Crop Profile for Peach in Canada, 2022

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Preface

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

Information on pest issues and management practices is provided for information purposes only. For detailed information on growing peach, 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 peach, 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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Peach (*Prunus persica* var. *persica*), a member of the rose family, is native to China and was introduced into Europe 2,000 years ago. It was first brought to North America in the 16th century by Spanish explorers.

There are two main types of peaches: semi-freestone peaches and freestone peaches. The flesh of semi-stone peaches tends to adhere partially to the stone and has a firm texture. Semi-stone peaches can be consumed fresh or used for canning. Freestone peaches are generally consumed fresh, and the flesh does not adhere to the stone.

The nectarine, *Prunus persica*, is closely related to peach. Peach and nectarine trees do not differ in appearance, growth response, bearing habit or other general characteristics. Nectarines are distinguished from peaches by their smaller size, greater aroma, distinct flavour and absence of fuzzy skin. Throughout this document, all descriptions, practices, growth stages and activities refer to both peaches and nectarines, unless otherwise stated.

Crop Production

Industry Overview

In 2022, total fresh peach and nectarine production continued to rank seventh in cultivated area and farm gate value among all fruits grown in Canada. The total farm gate value for peaches and nectarines in 2022 was $50.9 million and $13.7 million, respectively (Table 1 and 2).

Canadian exports of fresh peaches, including nectarines were $0.04 million and processed peach, including nectarines were $1.7 million (Table 1).

In Ontario, many varieties of semi-freestone peaches are available including Harrow, Diamond, Garnet Beauty, Springcrest, Candor, Harrow Dawn, Early Redhaven, Risingstar, Brighton, Sentinel and Sunhaven. Among freestone peaches, varieties include Redhaven, Vivid, Harbite, Harson, Blazingstar, Starfire, Harrowfair, Veeglo, Harrow Beauty, Loring, Allstar, PF24, Coralstar, Metronidaozole, Redskin, Harcrest and Glowingstar. Nectarine varieties include Fantasia and Harblaze.

In British Columbia, varieties of peaches available include Redhaven, a semi-freestone variety and freestone peaches including Blazing Star, Glohaven, PF23, Flamecrest and Elegant Lady. Nectarine varieties include Crimson Gold, Early Sungrand, Firebrite and Redgold.

Table 1. General production information for Canada, 2022

	Peach	Nectarine
Canadian Production[1]	20,533 metric tonnes	4,465 metric tonnes
	2,566 hectares	320 hectares
Farm Gate Value[1]	$50.9 M	$13.7 M
Availability[2]	Fresh: 0.96 kg/person	Fresh: 0.50 kg/person
	Canned: 0.49 kg/person	
Exports[3]	Fresh: $0.04 M	
	Processed: $1.7 M	
Imports[3]	Fresh: $113.8 M	
	Processed: $44.8 M	

[1]Source: Statistics Canada. Table 32-10-0364-01 Area, production and farm gate value of marketed fruits (Accessed: 2023-06-21).
[2]Source: Statistics Canada. Table 32-10-0054-01 Food available in Canada (Accessed: 2023-06-21).
[3]Source: Statistics Canada. Canada International Merchandise Trade Web Application. Fresh: HS # 0809.30 - Peaches, including nectarines, fresh. Processed: HS # 2008.70 - Peaches,incl nectarines,o/w prepared or preserved,w/n sugared/sweetened/spirited (Accessed 2023-06-21).

Production Regions

In Canada, the main production regions for peach and nectarine are the Niagara region of Ontario and the Okanagan Valley of British Columbia. Ontario led Canada with 79 percent and 81 percent of the national production of peach and nectarine, respectively (Table 2).

Table 2. Distribution of peach production in Canada, 2022[1]

Production Regions	Cultivated Area[2] (national percentage)		Farm Gate Value	
	Peach	Nectarine	Peach	Nectarine
British Columbia	522 ha (20%)	61 ha (19%)	$8.6 M	$1.8 M
Ontario	2,020 ha (79%)	259 ha (81%)	$41.9 M	$11.9 M
Canada	**2,566 ha**	**320 ha**	**$50.9 M**	**$13.7 M**

[1]Source: Statistics Canada. Table 32-10-0364-01 Area, production and farm gate value of marketed fruits (Accessed: 2023-06-21).
[2]Cultivated area includes bearing and non-bearing area.

Cultural Practices

Peaches grow best on sites that are protected from spring frosts, have full exposure to sun and have deep, well-drained, sandy loam soil. Slopes of about four to eight percent are the most suitable planting sites as they allow good air exchange and surface water run-off during heavy rains. Since peaches grown in Canada are at the northern limit of production, sites are typically located within close proximity to a body of water for temperature moderation and protection against frost and extreme cold during the winter. Wind machines have also been used in some areas to protect trees from damaging effects of spring frost episodes. Peach trees grown on standard Bailey rootstock normally produce commercial crops for 15 to18 years. Other rootstocks that are commercially used in Canada include: Krymsk 86, Krymsk 1 and Lovell. Currently, the most promising dwarfing rootstocks with high yield efficiency are the Controller series but there is limited commercial experience with these rootstocks in Canada. Soil tests are done in the fall and adjustments for nutrients or pH are done in the spring. The ideal soil pH for peach and nectarine orchards is between 6 and 7.

Land preparation for peach or nectarine orchards includes proper land levelling and the installation of tile drainage since the fruit trees cannot tolerate wet soils. Sites are ploughed in the fall, soil amendments added, cultivated and managed for weeds before planting, as required. If the season permits, a fall green cover crop is planted to build up organic matter. Peach tree planting takes place in the spring (usually in mid-April to mid-May) when soil temperatures rise and there is still good moisture in the soil. Trees are planted when dormant and budding typically starts two weeks later. Standard rootstocks are used with tree spacing ranging from 3.0 by 3.7 m to 5.5 by 3.7 m. In Canada's peach growing regions, open centre training systems are most commonly used with some growers utilizing central leader and four-column training systems. Trees are typically branched when planted, but are pruned to 1.2 to 1.5 m height with about six to ten shoots which have two to three buds each. During the establishment period, a number of commercial producers will grow an alternate crop (e.g., strawberries) between the rows. This allows for some revenue to be made from the block during the initial non-bearing years.

Peaches are self-fertile and do not require a different pollinizing variety to be located within the orchard. Peaches bear fruit on one-year-old wood, so heavy pruning is needed each year to produce a good crop.

Fruit-thinning must be done by hand. Thinning is necessary to improve the size of the remaining fruit. It will also increase the amount of bloom that will occur during the following season.

Leaf analysis is the most reliable method to determine tree nutrient needs. Nitrogen is applied in early spring. Excess nitrogen leads to poor fruit colour and poor storage quality and should be avoided. Irrigation is critical for peaches during the growing season (April to July) in drier climates. Irrigation is done with under-canopy micro-sprinklers, overhead sprinklers or drip irrigation.

Fruit is hand-picked to ensure fruit quality since fruit can bruise easily. Skilled workers climb ladders up to 2.4 m in height to pick fruits on mature trees. Multiple picks are usually required as there is often a range of fruit maturity.

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

Table 3. Peach production and pest management schedule in Canada

Time of Year	Activity	Action
November 15 – March (dormant)	Plant care	Removal of dead or damaged trees. Orchard renewal and renovation planning. Apply lime if needed.
	Disease management	Prune out branches with peach (cytospora) canker and brown rot; apply a dormant fungicide for peach leaf curl.
	Other	Monitor for vertebrate pests and control as needed.
Early – mid April (swollen bud)	Insect / mite management	Spray for scale and European red mite; use of dormant oil.
	Disease management	Monitor bud development.
Mid – late April (bud burst – 1.3 cm green tip)	Plant care	Fertilizer application, pruning, irrigation.
	Disease management	Monitor for powdery mildew, peach leaf curl, coryneum blight and blossom blight; apply controls as needed. Remove any mummified fruit from the previous season to reduce disease pressure during bloom.
	Weed management	Mow and maintain orchard alleyways; herbicide application.
May 1 – mid May (pink - petal fall, first new leaves open)	Plant care	Fertilizer application and pruning continues; cultivation and brush removal.
	Disease management	Continue to monitor for diseases; apply bloom time fungicides as appropriate.
	Insect / mite management	Monitor for peach twig borer, leafrollers, mites, aphids, lygus bugs and beneficial organisms; apply controls as needed.
	Weed management	Maintain orchard alleyways; monitor for weeds and apply controls as needed.
May 20 (fruit set, shuck (dried floral remnants present), fully expanded leaves)	Plant care	Pruning, brush removal, cultivation.
	Disease and insect management	Apply controls for 1st generation oriental fruit moth. Monitor closely for plum curculio and aphids and apply treatments as needed. Begin peach scab and bacterial spot protection program if there is history of either disease.
	Weed management	Maintain orchard alleyways; herbicide application as appropriate.
June 1 - mid-August (shoot growth, fruit development and maturation, terminal buds set)	Plant care	Thin crop, seed cover crop; apply supplemental nutrient sprays as needed; irrigate as needed; do leaf analysis.
	Disease management	Monitor for powdery mildew in susceptible cultivars; continue peach scab protection as appropriate.
	Insect / mite management	Monitor for spotted wing drosophila, peach tree borer, leafrollers, mites, aphids, Japanese beetles and other insects; apply controls as needed.
August to end September (fruit maturation harvest)	Disease management	Treat mature fruit for brown rot and Rhizopus rot as needed.
	Insect / mite management	Apply pre-harvest treatments focussed on oriental fruit moth and spotted wing drosophila.
	Other	Hand harvest, grading and packing; irrigation only if very dry.
Late September - November (leaf senescence, harvest and post-harvest care)	Plant care	Mow orchard; irrigate as needed after harvest; remove weak, dead and diseased trees; take soil samples for nutrient analyses; begin preparation of new sites for new plantings.
	Disease management	Apply post-harvest copper spray for coryneum blight. Apply a fall dormant fungicide for peach leaf curl once >90 percent of the leaves have dropped.
	Weed management	Monitor for weeds and apply controls if needed.

Abiotic Factors Limiting Production

Temperature

In Canada, peaches and nectarines can be produced commercially in limited areas, given their sensitivity to cold. Like most tender fruits, they are at high-risk for crop failure due to extreme weather conditions. Fruit buds are easily killed by cold winter temperatures and spring frosts. Winter injury also compounds the problem of tree decline caused by biotic factors such as borers and canker diseases.

Soil

Peach trees must be planted in soils that have very good water percolation. Planting on poorly drained soil may predispose trees to Phytophthora root rot, winter damage, low productivity or death.

Water

For sustained production and mitigation of risk, all acreage requires irrigation. Erratic weather patterns have resulted in a greater need for the industry to have access to water for irrigation. Losses have resulted where growers do not have access to water.

Diseases

Key Issues

- Resistance to fungicides is an ongoing concern for the management of brown rot and blossom blight. There is currently a heavy reliance on Group 3 and Group 7 fungicides. Additional cost effective rotational fungicides are needed to allow for improved disease resistance management.

- Bacterial diseases cause serious damage in peach production and can result in premature decline of orchards. With limited options available for in-season chemical control of bacterial spot in peaches, there is a need for the development and registration of effective bactericides. Cueva (copper octanoate) is currently registered for suppression although some phytotoxic foliar effects have been identified when Cueva is applied under certain environmental conditions.

- Additional research is required in bacterial spot, peach scab and perennial canker resistant cultivars that are suitable to the growing conditions in Ontario and British Columbia.

- There is a need for more organic/biological-based pesticides to protect against blossom blight and brown rot in organically managed peaches.

- Peach leaf curl (PLC) is an annual concern for all peach growers in Ontario. Dodine (Syllit) has recently been labelled for PLC, however, with all uses of chlorothalonil (Bravo/Echo) currently under review and the potential to lose the use pattern of this important active ingredient against PLC, there is a need for the registration of additional fungicides/fungicide groups for PLC management.

- Recent US data suggest there is a link between nematode presence and susceptibility to canker infections in stone fruit. Additional investigation is required into the potential role nematodes have on perennial canker infections in Canada.

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

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

Disease	British Colombia	Ontario
Brown rot		
Bacterial spot		
Coryneum blight		
Peach scab		
Peach leaf curl		
Powdery mildew		
Bacterial canker		
Peach (perennial canker)		
Verticillium wilt		
Crown gall		
Phytophthora root rot and crown rot		
Plum Pox Virus (Sharka)		
Rhizopus rot (post harvest)		
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: Peach stakeholders in reporting provinces (British Columbia and Ontario). 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 peach production in Canada[1]

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

… continued

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

Practices	Brown rot	Powdery mildew	Peach scab	Perennial canker	Peach leaf curl
Decision making tools:					
Economic threshold					
Use of predictive model for management decisions					
Crop specialist recommendation or advisory bulletin					
Decision to treat based on observed disease symptoms					
Use of portable electronic devices in the field to access pathogen / disease identification / management information					
Suppression:					
Use of diverse product modes of action for resistance management					
Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pathogen populations					
Use of biopesticides (microbial and non-conventional pesticides)					
Controlled atmosphere storage					
Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)					
Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms					
Crop specific practices:					
Timing of pruning					
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: Peach stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2020, 2021 and 2022 production years.

Brown Rot (*Monilinia fructicola*)

Pest Information

Damage: The brown rot fungus causes blossom blight, shoot dieback, twig cankers and fruit rot in peaches and nectarines. Infected blossoms wilt, shrivel and die. Developing or mature fruit may exhibit a brown spot that quickly develops as a soft dry rot over the entire fruit.

Life Cycle: Monilinia fructicola mycelia (vegetative strands) overwinter in infected, mummified fruit and twigs. As temperatures warm in spring, conidia (asexual spores) are produced. The conidia are dispersed by wind and rain and cause new infections. Frost injured blossoms are more susceptible to this infection. Rarely, apothecia (mushroom-like sexual spore producing structures) develop on fruit mummies left on the ground and release ascospores (sexual spores) during bloom. Developing fruit can be infected by conidia produced on blighted blossoms. Nectarine is more susceptible than peach to brown rot but both appear to be most susceptible during pink to shuck-fall period and also two to three weeks prior to picking. Brown rot development is favoured by extended wet conditions.

Pest Management

Cultural Controls: Sanitation is essential. The following practices minimize spore populations and reduce the likelihood of an epidemic: removal of all remaining fruit and brown rot mummies from the tree after the final picking; fruit thinning carried out before pit hardening, when possible; removal of infected blossoms and shoots as they occur; maintenance of a weed-free herbicide strip in high density orchards with sod between the rows to apply fertilizers to discourage the production of apothecia and ascospores; removal of abandoned blocks and wild susceptible hosts nearby. Refer to *Table 5* for practices used by growers in Canada to manage brown rot.

Resistant Cultivars: Although no variety has complete immunity to brown rot, several varieties appear to have some resistance to this disease.

Issues for Brown Rot

1. Resistance to fungicides is an ongoing concern for the management of brown rot and blossom blight. There is currently heavy reliance on Group 3 and Group 7 fungicides. Additional cost effective rotational fungicides are needed to allow for improved disease resistance management.
2. There is a need to develop cost effective approaches to disease monitoring and forecasting to improve treatment decisions.

Bacterial Spot (*Xanthomonas arboricola* pv. *pruni*)

Pest Information

Damage: Bacterial spot is a serious disease of peach, nectarine, apricot and Shiro plum. The disease attacks the fruit, leaves and current season's twigs. It can cause severe defoliation and reduction of yield and quality of harvested fruit. Early season infections result in very deep lesions in the fruit flesh, while infections within 30 days of harvest result in circular, yellowish spots.

Life Cycle: Bacterial spot is of most concern in regions with annual rainfall greater than 50 cm. The pathogen overwinters in cankers on twigs. Bacteria are produced in cankers during the spring and are spread by splashing rain to new leaves where they cause new infections. Frequent rainfall, winds and moderate temperatures favour infection. The bacteria multiply and spread to developing fruit throughout the season when favourable conditions occur. The three-week period following petal fall is critical for early-season fruit infection and for establishing inoculum on new foliage. Rainfall during this period is required for infection.

Pest Management

Cultural Controls: Wind breaks that prevent sand blasting of leaves and fruit can be helpful. Infections may be avoided by placing new plantings away from orchards of highly susceptible cultivars. Pruning to open up the canopy allows more rapid drying of foliage and helps to better manage fertility as it discourages excessive foliage growth or nutrient stress, and results in conditions less favourable for disease development.

Resistant Cultivars: Cultivars developed in the relatively humid areas of North America have fair to good tolerance to bacterial spot. Cultivars developed in the drier areas are frequently too susceptible to the disease to be grown successfully in humid areas.

Issues for Bacterial Spot

1. With limited options available for in-season chemical control of bacterial spot in peaches, there is a need for the development and registration of effective bactericides. Cueva (copper octanoate) is currently registered for suppression although some phytotoxic folia effects have been identified when Cueva is applied under certain environmental conditions.
2. Additional research is required to identify bacterial spot resistance varieties that are suitable to growing conditions in Ontario and British Columbia.

Coryneum Blight or Shot Hole (*Wilsonomyces carpophilus*)

Pest Information

Damage: The coryneum blight pathogen causes small spots on fruit. Frequent rainy periods at shuck-fall stage result in more severe symptoms. Small spots that may become gummy also develop on twigs. Infections of bud tissues can result in bud death, blossom blight or shot hole symptoms on leaves. Twig infections can result in girdling and dieback of twigs.

Life Cycle: The pathogen overwinters in buds and twig cankers. Under suitable weather conditions, spores are produced in infected tissues in the spring and are blown to fruit and leaves where they cause new lesions. Spores are spread by rain to new bud and twig tissues where they give rise to blight infection.

Pest Management

Cultural Controls: The pruning-out of infected twigs during dormancy will reduce overwintering disease. The use of drip irrigation systems that do not result in foliar wetness is less conducive to disease development than overhead systems.

Resistant Cultivars: None identified.

Issues for Coryneum Blight

1. New fungicides are required to replace older products for the management of coryneum blight.
2. There is a need for a predictive development model for coryneum blight in BC for better management.

Peach Scab (*Cladosporium carpophilum*)

Pest Information

Damage: Numerous, grey-green spots, about two to three mm in diameter develop on fruit. The spots eventually take on a corky appearance and may coalesce and cause cracking. This injury can lead to secondary rots or cause fruit to dry out. Spots also develop on the underside of leaves and along twigs. Severely infected leaves can drop prematurely.

Life Cycle: Conidia (asexual spores) are produced in the spring in infected one-year old twigs where the pathogen overwintered. The conidia are splashed by rain on to fruit, foliage and growing twigs where the conidia cause new infections. Infection of new growth can occur throughout the growing season and is favoured by the presence of free moisture and temperatures of 22 to 30 °C.

Pest Management

Cultural Controls: Pruning to open up the canopy will facilitate more rapid drying of foliage and fruit and result in conditions less favourable for disease development. Monitoring for peach scab is important, especially if the disease was prevalent in the orchard the preceding year. It is important that fungicide sprays be initiated at the shuck split stage of fruit development before symptoms are apparent on the fruit. Refer to *Table 5* for practices used by growers to manage peach scab.

Resistant Cultivars: None identified.

Issues for Peach Scab

1. There is a need for a local disease forecasting model to better predict potential peach scab infection periods. This will allow for better preventative management of this disease when high pressure conditions are experienced following shuck split.

Peach Leaf Curl (*Taphrina deformans*)

Pest Information

Damage: The pathogen causes discolouration, curling and thickening of leaves. Reddish areas appear on developing leaves in the early spring. These reddish areas soon become thickened and puckered causing infected leaves to curl. Affected leaves eventually wither and die and are replaced by healthy leaves, however, repeated loss of leaves weakens the tree. Due to defoliation, fruits may become exposed and prone to sunburn injury. Severe early defoliation and dieback of foliage in the spring causes crop loss for many peach and nectarine cultivars. The destructive potential of peach leaf curl is frequently underestimated, resulting in important control measures being forgotten or delayed.

Life Cycle: The fungus overwinters as spores on twigs and bark crevices. Buds are infected in the spring as they expand, with long periods of cool (10 to 21 $^{\circ}$C) and wet (>95 percent humidity) weather facilitating infection. Leaves become less susceptible to infection as they mature. Budding ascospores discharge from curled leaves onto peach twigs and buds. New spores are produced within infected tissues and remain on the branches and twigs until the following spring when they cause new infections. Viable spores can survive on branches for several years in the absence of conditions suitable for infection.

Pest Management

Cultural Controls: Treatment is not effective once infection has occurred and symptoms appear. When infection is severe, thinning more fruit than normal, reducing drought stress through irrigation and applying extra nitrogen fertilizer will help maintain tree vigour. Refer to *Table 5* for practices used by growers to manage peach leaf curl.

Resistant Cultivars: All cultivars are susceptible to some degree. Red haven and its derived cultivars are less susceptible.

Issues for Leaf Curl

1. There is concern regarding the potential for unusual weather patterns resulting from climate change to cause de-acclimatization in peach trees exposed to warm temperatures for consecutive days in February-March. The risk for peach leaf curl infections dramatically increases if these temperatures result in early bud scale separation. There is a need for additional research on degree-days accumulation and for the development of a predictive model for peach leaf curl.
2. Dodine (Syllit) has recently been labelled for peach leaf curl, providing another resistance management option; however, with all uses of chlorothalonil (Bravo/Echo) currently under review and the potential to lose the use pattern of this important active ingredient against peach leaf curl, there is a need for the registration of additional fungicides/fungicide groups for peach leaf curl management.

Powdery Mildew (*Podosphaera pannosa* and *Podosphaera clandestina*)

Pest Information

Damage: Powdery mildew attacks young shoots, leaves and fruits. Under favourable weather conditions, the disease can reduce fruit quality, defacing the fruit with netting or white spots which increase in size until a large portion of the surface is covered. Skin eventually turns dark brown and the surface becomes leathery and hard. As the fruit matures, it becomes more resistant to the fungus.

Life Cycle: The powdery mildew pathogen overwinters in infected buds and shoots. With the onset of growth in the spring, the fungus produces conidia which are dispersed by wind and rain to expanding leaves, shoots and young fruits where they cause new infection. Warm, humid weather favours disease development. Conidia develop in the new infections and are dispersed by wind and rain to new infection sites.

Pest Management

Cultural Controls: Practices that facilitate drying of the foliage, such as pruning to promote air circulation in the canopy and reduce relative humidity, will reduce the development of powdery mildew. Irrigation should be avoided in the late afternoon or evening. Refer to *Table 5* for practices used by growers to manage powdery mildew.

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

Issues for Powdery Mildew

1. There is a continued need for the registration of alternative chemistries for powdery mildew management in susceptible processing peaches and fresh market nectarines.
2. Further studies are required on the yield impact and economic thresholds of powdery mildew on different cultivars as differences in disease susceptibility have been observed. There is a need to refine prediction models for peaches and nectarines for improved management of powdery mildew.

Bacterial Canker (*Pseudomonas syringae*)

Pest Information

Damage: Bacterial canker can affect peach, cherries and other stone fruits. Symptoms of bacterial canker include dieback of blossoms, leaf spotting and shot hole symptoms and fruit spots. Infections on trunks and limbs are often initiated at pruning sites resulting in cankers that exude a gummy ooze. Infections can lead to twig and branch dieback.

Life Cycle: The pathogen overwinters in trunk cankers and in buds of host trees. The bacterium also survives on the surface of leaves and weeds in the orchard. The pathogen is spread by rain splashing and by pruning tools. Infections are favoured by cool and wet conditions.

Pest Management

Cultural Controls: Cultural practices that minimize stress on peach trees, such as planting on good sites and providing adequate moisture and nutrients, will reduce the likelihood of infection. Pruning during rainy periods or in late spring or fall when bacterial populations are highest is not recommended as these conditions favour infections. The removal of severely affected branches and trees will remove a source of disease.

Resistant Cultivars: None identified.

Issues for Bacterial Canker

1. The registration of bactericides is required for the control of bacterial canker.

Peach Canker: Cytospora Canker, Valsa Canker, Perennial Canker (*Leucostoma persoonii*)

Pest Information

Damage: The disease results in the formation of cankers on branches that restrict the movement of water and nutrients resulting in nutrient deficiencies, reduced growth and dieback on affected branches. Cankers on trunks can kill a tree.

Life Cycle: Canker fungi invade weakened, dying and dead tissues. Once established, the pathogens grow into adjacent healthy tissues. The advancement of fungal growth is halted during the growing season when tree growth produces a ring of callus around the canker. Alternate periods of fungal and tree growth result in concentric rings of growth. Although the causal fungi are found primarily on peach, they can also cause canker and twig dieback on apricot, nectarine, plum, cherry and wild cherry species and apple. Fruiting bodies develop in the cankers and release spores. The spores are spread to wounds by rain, insects, birds and pruning tools, where they cause new infection. In the late winter and early spring, cankers may expand due to the activity of the lesser peach tree borer. In the fall, the incidence of new cankers may be related to injury to twigs caused by the oriental fruit moth.

Pest Management

Cultural Controls: Practices that minimize winter and physical injury will help reduce the chances of disease development. Proper site selection for new plantings is essential. Hilling of soil or mulching at the base of the tree will help water drain away and prevent cold injury to the crown. Planting new orchards away from known sources of *Leucostoma* inoculum will minimize risk of infection. The use of disease-free nursery stock and effective management of oriental fruit moth and peach tree borer, even in the first few non-bearing years, will help to protect young orchards from this disease. Training trees during the first season so branches develop wide crotch angles, necessary for long orchard life, and use of wire or plastic guards against rodent damage may also be beneficial. Pruning delayed until the first forecasts of warm, dry weather will heal more quickly, reducing likelihood of infections through pruning wounds. Refer to *Table 5* for practices used by growers to manage perennial canker.

Resistant Cultivars: None available.

Issues for Peach Canker

1. Effective management approaches, including the use of resistant varieties, are required for peach canker, which is the major cause of decline and short life span of orchards.
2. There is a need to develop and register effective chemical controls as well as educating growers on best management practices (e.g., timing of pruning and borer control) to reduce the occurrence of perennial canker infections.
3. Additional investigation is required into the potential role nematodes have on perennial canker infections in Canada. US data suggests there is a link between nematode presence and susceptibility to canker infections in stone fruit.

Verticillium Wilt (*Verticillium dahliae*)

Pest Information

Damage: Verticillium wilt invades the xylem and interferes with water transport within the tree, resulting in wilting of foliage and dieback of branches. Affected sapwood becomes dark stained and trees up to four years old often die. Mature trees develop dieback and produce reduced yields.

Life Cycle: Verticillium dahliae is a soil borne organism that infects the roots and invades the vascular system of the tree. The pathogen produces resistant structures (microsclerotia) that can survive in the soil for many years in the absence of any host.

Pest Management

Cultural Controls: Growing several seasons of grass or green manure crops can reduce inoculum levels. Orchards should not be planted where susceptible crops were previously planted. Maintenance of adequate soil fertility, soil moisture levels and other methods of reducing stress will help trees tolerate the disease.

Resistant Cultivars: None identified.

Issues for Verticillium Wilt

None identified.

Crown Gall (*Agrobacterium tumefaciens*)

Pest Information

Damage: The pathogen induces the formation of galls on the surface of roots, crowns and sometimes trunks and scaffolds. The galls interfere with the normal flow of water and nutrients. Young trees may be killed while older trees suffer reduced growth and vigour.

Life Cycle: The pathogen affects a wide range of broadleaf woody plants including stone fruits. Bacteria are released into the soil when galls are wet or when older gall tissue disintegrates. The bacterium can survive in the soil for at least one year in the absence of host tissue. Established trees are infected only through wounds, such as those caused by growth cracks, pruning and damage from cultivation equipment or freezing injury. Seedlings can be infected during germination if planted into infested soil.

Pest Management

Cultural Controls: Careful site selection and using disease-free planting stock raised in sterile planting media in the nursery are important practices for avoiding infections.

Resistant Cultivars: None identified.

Issues for Crown Gall

None identified.

Phytophthora Root Rot and Crown Rot (*Phytophthora* spp.)

Pest Information

Damage: Phytophthora root and crown rot is characterized by a decay of roots and crown tissues. Peach, nectarine, apricot and cherry can be seriously affected. The disease interferes with the uptake and translocation of water and nutrients. The disease may reduce growth and vigour or can progress rapidly resulting in death of the tree. The disease can severely affect the establishment of new plantings at some locations.

Life Cycle: The disease is a greater problem on heavy, wet soils with poor drainage. The pathogen remains in soil as resting spores (oospores or chlamydospores). The fungus is carried from place to place on infected plants, in contaminated soil or in surface water. *Phytophthora* spp. spread by the production of mobile zoospores which are able to move long distances in ground water and runoff of saturated soils. Under saturated conditions, spores germinate and infect roots and the bark on the crown. The fungus develops within the bark, cambium or young xylem tissue, killing the colonized host tissues as it progresses.

Pest Management

Cultural Controls: The planting of trees on sites that are well-drained and have sandy loam soil will reduce the chances of disease development. Managing irrigation so prolonged periods of saturated soils are avoided will result in conditions less favourable for disease development.

Resistant Cultivars: None identified.

Issues for Phytophthora Root Rot and Crown Rot

None identified.

Plum Pox Virus (Sharka)

Pest Information

Damage: Plum pox virus (PPV) is a serious disease that infects peach, plum, nectarine, apricot, almond, cherry, as well as some ornamental varieties and wild *Prunus* species. The virus does not kill trees but can severely reduce yield and affect fruit quality. Disease symptoms can vary with host species and cultivar. Symptoms may develop on leaves or fruits, on a portion of a tree or on a single branch. Fruit infections may appear as chlorotic areas and deformation with internal browning of flesh and pale rings or spots on the stones.

Life Cycle: Plum pox virus is transmitted from infected trees by aphids or by grafting infected buds or scions. Long distance spread can occur via the movement of infected plant material such as nursery trees, bud wood or scion wood. It is not spread by mechanical means such as pruning.

Pest Management

Cultural Controls: Planting only virus-free, certified nursery stock will prevent the introduction of the disease into new areas. Avoiding growing susceptible trees within a plum pox infected zone helps to prevent new infections. Annual testing of mother trees for the presence of plum pox by laboratory analysis (e.g., ELISA and PCR) of tissue samples and the elimination of infected trees will help maintain a virus-free orchard. Control can be achieved by monitoring, sanitation and quarantine, avoiding introduction and preventing the movement of material out of an infected area. When the virus is detected, eradication by removing infected trees is necessary. Foliar oil sprays may reduce virus transmission by aphids.

Resistant Cultivars: No natural resistance has been found.

Issues for Plum Pox Virus

1. There is a need for continued and routine monitoring of visual PPV symptoms in commercial orchards in Ontario to quickly identify and properly manage potentially infected trees.
2. There is a need to develop varieties resistant to plum pox virus as well as to develop a certified virus-free clean stock program. Nurseries need to maintain awareness to prevent propagation from virus infected material and continue to deliver trees free of PPV.

Rhizopus Rot (*Rhizopus* spp.)

Pest Information

Damage: The disease causes a soft rot of harvested or over-ripe stone fruits. Lesions may be difficult to distinguish from early brown rot lesions. At warm temperatures, the fungus rapidly advances, causing the loss of fruit within a shipping container.

Life Cycle: Rotted fruits on the orchard floor allow for inoculum build up as the season progresses. In the early stages of fruit ripening, injuries such as those caused by insects, hail or cracking provide entry sites for infection. After harvest, infection on ripe fruit can spread in the absence of injury from fruit to fruit at contact points. The fungus does not grow at temperatures below 4 ˚C.

Pest Management

Cultural Controls: Storing fruit below 4 °C will stop the progress of the disease. Careful fruit handling to avoid wounding will minimize potential sites of infection. Sanitation practices including maintaining cleanliness of storage containers, warehouses and hydro-cooling water and the proper disposal of culled fruit will reduce infection sources of the disease.

Resistant Cultivars: None identified.

Issues for Rhizopus Rot

1. The development of a strategy for the management of Rhizopus rot is required for BC, including effective fungicides for pre- and post-harvest application.

Insects and Mites

Key Issues

- Spotted wing drosophila continues to be a very serious pest of peach and nectarine. Products with effective modes of action and short pre-harvest intervals have been registered for this pest recently, however, new products with unique modes of action are important to maintain resistance management options. Soft chemistries and effective commercial lures for mass trapping should also be explored.

- The loss of clothianidin (Clutch) and phosmet (Imidan) has limited insecticide options for plum curculio. Currently, stone fruit growers are relying on a single insecticide group for control of plum curculio. Additional effective insecticides are needed for resistance management at high pressure locations.

- There is a need for the development of robust integrated pest management strategies that include alternative products, biological controls, cultural practices and possibly preferred host cover crops to manage *Lygus* spp., including tarnished plant bug.

- The presence of western flower thrips and onion thrips during the bloom and fruit set periods in peach and nectarine orchards has been confirmed. Some management options have been explored, however, additional cost-benefit analysis is required to determine if these strategies are economically feasible. Current strategies utilize fully systemic insecticides combined with contact-based products. Even though peaches and nectarines do not require a pollinator to fertilize, off-target pollinator impact must also be investigated closely.

- It is important that both peach and nectarine be considered for new pesticide registrations. Where applicable, it is highly recommended for agrochemical companies to pursue registration on the entire crop group (CG 12), so all stone fruit commodities are included in the labelling of new products.

- There is a need for additional resources to better track peach tree borer populations to accurately time insecticide applications, especially in young orchards where mating disruption is not being used.

- Japanese beetles are an annual pest in Ontario and have been identified in the lower mainland of BC. These insects are mostly foliar feeders; however, they have also been observed feeding on previously injured fruit. With the recent loss of phosmet (Imidan), growers are left with few effective control options for Japanese beetles. There is a continued need to register chemistries that provide quick knockdown, have short pre-harvest intervals and/or have some repellency activity.

…continued

Key Issues (continued)

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

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

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

Insect/Mite	British Columbia	Ontario
Oriental fruit moth		
Plum curculio		
Green peach aphid		
Brown marmorated stinkbug		
Tarnished plant bug		
European red mite		
Two-spotted spider mite		
Peach silver mite		
Comstock mealybug		
San Jose scale		
Japanese beetle		
Obliquebanded leafroller		
European earwig		
Spotted wing drosophila		
Western flower thrips		
Peach tree borer		
Lesser peach tree borer		
Peach twig borer		
American plum borer		
Shothole borer		
Ambrosia beetle		
Granulate ambrosia beetle		
Black stem borer		
Red-banded leafroller		
Variegated leafroller		
Fruit-tree leafroller		
Eastern tent caterpillar		
Forest tent caterpillar		
Eyespotted bud moth		
LDD moth		
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: Peach stakeholders in reporting provinces (British Columbia and Ontario). 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 peach production in Canada[1]

Practices	Oriental fruit moth	Green peach aphid	Tarnished plant bug	Peach tree 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					
Pruning out / removal of infested material throughout the growing season					
Tillage / cultivation to expose soil insect pests					
Removal of other hosts (weeds / wild plants / volunteer crops) in field and vicinity					

…continued

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

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

…continued

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

Practices	Oriental fruit moth	Green peach aphid	Tarnished plant bug	Peach tree borer	Spotted wing drosophila
Mating disruption through the release of sterile insects					
Trapping					
Targeted pesticide applications (e.g., banding, spot treatments, use of variable rate sprayers)					
Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms					
This practice is used to manage this pest by at least some growers in the province.					
This practice is not used by growers in the province to manage this pest.					
This practice is not applicable for the management of this pest.					

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

Oriental Fruit Moth (*Grapholita molesta*)

Pest Information

Damage: Oriental fruit moth (OFM) larvae enter terminal shoots at the base of young leaves and tunnel toward the base of the shoot. Infested terminals wilt and die. Heavy twig infestations in nursery stock and new orchards adversely affect the shape of trees. Later generations attack the fruit. During early fruit development, fruit infestations can cause fruit drop. Feeding by later infestations does not cause fruit drop but results in visible entrance holes in the fruit.

Life Cycle: Full sized larvae form cocoons and overwinter in bark crevices or in fallen fruit in the orchard. The larvae pupate in the early spring and the first adults are seen at the pink to early bloom stage of bud development. Adult moths lay eggs on leaf surfaces. Following hatching, larvae move into terminal shoots to feed. Excessive tree growth or high temperatures during late summer and fall can result in the development of four full generations which can cause losses to later maturing varieties.

Pest Management

Cultural Controls: Pruning to facilitate good spray penetration and adjusting irrigation schedules to avoid washing off insecticide residue after application will improve chemical control. Pheromone traps can be used to monitor the pest population and determine spray timing. The inter-planting of peach and nectarine with apple or pear will make control more difficult as the development of OFM is different on these crops. The removal of susceptible hosts within 2.2 km of the orchard will help to eliminate sources of infestation. Mating disruption with insect pheromones is effective under specific conditions for the management of OFM. The economic threshold for fruit moth injury in most commercial peach orchards is below 1 percent of the total crop infested at harvest. Refer to *Table 7* for practices used by growers in Canada to manage OFM.

Resistant Cultivars: None available.

Issues for Oriental Fruit Moth

1. The continued education of growers on the importance of proper insecticide timings and product rotations is required to minimize the risk of the development of resistance in oriental fruit moth populations.

Plum Curculio (*Conotrachelus nenuphar*)

Pest Information

Damage: Plum curculio attacks stone and pome fruits. Overwintering adult beetles attack fruit soon after it forms, causing bumps on the fruit, making holes through the skin and feeding on the pulp next to the pit. Females cause crescent-shaped scars when laying eggs and larvae cause internal injuries as they burrow through the fruit, resulting in fruit drop of infested fruit in June.

Life Cycle: Adult plum curculios overwinter in plant debris in protected sites near orchards. Eggs are laid on young fruit in the spring. Larvae develop within the fruit and drop to the soil to pupate. Adults emerge in July and August and feed on developing fruit throughout the rest of the season. Beetles are more active on warm, damp, cloudy days and in the centre of thick, heavy trees that provide the appropriate micro-climate. Temperature is the most important factor affecting development, particularly early in the spring.

Pest Management

Cultural Controls: The removal of wild, susceptible hosts around orchard blocks will help to remove a potential source of infestation. Monitoring methods have been developed that give advance warning of migration into an orchard and potential for fruit injury.

Resistant Cultivars: Nectarine, plum and apricot fruits are more attractive to the pest than peach, but there are no resistant cultivars.

Issues for Plum Curculio

1. The loss of clothianidin (Clutch) and phosmet (Imidan) has seriously limited insecticide options for plum curculio in Ontario. Currently, stone fruit growers rely on a single insecticide group for control of plum curculio. Additional effective insecticides are needed for resistance management at high pressure locations.
2. Research is needed on more effective plum curculio attractant lures (pheromone or botanical-based) and how trapping methods can be used effectively to provide early warning and timing of sprays for plum curculio in Ontario.

Green Peach Aphid (*Myzus persicae*)

Pest Information

Damage: Aphids feed primarily on the underside of leaves, causing them to curl, become distorted and yellow, and to drop prematurely. Feeding may also occur on flowers, resulting in distortion and drop. Peach fruit is not usually attractive for direct aphid feeding. Cool, cloudy weather in May and June can lead to substantial stress and stunting of nectarine and peach leaves, as well as direct aphid damage to nectarine fruit because aphid populations do not develop wings and migrate to other hosts during this period. In addition to direct damage, aphid feeding results in excretion of honeydew, which supports the growth of a black sooty fungus that causes spotting on leaves and fruits. This aphid is also a vector of virus diseases including plum pox.

Life Cycle: The green peach aphid has a diverse host range, including all stone fruits and many ornamental shrubs and vegetables. The insect overwinters as eggs on peach and nectarine. The eggs hatch in the spring as females, developing through several nymph stages to adults. Subsequent generations develop without mating (parthenogenesis) and bear live young. Through the summer, aphids migrate to other hosts. In the fall, the aphids return to peaches where they mate, lay overwintering eggs and die.

Pest Management

Cultural Controls: The wide host range, ability to migrate or to remain resident in the orchard makes control of green peach aphids difficult. Over-fertilization with nitrogen can lead to high populations of aphids. Avoiding excessive growth with balanced fertilization and irrigation is important. Threshold levels, based on the number of colonies per tree or the percentage of infested shoots, have been established for insecticide treatments of bearing trees. Beneficial predators and parasitic species which can help to keep populations in check include ladybird beetles, lacewings, syrphid flies and chalcid wasps. Refer to *Table 7* for additional practices used by growers to manage green peach aphids.

Resistant Cultivars: Nectarines are more susceptible to fruit damage than peaches, as the pubescence of peach fruit discourages aphid feeding.

Issues for Green Peach Aphid

1. The green peach aphid is a concern because it is the major vector of plum pox virus. Routine monitoring after bloom remains important to identify aphid colonies and properly manage populations. With the loss of many Group 4 insecticides, new chemistries are needed to properly manage aphids.
2. There appears to be higher populations of black cherry aphid recently in Ontario that is affecting peaches and nectarines as well as other stone fruit commodities. Insect modelling and population dynamics studies would be beneficial to help manage this insect before populations climb.

Brown Marmorated Stinkbug (*Halyomorpha halys*)

Pest Information

Damage: The brown marmorated stinkbug (BMSB) has not yet been identified as a pest in agricultural crops in Canada but it is a concern as it has caused 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: The 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 Stinkbug

1. There is concern with BMSB in mid-to-late ripening peach, nectarine and plum cultivars, especially along orchard border areas where alternative hosts are present. Careful monitoring needs to continue in order to identify any change in the population dynamics of BMSB and economic thresholds need to be established for later maturing cultivars.
2. Even though BMSB has not been identified as a major pest in Ontario or BC, if populations climb and pressure increases, we currently do not have any effective products registered for this pest on peach and nectarine. Registered control products for this emerging pest are needed.

Tarnished Plant Bug (*Lygus lineolaris*)

Pest Information

Damage: The tarnished plant bug (TPB) attacks buds, flowers and fruit. It feeds by piercing the plant and sucking sap. Prior to shuck split, feeding causes bud, flower or fruit to drop. Feeding prior to pit hardening will cause young fruit to become deeply injured and deformed. As the fruit matures after pit hardening, additional injury can appear.

Life Cycle: The TPB is a general feeder on many wild and cultivated herbaceous plants, especially legumes, where both adults and nymphs can be found. Only adults are found on peach and nectarine. Resident populations overwinter and subsequent generations develop on ground cover in the orchard. Migratory populations move into orchard blocks when food sources dry up and hot, humid conditions encourage dispersal.

Pest Management

Cultural Controls: Fruit injury and populations within the tree are influenced by ground cover management and the presence of alternate host crops, such as alfalfa. The use of cover crop species that are not hosts to TPB and a trap crop strip which is an alternate host to TBP are effective tools in managing this pest. Ground cover sampling can be used to determine the presence of populations that can move into peach trees, and flower bud and fruit monitoring early in the season will expose signs of feeding. Border sprays are warranted when two percent of fruit damage is observed on the edge of the orchard. Economic thresholds are available to guide spray decisions for both migratory and resident populations of TPB. Refer to *Table 7* for additional practices used by growers to manage TPB.

Resistant Cultivars: Some varieties incur less damage but the reasons are unknown.

Issues for Tarnished Plant Bug

1. Currently growers are relying on a single group of insecticides to control this pests. There is a need for additional effective management strategies that include alternative chemical control products, biological controls, cultural practices and possibly preferred host cover crops to manage the resistance of TPB to commonly used insecticides.
2. There is a concern this pest has the potential of becoming a major disruptive pest in blocks where chemical insecticides are being reduced in favour of mating disruption technology.
3. An increase in fruit damage from this pest has been documented in Ontario and BC, appearing to be a greater concern in hot and dry growing seasons. There is a need to identify optimal application timings and distribution patterns of this insect within each growing area.

European Red Mite (*Panonychus ulmi*)

Pest Information

Damage: Mites feed on leaves causing a characteristic leaf injury referred to as bronzing. Photosynthesis and nitrogen content of leaves are reduced. Prolonged feeding causes tree stress and will reduce shoot growth and fruit bud set the following year. Aspects of quality, including fruit color, soluble solids and firmness, as well as size and weight can all be negatively affected by European red mite.

Life Cycle: European red mites overwinter as eggs on fruit spurs and buds. Overwintering eggs hatch by the end of the blooming period. Mites develop from egg through three nymph stages to adult and produce six to eight generations per year. Both adults and nymphs cause plant injury. Development is temperature related with faster development during the hot summer months.

Pest Management

Cultural Controls: The use of cover crops on the orchard floor will reduce dusty conditions that favour the build-up of mite populations. Providing sufficient water by following an irrigation schedule will reduce overall stress on trees and reduce the impact of mite feeding. Annual pruning to allow good air flow and spray penetration along with regular monitoring are helpful in managing pest mite populations. Using a threshold of 10 to 15 mites per leaf for treatment decisions and making a careful selection of pesticides to avoid those that are harmful to beneficial predatory mite species are important elements of an integrated pest management program for this pest. Naturally occurring predatory mites provide the most effective control of pest mite populations. The main predatory mites are of the *Phytoseiidae* family.

Resistant Cultivars: None available.

Issues for European Red Mite

None identified.

Twospotted Spider Mite (*Tetranychus urticae*)

Pest Information

Damage: Twospotted spider mites feed on the lower surface of leaves resulting in a characteristic mottling and bronzing. Photosynthesis and nitrogen content of leaves are reduced. Injury is more severe under hot dry conditions.

Life Cycle: Twospotted spider mites are dispersed by wind currents and can move into the orchard in late summer following the drying of vegetation on the orchard floor. Mites overwinter as adults under tree bark. Eggs are laid in the canopy in the spring. Following hatch, mites develop through a number of different nymph stages to become adults. There may be five to nine generations each year.

Pest Management

Cultural Controls: The use of cover crops in the orchard will reduce dusty conditions that are favourable for mite populations. Annual pruning to allow good air flow and spray penetration along with regular monitoring are helpful in managing pest mite populations. Using a threshold of five to 10 mites per leaf for treatment decisions and careful selection of pesticides to avoid those that are harmful to beneficial predatory mite species are important elements of an integrated pest management program for this pest. Naturally occurring predatory mites provide the most effective control of pest mite populations.

Resistant Cultivars: None available.

Issues for Twospotted Spider Mite

None identified.

Peach Silver Mite (*Aculus cornutus*)

Pest Information

Damage: The peach silver mite feeds on the lower leaf surface and tends to congregate around the leaf mid-rib. Light feeding injury is apparent as fine yellow mottling on leaves. Leaves may curl and become silvery green late in the season due to feeding by high populations (200 to 300 mites per leaf). Combined with drought stress, peach silver mite can impact fruit size on late maturing varieties, decrease fruit buds and reduce tree winter hardiness. The pest is actually beneficial in low numbers because they are an important food source for predatory mites when other pest mites are in low numbers.

Life Cycle: The peach silver mite overwinters under bud scales on the tree and has several generations per year.

Pest Management

Cultural Controls: The use of cover crops in the orchard will reduce dusty conditions that are favourable for mite populations. Annual pruning opens up the tree allowing good air flow and spray penetration. Any pesticides used in the orchard must be chosen carefully to ensure the preservation of predatory mites that are often the most effective control of pest mite populations. The main predatory mites are of the *Phytoseiidae* family. Regular monitoring is essential during the summer. It is important to irrigate trees post-harvest if heavy infestations of peach silver mite are present late in the season and if drought conditions persist into September.

Resistant Cultivars: None available.

Issues for Peach Silver Mite

1. There is a need to establish economic thresholds for better decision making in the management of the peach silver mite. This is an occasional and site-specific pest with minor economic impact, which highlights the importance of establishing economic thresholds.

Comstock Mealybug (*Pseudococcus comstocki*)

Pest Information

Damage: Fruit hosts of the Comstock mealybug include peach, pear and apple. It is also a pest of several ornamental plants such as catalpa, mulberry and pine. This insect feeds on sap and is found on leaves and fruits. When peaches or pears are made into puree or are canned mechanically, infestations can potentially result in unacceptable contamination of the finished product. It may also slow the packing line as hand labour must be used for sorting. Honeydew secreted by the crawlers is a substrate for sooty moulds growing on the fruit surface. These moulds result in a downgrading of the fresh fruit and are an additional cause of economic loss.

Life Cycle: This pest overwinters as eggs in protected areas on the bark and near pruning wounds. Eggs hatch from mid-April to May and crawlers feed on terminal growth and lower leaf surfaces. The insect progresses through three instars prior to pupation and development into adult stage. Mating occurs in the spring.

Pest Management

Cultural Controls: Proper pruning to allow good air flow and spray penetration is important in managing this pest.

Resistant Cultivars: None identified.

Issues for Comstock Mealybug

None identified.

San Jose Scale (*Quadraspidiotus perniciosus*)

Pest Information

Damage: San Jose scale is most destructive on apple and pear; however, it can also cause serious damage on peach, plum and cherry. Feeding by San Jose scale causes small red spots on fruit and injures the host tree by reducing tree vigour, especially on young trees.

Life Cycle: The insect may have two to three generations per year. The first nymph stage overwinters on the bark. This stage matures when trees reach full bloom the following spring. Mating occurs in late May or early June and females bear live young called crawlers. The scale crawlers find a suitable feeding site, usually in the upper branches. As they grow, they secrete a protective scale under which they live.

Pest Management

Cultural Controls: Annual pruning to open up the tree and allow for good air flow and spray penetration will contribute to good management of scale populations in the canopy. There are no economic thresholds available for scale insects on fruit and growers may apply controls the following spring if fruit injury was seen at harvest.

Resistant Cultivars: None identified.

Issues for San Jose Scale

1. An effective best management practice needs to be investigated for both the prevention of scale occurrence and for the management of established scale populations in stone fruit.

Japanese Beetle (*Popillia japonica*)

Pest Information

Damage: Japanese beetle adults feed on tender leaf tissues leaving a network of veins, resulting in browning and drop of severely affected leaves. The beetles may also feed on the fruit of early ripening peaches. Japanese beetles are general feeders and will attack over 300 different plants.

Life Cycle: White grubs, the immature stage of Japanese beetles, overwinter in the soil. They feed on plant roots in the spring, pupate and emerge as adult beetles in early July. As adults, they feed on plant foliage and mate; females oviposit in the soil. Adults can fly up to 1.6 km with longer flights possible when there is a good wind. There is one generation per year.

Pest Management

Cultural Controls: Economic thresholds for spray decisions have not been established for Japanese beetle on peach. Recent research indicates mass trapping approaches may be helpful for both conventional and organic producers.

Resistant Cultivars: None available.

Issues for Japanese Beetle

1. Japanese Beetles are now an annual pest in Ontario and have been identified in the lower mainland of BC. With the recent loss of phosmet (Imidan), growers are left with few effective control options for Japanese beetles. There is a continued need to register chemistries that provide quick knockdown, have short pre-harvest intervals and/or have some repellency activity.
2. Further investigation into predatory nematodes as a method of reducing overall Japanese beetle populations, targeting the grub stage, is needed. The logistics of application, timing and product shelf life should be considered.

Obliquebanded Leafroller (*Choristoneura rosaceana*) and other Leafroller species

Pest Information

Damage: Leafroller larvae cause serious injury by webbing a nearby leaf to the surface of the fruit and eating the skin of the fruit. Feeding injury on fruit is evident as irregular holes and russet scars appear on mature fruits. Feeding by the second summer generation of obliquebanded leafroller results in small holes on fruits which may develop rot.

Life Cycle: There are two generations of obliquebanded leafroller per year. The insect overwinters as second or third instar (stage) larvae. In spring, larvae feed on leaves and flower buds and on fruit after petal fall. Larvae develop through six instars before pupating and emerging as adults. Eggs are laid on the underside of leaves.

Pest Management

Cultural Controls: Avoiding fertilization and irrigation before the pit hardening stage and minimizing fruit thinning early in the season can be helpful in reducing the impact of this pest. Isolating blocks of sweet cherries, apples and pears from peach to avoid migration of larvae will reduce infestations from other host crops. Monitoring populations in other nearby crops and using pheromone trap monitoring to guide the application of insecticides has been shown to be effective. Pheromone products related to mating disruption technology are available for use under select conditions.

Resistant Cultivars: Varieties prone to developing split-pits seem particularly susceptible to damage.

Issues for Leafrollers

None identified.

European Earwig (*Forficula auricularia*)

Pest Information

Damage: Earwigs damage peaches by boring into ripening, over-ripened and injured fruit. This feeding damage increases the risk of brown rot infection by wind-borne or water-borne spores. Earwigs may also transfer pathogen spores directly, as they feed.

Life Cycle: Earwigs have one generation per year. Adult earwigs overwinter in the soil. Eggs are laid in the soil during the spring and upon hatching, earwig nymphs begin to feed on a variety of materials. Earwigs are very sensitive to sunlight, hiding during the day in sheltered cracks and crevices.

Pest Management

Cultural Controls: Removal of debris and weeds from the base of trees will remove hiding places for this pest. Earwigs can be kept out of trees by wrapping a smooth part of the trunk with an adhesive tape before activity is first noticed. Small boxes stuffed with crumpled paper or rolls of newspaper can be set on the ground to capture earwigs. Tucking newspapers, covered with plastic bags to keep them dry, into limb crotches is a useful way of monitoring them.

Resistant Cultivars: None identified.

Issues for European Earwig

1. There is a need for the registration of pest control products for the control of European earwigs as this pest is becoming more common in Ontario tender fruit orchards and remains a difficult pest to manage in BC peach and nectarine.

Spotted Wing Drosophila (*Drosophila suzukii*)

Pest Information

Damage: Spotted wing drosophila (SWD) is known to infest all stone fruits, raspberry, blackberry, blueberry and strawberry, as well as numerous wild hosts. Late season cultivars appear to be at most risk as drosophila populations are higher later in the summer. Unlike other fruit flies, SWD will attack sound fruit. Larvae feed within fruit causing softening and a breakdown of flesh which makes the fruit unmarketable. Wounds caused by egg-laying serve as entry points for disease.

Life Cycle: This insect overwinters as an adult fly. In the spring, SWD mate and lay eggs under the skin of ripening fruit. Larvae feed and develop within the fruit. Due to the short generation time and extended period of egg laying by adults, there can be three to nine overlapping generations each year. SWD is spread over 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 orchard will help to reduce food sources. Mowing of the orchard floor immediately after harvest may also help to destroy any fruit on the ground. Flies can be monitored using apple-cider vinegar traps. Refer to *Table 7* for additional practices used by growers to manage SWD.

Resistant Cultivars: None identified.

Issues for Spotted Wing Drosophila

1. Spotted wing drosophila continues to be a very serious pest of peach and nectarine. Products with effective modes of action and short pre-harvest intervals have been registered for this pest recently; however, new products with unique modes of action are important to maintain resistance management options. Soft chemistries and effective commercial lures for mass trapping should also be explored.

Western Flower Thrips (*Frankliniella occidentalis*)

Pest Information

Damage: Western flower thrips feeding on the surface of fruit results in scarring, starting from pink through shuck fall stages of fruit development. The scars enlarge as the fruit grows.

Life Cycle: Western flower thrips feed on a wide variety of plants. Populations can build up on nearby host species and move into the orchard. Eggs are laid on peach during bloom. Following hatch, nymphs feed for a number of weeks before becoming adults. There are several generations per year.

Pest Management

Cultural Controls: Close examination of blossoms in the early spring is important to monitor for the presence of western flower thrips.

Resistant Cultivars: None identified.

Issues for Western Flower Thrips

1. The presence of Western flower thrips and onion thrips are during bloom and flower set periods in peach and nectarine orchards has been confirmed. Some management options have been explored, however, additional cost-benefit analysis is required to determine if these strategies are economically feasible. Current strategies utilize fully systemic insecticides combined with contact-based products. Even though peaches and nectarines do not require a pollinator to fertilize, off-target pollinator impact must also be investigated closely.
2. Additional research is needed on the activity patterns of thrips in nectarine orchards, along with the development of predictive models so proper management strategies can be implemented.

Peach Tree Borer (*Synanthedon exitiosa*)

Pest Information

Damage: The peach tree borer can cause serious damage to cultivated cherry, plum, apricot, peach, nectarine and ornamental shrubs. Larvae feed on the cambium, growing tissues and the inner bark of the tree. Most of the larval activity is confined to the trunk area, from five to seven cm above the soil line to a few centimetres below. Larval feeding may completely girdle and kill young trees. Older trees are less likely to be girdled but are often severely injured, making them susceptible to attack by other insects and diseases.

Life Cycle: The adult clearwing moths, present from mid to late summer, lay eggs on the lower trunk and in cracks in the soil near peach trees. Following egg hatch, the larvae bore into the lower trunk and begin to feed. The larvae overwinter in feeding tunnels, and complete their feeding and pupating in the spring.

Pest Management

Cultural Controls: Painting trunks of young trees with white latex paint reduces their attractiveness to adult peach borers. Removal of other hosts from surrounding orchard blocks and removal of waste wood from orchard trees can reduce infestation levels. Pheromone traps can be used to optimize the timing of sprays. In British Columbia, well defined thresholds are available. Physical control methods which can be used for small plantings include placing a metal cone-shaped collar around the base of the tree before eggs are laid and probing tunnels with a wire or opening the tunnels to find and destroy larvae. Mating disruption technology is available for use under select conditions. Refer to *Table 7* for additional practices used by growers to manage peach tree borers.

Resistant Cultivars: None identified.

Issues for Peach Tree Borer

1. There is a continued need to register effective control products or develop alternate control strategies for use in orchards that are not using mating disruption technology. Controlling damage caused by peach tree borers is the most important management practice to minimize perennial canker infections.
2. There is a need for additional resources to better track peach tree borer populations to accurately time insecticide applications, especially in young orchards where mating disruption is not being used.

Lesser Peach Tree Borer (*Synanthedon pictipes*)

Pest Information

Damage: The lesser peach tree borer attacks peach, plum, sweet cherry, tart cherry, apricot and nectarine. Wild crop hosts include wild black cherry, wild red cherry, beach plum, wild plum and Saskatoon berry. The borer attacks the bark of trunks and branches previously injured by pruning, canker diseases or other insects. Larvae feed on the bark at the margins of the injured area, enlarging the wounded area and often girdling and killing the branch. Trees infested by the borer are more susceptible to perennial canker.

Life Cycle: This pest overwinters as larvae under the bark. After a short period of feeding in the spring, mature larvae move to the bark surface where they pupate and eventually emerge as adult moths. Following mating, female moths lay eggs on injured bark tissues. After egg hatch, larvae enter the bark and begin to feed. There is one generation and sometimes a partial second generation per year. The rate of development of this pest is highly temperature dependent.

Pest Management

Cultural Controls: The removal of wood cut from orchard trees may eliminate a source of continued infestation. Pheromone products related to mating disruption technology are available for use under select conditions. In British Columbia, thresholds based on the number of moths caught per trap per week have been established for insecticide treatments.

Resistant Cultivars: None identified.

Issues for Lesser Peach Tree Borer

1. There is a continuing need to register effective control products or develop alternate control strategies for use in orchards that are not using mating disruption technology. Controlling damage caused by lesser peach tree borers is the most important management practice to minimize perennial canker infections
2. There is a need for additional resources to better track lesser peach tree borer populations to accurately time insecticide applications, especially in young orchards where mating disruption is not being used.

Peach Twig Borer (*Anarsia lineatella*)

Pest Information

Damage: Larvae of the peach twig borer tunnel into buds and new shoots causing them to wilt and die. Larvae of later generations feed on fruit, creating entry holes near the stem. A gummy exudate is produced on damaged fruit and twigs. Host trees include peach, nectarine, apricot, plum and prune.

Life Cycle: Peach twig borer has two generations per year with a partial third generation in some years. Adults are present in May and June and again in late July. Female moths lay eggs on leaves, fruit or twigs and following hatch, larvae feed on plant tissues. Egg hatch of the second generation occurs in late September and larvae feed for a short time before seeking over-wintering sites. Overwintering larvae resume feeding in the spring before pupating and emerging as adults in May.

Pest Management

Cultural Controls: To optimize timing of sprays to control larvae, the flight of male moths can be monitored through the use of pheromone traps. Sprays can also be timed based on the visual examination of developing shoots, buds and fruits. Threshold levels have been established for insecticide treatments based on the number of moths caught per trap per week during the first and the second generations.

Resistant Cultivars: None identified.

Issues for Peach Twig Borer

1. In BC, there is a need to register control products that are compatible with and can be used to support mating disruption programs.

American Plum Borer (*Euzophera semifuneralis*)

Pest Information

Damage: The American plum borer (APB) has an extensive range of hosts, including fruits, ornamentals and forest trees. The number of larvae per tree is correlated with the severity of bark damage. Forty or more larvae observed on a single tree are considered important. The APB's boring activity is most damaging to the scaffold crotches or graft unions of young trees. Vigorous trees will heal over but with heavy, prolonged infestations, scaffolds may break with wind or under a heavy crop load. Damage often goes unnoticed as outer bark usually remains intact. In heavily infested trees, seemingly live bark can be pulled away to reveal many cocoons under its surface.

Life Cycle: APB eggs are laid in small masses in or near the gum caused by bark wounds from mechanical damage, diseases, sunscald or winter injury. Larvae are usually found 1.2 m above ground. Pupae develop within silken cocoons (approx. 11-12 mm long) in frass left under the bark.

Pest Management

Cultural Controls: Latex white paint applied on the tree trunks can deter female moths from laying eggs. Natural enemies may play an important role in reducing APB larval populations. Woodpeckers can feed on larvae throughout the year. Parasitic wasps, predatory insects and spiders also feed on APB.

Resistant Cultivars: None identified.

Issues for American Plum Borer

None identified.

Shothole Borer (*Scolytus rugulosus*)

Pest Information

Damage: The shothole borer attacks peach, pear, apple, cherry and plum, as well as mountain ash. Most damage is caused by larval feeding between the bark and wood of twig, branches and trunks, leading to girdling and death of the affected parts. Adults often attack weakened trees but will attack healthy trees when population numbers are high.

Life Cycle: Shothole borers overwinter as larvae within feeding tunnels of host trees. Adults emerge in April through May. Females bore through the bark and oviposit eggs within individual galleries. Following pupation, adult shothole borers will chew an emergence hole. There are two generations per year.

Pest Management

Cultural Controls: Pruning and destruction of infested or weakened branches and trees may help to eliminate breeding and emergence sites. Avoid planting new orchards near borer-infested trees or wood piles.

Resistant Cultivars: None identified.

Issues for Shothole Borers

1. Additional research is required to determine the distribution of shothole borers in production areas. As well, thresholds need to be established so management strategies can be developed, if necessary.

Ambrosia Beetles: Ambrosia Beetle (*Xyloborus dispar*), Granulate Ambrosia Beetle (*X. crassiusculus*) and Black Stem Borer (*X. germanus*)

Pest Information

Damage: Contrary to other beetles, ambrosia beetles do not digest the woody tissue of host plants. Instead, these beetles have a symbiotic relationship with a group of fungi (*Ambrosiella* spp.) that serve as a food source. Healthy trees will often recover from a light infestation of ambrosia beetles; however, affected trees may exhibit sudden wilting and death, or delayed emergence in spring. Branches and stems of affected trees may wilt and die with larger branches subject to breakage as a result of becoming riddled with galleries. There is also a concern that these beetles could be a vector for pathogens.

Life Cycle: Ambrosia beetles overwinter as adults, emerging in April to mate and lay eggs. Adult females carry spores from the symbiotic fungi and initiate oviposition only after their symbiotic fungus is established within the gallery. The fungus develops a dark mycelial form that can be consumed and a white ambrosial form. The latter consist of conidia and sprout cells, and is only produced in association with the beetles. This form is required for proper development of the larvae and pupae which feed on the ambrosia fungus within the gallery. There are up to two generations per year depending on growing region.

Pest Management

Cultural Controls: There are limited options available for the control of ambrosia beetles in general. Maintaining tree vigour, using latex paint on trunks, and removal of infested trees and branches can reduce infestations. Trap logs can also be used, by placing fresh cut pieces of hardwood logs along the orchard edges. The logs must be removed and destroyed before any new adults emerge. Pruning out infested branches, dead or dying trees and burning or shredding trees to eliminate breeding or emerging sites can help to reduce the problem. Studies using mass trapping or perimeter trapping of ambrosia beetles (ethanol baited traps, freshly cut hardwood logs along borders) showed promise in reducing injury in tree nurseries. Monitoring is important to show when the beetles are migrating to new host trees and to assess when to protect trees from infestations.

Resistant Cultivars: None identified.

Issues for Ambrosia Beetles

1. Additional research is required to determine the distribution of the ambrosia beetle in production areas and to establish thresholds so that management strategies can be developed.

Spring Feeding Caterpillar Complex: Redbanded Leafroller (*Argyrotaenia velutiana*), Variegated Leafroller (*Platynota flavedana*), Fruit-tree Leafroller (*Archips argyrospila*), Eastern Tent Caterpillar (*Malacosoma americanum*), Forest Tent Caterpillar (*M. disstria*), Eyespotted Bud Moth (*Spilonota ocellana*) and LDD Moth (*Lymantria dispar dispar*)

Pest Information

Damage: Caterpillars feed on foliage, blossoms and fruit of peach trees in the spring. Larvae of some species web and roll terminal leaves into a protective covering. Early season feeding on fruit may result in the development of corky scars that expand as the fruit grows.

Life Cycle: Spring feeding caterpillars develop through a number of stages: egg, larva, pupa to adult butterfly or moth. The timing of the life stages differs among species, with some species overwintering as eggs and others as larvae or pupae.

Pest Management

Cultural Controls: These insects are general feeders on a wide variety of broadleaf trees. They tend to be more prevalent on trees towards the outside of the orchard. Monitoring for these insects involves visual examination of new growth.

Resistant Cultivars: None identified.

Issues for Spring Feeding Caterpillars

None identified.

Weeds

Key Issues

- There is a need for registration of broad-spectrum contact herbicides with different modes of action in order to slow or prevent the development of resistance and to mitigate the impacts of glyphosate resistant weed species.
- There is a need to investigate additional pre- and post-emergent herbicides that are safe to use around young plantings in all tree fruit commodities.
- There is a need for the development and assessment of the efficacy, economics and environmental impact of non-chemical methods of weed control such as steam treatment, flaming, electrification, development and use of mulch application, and mechanical weed removal.
- There is a need to survey for new weed species and to screen herbicides for the control of these new species.
- For provincial evaluations of weed occurrence by species, see Table 8

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

Weeds	British Columbia	Ontario
Annual broadleaf weeds		
Annual grass weeds		
Perennial broadleaf weeds		
Perennial grass weeds		
Widespread yearly 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.		

[1]Source: Peach stakeholders in reporting provinces (British Columbia and Ontario). 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 peach 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 peach 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, mowing)				
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: Peach stakeholders in reporting provinces (British Columbia and Ontario); the data reflect the 2020, 2021 and 2022 production years.

Weeds

Pest Information

Damage: A 50 percent reduction in tree trunk diameter may occur in areas where weeds are not controlled. Newly planted trees do not compete well with large annual weeds. New trees will lose a year's growth if competition is intense and can be killed if water or nutrients are a limiting factor. Losses on larger trees manifest as smaller fruit due to competition and in reduced fruit bud set for the next season. Perennial weeds that have been established for several years can become very large and consequently be very competitive. For new peach plantings, the critical period for control is during May and June. For bearing trees, the critical period is from bud-break until 30 days after bloom. The critical weed-free period means that no yield reduction will result if the crop is kept free of weeds during that time. Weeds emerging after that period will not affect yield, however, control efforts at that time will help make harvest more efficient and reduce weed problems in subsequent years.

Life Cycle: Annual weeds complete their life cycle in one year, from seed germination through vegetative growth and flowering, and then to seed production. Many weeds in fruit crops are winter annuals; plants that begin their growth in the fall and flower the following growing season. Spring annual weeds germinate in the early spring, grow during May and June and produce seeds in the summer for germination the following year. Annual weeds are very successful at reproducing from seeds. They produce large numbers of seeds, some of which remain viable in the soil for many years, germinating when conditions are right. Biennial weeds germinate in the spring and remain vegetative during the first summer. They over-winter as rosettes and then in the second growing season they bolt, sending up a flower stock on which seeds are produced. The original plants die at the end of the second growing season. Perennial weeds are plants that live for many years. They spread through the expansion of various types of root systems and other vegetative means as well as by seeds.

Pest Management

Cultural Controls: The management of surrounding fields, ditches and lanes by regular cultivation, fallowing and/or mowing to prevent flowering of weeds helps keep the weed seed bank lower in the soil. The use of a clean, seed-free source of mulch and manure prevents the introduction of additional seeds and new species. A green manure crop, combined with fallow periods, can stimulate weed seed germination and deplete the weed seed bank contained in the soil. Site preparation may also involve planting a green manure crop such as rye-grass or Sudan grass the year before planting the orchard and using non-selective herbicides for broadleaf weeds in the green manure cropping system. Biodegradable plastic mulch or straw mulch can be used to cover the soil. Establishing sod cover the year before planting and then planting into the sod after termination, will reduce the need for herbicides in the year of planting. Weed whippers and mowers that cut close to the trees without injury are helpful but mowing on its own will not completely eliminate weed competition. The establishment of a vigorous sod growth between tree rows will reduce weed pressure. Hand removal of new weed species or resistant biotypes may be an important method of preventing them from becoming established. Refer to *Table 9* for practices used by growers in Canada for the management of weeds.

Issues for Weeds

1. There is a need for registration of broad-spectrum contact herbicides with different modes of action in order to slow or prevent the development of resistance and to mitigate the impacts of glyphosate resistant weed species.
2. New conventional and non-conventional weed management options are required to offer growers new chemical groups for resistance management. New biological weed control products should have all tree fruit crops added to the first label.
3. There is a need for the development and assessment of the efficacy, economics and environmental impact of non-chemical methods of weed control in peaches such as steam treatment, flaming, electrification, development and use mulch application and mechanical weed removal.
4. There is a need to investigate additional pre- and post-emergent herbicides that are safe to use around young plantings in all tree fruit commodities.
5. There is a need to survey for new weed species and to screen herbicides for the control of these new species.

Resources

Integrated Pest Management & Integrated Crop Management Resources for Peach Production in Canada

British Columbia Ministry of Agriculture. Tree Fruits Information on identification and management of insect and mite pests and plant diseases of tree fruit crops in British Columbia: Insects and Mites. https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/tree-fruits

British Columbia Ministry of Agriculture. BC Tree Fruit Production Guide. https://www.bctfpg.ca/

British Columbia Ministry of Agriculture. BC Tree Fruit Production Guide: Integrated Pest Management. https://www.bctfpg.ca/ifp-organics/integrated-pest-management/

Ontario Ministry of Agriculture, Food and Rural Affairs. Publication 360D, Crop Protection Guide for Tender Fruit. 2021. http://omafra.gov.on.ca/english/crops/pub360/pub360D.pdf

Ontario Ministry of Agriculture, Food and Rural Affairs. Ontario CropIPM. www.omafra.gov.on.ca/IPM/english/index.html

Provincial Contacts

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	AgriService BC www2.gov.bc.ca/gov/content/industry/agriservice-bc		Caroline Bédard Caroline.Bedard@gov.bc.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca	Kathryn Carter Kathryn.Carter@ontario.ca	Joshua Mosiondz Joshua.Mosiondz@ontario.ca

National and Provincial Fruit Grower Organizations

British Columbia Fruit Growers Association: www.bcfga.com

BC Tree Fruits: www.bctreefruits.com

Canadian Federation of Agriculture: www.cfa-fca.ca

Canadian Organic Growers: cog.ca

Fruit and Vegetable Growers of Canada: fvgc.ca

Nova Scotia Fruit Growers' Association: www.nsfga.com

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

Ontario Tender Fruit Growers: www.ontariotenderfruit.ca

Appendix 1

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

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

<table>
<tr><th>Presence</th><th colspan="4">Occurrence information</th><th>Colour Code</th></tr>
<tr><td rowspan="11">Present</td><td rowspan="9">Data available</td><td>Frequency</td><td>Distribution</td><td>Pressure</td><td></td></tr>
<tr><td rowspan="3">**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="3">**Sporadic** - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="2">**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>Grey</td></tr>
</table>

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