and Rose Chafers (*Macrodactylus subspinosus*)

Pest Information

Damage: White grubs are the larvae of beetles of the *Scarabaeidae* family. They feed on plant roots. Injured plants may wilt and lose vigour. Japanese beetle adults are general feeders and will attack over 300 different plants. They feed on fruit and tender leaf tissues of raspberry, leaving a network of veins resulting in browning and dropping of severely affected leaves.

Life Cycle: The Japanese beetle, European chafer and rose chafer have one-year life cycles. Eggs are laid in the soil and after hatching, the white grubs feed on roots in the upper 10 to 12 cm of soil. European chafer and Japanese beetle feed in the fall while rose chafer feeds during bloom. All three species overwinter as grubs, emerging the following year as adults.

Pest Management

Cultural Controls: Avoidance of planting raspberries in fields following sod, corn, potato, strawberry or cereal species, all of which are hosts for white grubs, will help reduce damage from grubs. Controlling grassy weeds will make the field less attractive to white grubs. Summer fallowing and frequent cultivation can also reduce grub populations by physically destroying larvae and pupae, or exposing them to predators such as birds.

Resistant Cultivars: None available.

Issues for White Grubs

1. Japanese beetles are an increasing concern. There is a need to develop effective management strategies including control options with short pre-harvest intervals.

Redheaded Flea Beetle (*Systena frontalis*)

Pest Information

Damage: Adults forage on leaves, leaving them riddled with holes. Infested plants often have a delay in fruit maturation.

Life Cycle: This insect has one generation per year. Eggs overwinter in the soil and some adults overwinter in hedgerows and the edges of woodlots. This flea beetle has three larval stages. After hatching in late May to early June, larvae feed on roots until the adult stage when they feed on leaves.

Pest Management

Cultural Controls: Removal of weeds from raspberry fields will help to reduce pest numbers.

Resistant Cultivars: None available.

Issues for Redheaded Flea Beetle

1. This is a common pest on newer plantings within raspberry production in Ontario.

Harvest Contaminants

Pest Information

Damage: Insects may be shaken off with the raspberries during machine harvesting and may contaminate the harvested fruit. Any insect present in the crop at harvest, including innocuous and beneficial insects, have the potential to become contaminants. Insects that can contaminate crops include raspberry aphids, European earwigs *(Forficula auricularia)*, sap beetles, various stink bugs (Family: *Pentatomidae*), lygus bugs (Family: *Miridae*), weevils, spiders, slugs, snails and ants. Fruit contamination can result in the crop being downgraded or rejected by processors.

Life Cycle: The biology and life cycle of the harvest contaminants varies with the insect.

Pest Management

Cultural Controls: Some insects can be removed by hand on the machine belt and the sorting belt in the processing plant. Harvesters are equipped with air suction fans, which help remove some plant and insect debris.

Resistant Cultivars: None available.

Issues for Harvest Contaminants

1. Harvest contaminants such as sap beetles, earwigs, caterpillars, stink bugs, lygus bugs, aphids and weevils are often an issue with machine-harvested raspberries. Conventional and non-conventional products, with short pre-harvest intervals, are needed.

Weeds

Key Issues

- Weed management continues to be a challenge in raspberry production. Alternative, residual herbicides are required for the management of both annual and perennial weeds.
- An IPM approach for the management of annual and perennial grass weeds needs to be developed for use in raspberry production.
- Physical barriers to weeds, including woodchips and plastic mulch, show promise for weed control in raspberry production.
- For provincial evaluations of weed occurrence by species, see Table 8.

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

Weeds	British Columbia	Quebec	Ontario
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: Raspberry stakeholders in reporting provinces (British Columbia, Ontario and Quebec). 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 raspberry 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				

…continued

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

Practices	Annual broadleaf weeds	Annual grass weeds	Perennial broadleaf weeds	Perennial grass weeds
Decision making tools:				
Economic threshold				
Crop specialist recommendation or advisory bulletin				
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				
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: Raspberry stakeholders in reporting provinces (British Columbia, Ontario and Quebec); the data reflect the 2020, 2021 and 2022 production years.

Weeds

Pest Information

Damage: Annual and perennial grass and broadleaf weeds compete with raspberry plants for water and nutrients. In addition, weeds interfere with harvesting efficiency and reduce air circulation, thus increasing the likelihood of cane, fruit and foliar diseases. Also, many weeds are hosts to nematodes, a number of which are vectors of virus diseases.

Life Cycle: Winter annuals are weeds that germinate in the fall, overwinter in a vegetative state, flower in the spring, form seeds and then die. Summer annual weeds germinate in the spring, flower and fruit in the summer or fall, dying before the onset of winter.

Simple perennials regenerate each year from a root or crown tissues and reproduce by flowering and setting seed. Creeping perennials can regenerate from roots, shoots and other structures and can also reproduce by flowering. Broken root pieces, tubers and rhizomes can give rise to a new weed.

Pest Management

Cultural Controls: Cultural controls of annual weeds include mechanical weeding, hand weeding, cover cropping and mulching. Weeds between the rows are managed primarily by regular, frequent, shallow cultivation during the growing season and/ or use of perennial or annual cover crops. Managing all types of weeds in headlands and other non-productive areas and preventing weeds from setting seed on cropland can gradually decrease the reservoir of weed seeds in raspberry fields. Weeds are controlled in areas immediately around fields primarily by maintaining year-round sod, which is mowed regularly during the growing season. Avoiding infested fields when establishing a new raspberry planting can reduce perennial weed problems. Removing seedlings during hand weeding operations and following strict sanitation procedures to avoid spreading perennial roots, tubers or rhizomes, will help prevent new weed infestations. Prior to planting new fields, perennial weeds may be controlled by cultivation and herbicide treatments. Deep ploughing to thoroughly invert the soil is an effective cultural control of nutsedge infestations. Refer to *Table 9* for practices used by growers to manage weeds.

Issues for Weeds

1. Alternative residual herbicides are needed for control of perennial weeds such as creeping yellow cress, yellow nutsedge, field bindweed, curled dock, buttercup, goldenrod, vetch, thistles, wild burdock, purple dead nettle and Watson's willow herb.
2. The development of an integrated approach for the management of perennial weeds is required.

Resources

Integrated Pest Management Resources for Production of Raspberry in Canada

British Columbia Ministry of Agriculture. *Raspberries.* https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/berries/raspberries

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Provincial Contacts

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	AgriService BC https://www2.gov.bc.ca/gov/content/industry/agriservice-bc	Carolyn Teasdale Carolyn.Teasdale@gov.bc.ca	Caroline Bédard Caroline.Bedard@gov.bc.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca	Erica Pate Erica.Pate@ontario.ca	Joshua Mosiondz Joshua.Mosiondz@ontario.ca
Quebec	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec www.mapaq.gouv.qc.ca	Stéphanie Tellier Stephanie.Tellier@mapaq.gouv.qc.ca Dominique Choquette Dominique.Choquette@mapaq.gouv.qc.ca Christian Lacroix Christian.Lacroix@mapaq.gouv.qc.ca Guy-Anne Landry Guy-Anne.Landry@mapaq.gouv.qc.ca	Mathieu Coté Mathieu.Cote@mapaq.gouv.qc.ca

National and Provincial Fruit Grower Organizations

British Columbia Raspberries: bcraspberries.com

Fruit and Vegetable Growers of Canada: fvgc.ca

Les Fraîches du Québec (French only): fraisesetframboisesduquebec.com

Ontario Berries: ontarioberries.com

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

Organic Federation of Canada: organicfederation.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 rowspan="2">Presence</th><th colspan="4">Occurrence information</th><th rowspan="2">Colour Code</th></tr>
<tr><th></th><th>Frequency</th><th>Distribution</th><th>Pressure</th></tr>
<tr><td rowspan="14">Present</td><td rowspan="12">Data available</td><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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