# Crop Profile for Peach in Canada, 2016

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# Preface

National crop profiles are developed by the Pest Management Program of Agriculture and Agri-Food Canada (AAFC). The national crop profiles provide baseline information on crop production and pest management practices and document the pest management needs and issues faced by growers. This information is developed through extensive consultation with stakeholders.

Information on pest management practices and pesticides is provided for information purposes only. No endorsement of any pesticide or pest control technique here discussed is implied. Product names may be included and are meant as an aid for the reader, to facilitate the identification of pesticides in general use. The use of product names does not imply endorsement of a particular product by the authors or any of the organizations represented in this publication.

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.

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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# Crop Profile for Peach in Canada

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. Grown since the 1700's, peaches and nectarines produced in Ontario and British Columbia are primarily for fresh consumption.

The nectarine, *Prunus persica* is a closely related fruit. 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 pubescence (fuzzy skin). Throughout this document, all descriptions, practices, growth stages and activities refer to both peaches and nectarines unless otherwise stated.

There are two main types of peaches: semi-freestone peaches, so called because the flesh tends to adhere partially to the stone, have a firmer texture and can be consumed fresh or for canning, and freestone peaches, generally consumed fresh, in which the stone does not adhere to the flesh.

Peaches and nectarines are low in calories, fat and sodium and contain vital nutrients. Peaches are also high in vitamins A, B and C and potassium.

# Crop Production

## *Industry Overview*

In 2016, total fresh and processed peach production, including nectarines, ranked 7th in farm gate production value among all fruits grown in Canada. Total farm gate value for peaches, including nectarines reached $40.5 Million for the country.

Canadian exports of fresh peaches, including nectarines were $0.4 Million and processed peach were $1.5 Million.

In Ontario, many varieties of semi-freestone peaches are available including Harrow, Diamond, Garnet Beauty. Among freestone peaches, varieties include Redhaven, Vivid, Harbite, Harson, Blazingstar and nectarine varieties include Fantasia and Harblaze.

**Table 1. General production information, 2016**

| | Peach | Nectarine |
|---|---|---|
| **Canadian Production[1]** | 22,031 metric tonnes<br>2,664 hectares | 4,097 metric tonnes<br>336 hectares |
| **Farm gate value[1]** | $32.8 Million | $7.7 Million |
| **Fruit consumption[2]** | 1.15 kg/ person (fresh)<br>0.67 kg/ person (canned) | 0.66 kg/ person (fresh)<br>N/A (canned) |
| **Exports** | Peach (fresh, including nectarines[3]): $0.44 Million<br>Peach (not else specified, processed[4]): $1,5 Million | |
| **Imports** | Peach (fresh, including nectarines[3]): $105.5 Million<br>Peach (not else specified, processed[4]): $39.8 Million | |

[1] Source: Statistics Canada. Table 32-10-0364-01 (formerly CANSIM 001-0009) - Area, production and farm gate value of fresh and processed fruits in Canada, Annual (Database accessed: 2018-07-27).
[2] Source: Statistics Canada. Table 32-10-0054-01 (formerly CANSIM 002-0011) - Food available in Canada, Annual (Database accessed: 2018-07-27).
[3] Source: Statistics Canada. Trade Data Online (Report). HS # 080930: Peaches (including nectarines) - Fresh (Database accessed: 2017-07-27).
[4] Source: Statistics Canada. Trade Data Online (Report). HS # 200870: Peaches (Not else specified - Prepared, Whether or not sugared, Sweetened or spirited (Database accessed: 2017-07-27).

## *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, see Table 2. There are also small areas of production in Nova Scotia. Ontario led Canada in both peach and nectarine production with 71 and 74 per cent of the national production of peach and nectarine, respectively (Table 2).

**Table 2. Distribution of peach production by province, 2016**

| Production Regions | Cultivated area[1] (hectares) and percentage (%) | Marketed production[1] (metric tonnes) and percentage (% ) | Farm gate value[1] ($) |
|---|---|---|---|
| **British Columbia** | | | |
| **Peach** | 522 ha (20%) | 6,309 m. t. (29%) | $8.2 Million |
| **Nectarine** | 63 ha (19%) | 1,078 m. t. (26%) | $1.6 Million |
| **Ontario** | | | |
| **Peach** | 2,117 ha (80%) | 15,595 m. t. (71%) | $24.4 Million |
| **Nectarine** | 273 ha (81%) | 3,019 m. t. (74%) | $6.1 Million |
| **Nova Scotia** | | | |
| **Peach** | 25 ha (1) | 127 (<1%) m. t. | $0.2 Million |
| **Nectarine** | x | x | x |
| **Canada** | | | |
| **Peach** | 2,664 ha | 22,031 m. t. | $32.8 Million |
| **Nectarine** | 336 ha | 4,097 m. t. | $7.7 Million |

x : suppressed to meet the confidentiality requirements of the Statistics Act.

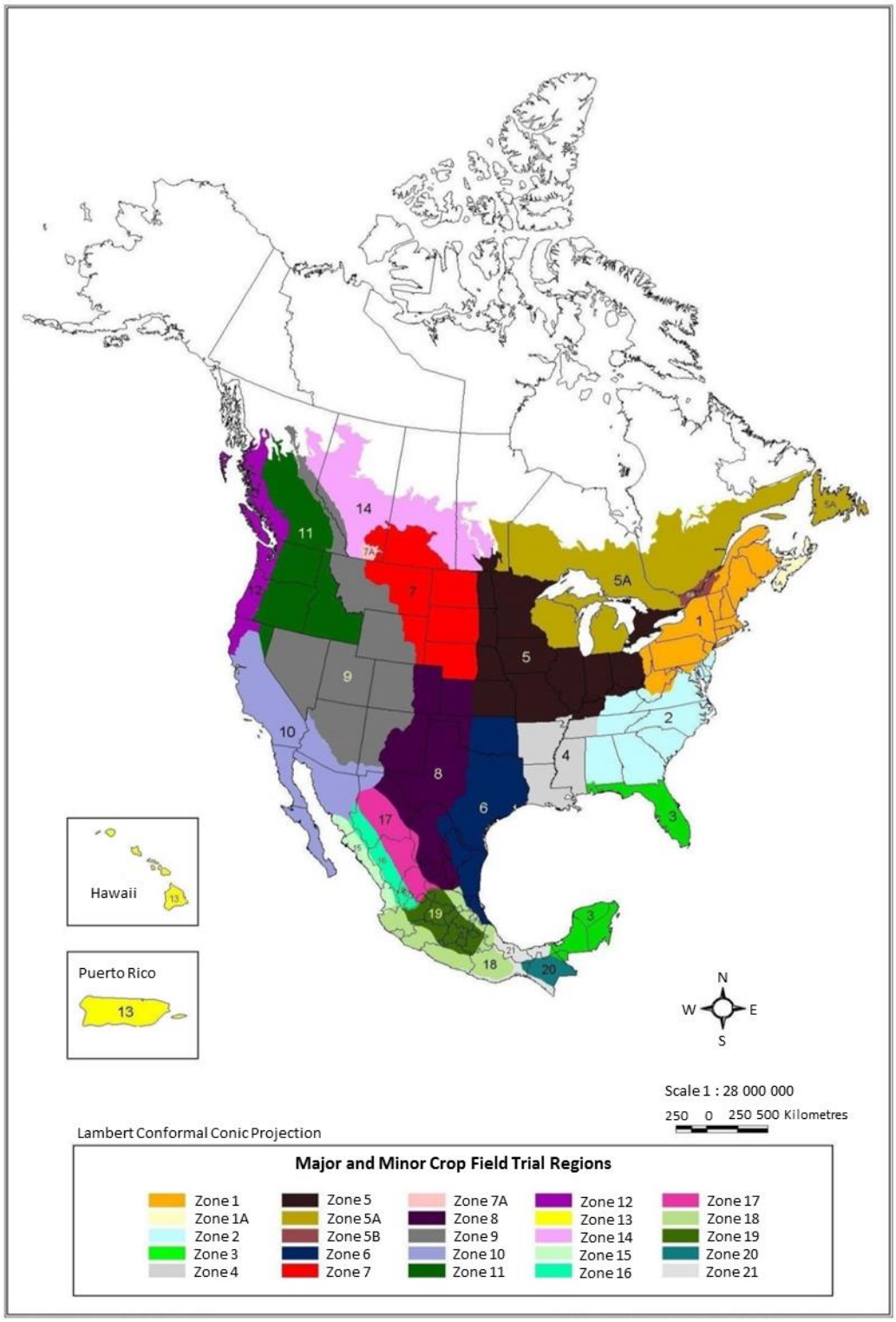
[1] Source: Statistics Canada. Table 32-10-0364-01 (formerly CANSIM 001-0009) - Area, production and farm gate value of fresh and processed fruits, by province. Annual (Database accessed: 2018-07-27).

[2] Source: Statistics Canada. Trade Data Online (Report). HS # 080930-Peaches, including nectarines - Fresh; HS # 200870-Peaches, not else specified - Prepared, whether or not sugared, sweetened or spirited (Database accessed: 2018-07-27).

## *North American major and minor field trial regions*

Major and minor crop field trial regions (Figure 1), are used by the Pest Management Regulatory Agency (PMRA) in Canada and the United States (US) Environmental Protection Agency (EPA) to identify the regions where residue chemistry crop field trials are required to support the registration of new pesticide uses. The regions are based on a number of parameters, including soil type and climate but they do not correspond to plant hardiness zones. For additional information, on field trial regions and requirements, please consult the PMRA Regulatory Directive 2010-05 *Revisions to the Residue Chemistry Crop Field Trial Requirements* (www.hc-sc.gc.ca/cps-spc/pubs/pest/_pol-guide/dir2010-05/index-eng.php).

**Figure 1. Common zone map: North American major and minor field trial regions[1]**




[1]Produced by: Spatial Analysis and Geomatics Applications, Agriculture Division, Statistics Canada, February 2001

## *Cultural Practices*

Peaches grow best on sites that are protected from spring frosts and in deep, well-drained, sandy loam soil. Slopes of about four to eight percent which allow good air exchange and surface water run-off during heavy rains and have the greatest exposure to the sun are the most suitable planting sites. Since peaches grown in Canada are at the northern limit of production, sites are typically located within three to four kilometres of a body of water, for temperature moderation and protection against frost and extreme cold during the winter. Properly designed wind breaks are also used to reduce winter damage and raise temperatures. Peach trees grown on standard Bailey rootstock normally produce commercial crops for 15 to18 years. 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 6.5.

Land preparation for a peach or nectarine orchards includes installing tile drainage, since peach trees cannot tolerate wet soils. Sites are ploughed in the fall, cultivated, soil amendments added and sites 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. Before planting, crown or root galls are pruned off. Standard rootstocks are used and densities are normally 496 trees per ha (201 trees per acre) with a 5.5 by 3.7 m (18 x 12 feet) spacing. Trees are typically branched when planted, but are pruned to 1.2-1.5 m (4-5 feet) height with about six to ten shoots which have two to three buds each.

Successful pollination is essential to achieve good fruit quality. However, 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 the late fall or early spring. Excess nitrogen leads to poor fruit colour and poor storage quality and should be avoided. Fertigation (the addition of fertilizer to irrigation water) is a method of growing interest and is a research area for tree fruit production.

Irrigation is critical for peaches during the growing season (April to July). After harvest, trees are thoroughly watered before being allowed to dry-out for the winter. 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 (up to 8 feet) to pick fruits on mature trees.

## Table 3. Peach production and pest management schedule in Canada

| Time of year[1,2] (growth stage) | Activity | Action[3] |
|---|---|---|
| November 15 – March (dormant) | Plant care | Removal of dead or damaged trees. Orchard renewal and renovation planning. |
| | Disease management | Prune out branches with peach (cytospora) canker. |
| | Other | Monitor for vertebrate pests and control as needed. |
| Early – mid April (swollen bud) | Insect and mite management | Spray for scale and European red mite; use of dormant oil. |
| | Disease management | Monitor bud development and initiate peach leaf curl control. |
| Mid – late April (bud burst - 1/2 inch green tip) | Plant care | Fertilizer application, pruning, irrigation. |
| | Disease management | Monitor for powdery mildew, peach leaf curl, coryneum blight and brown rot; apply controls as needed. |
| | Weed management | Mow and maintain orchard alleyways; herbicide application. |
| May 1 – mid May (pink - petal fall, first new leaves open) | Plant care | Pruning, cultivation, brush removal. |
| | Disease management | Monitor for powdery mildew, peach leaf curl, coryneum blight and blossom blight; apply bloom time products as appropriate. |
| | Insect and mite management | Monitor for peach twig borer, leafrollers, fruitworms, mites, aphids, lygus bugs and beneficial organisms; apply controls as needed. |
| | Weed management | Maintain orchard alleyways; monitor for weeds and apply controls as needed. |
| | Other | Monitor for vertebrate pests and control 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 appropriate<br>Begin peach scab protection program if there is history of this 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 and mite management | Monitor for spotted wing drosophila, peach tree borer, leafrollers, mites, aphids and other insects; apply controls as needed. |
| Mid-August to end September (fruit maturation harvest) | Disease management | Treat harvested fruit for brown rot and rhizopus rot as needed. |
| | Insect and mite management | Apply pre-harvest treatments focussed on oriental fruit moth (Ontario) |
| | Other | Hand harvest, grading and packing; irrigation only if very dry. |

… continued

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

| Time of year[1,2] (growth stage) | Activity | Action[3] |
|---|---|---|
| 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 and peach leaf curl. |
| | Weed management | Monitor for weeds and apply controls if needed. |
| | Other | Monitor for vertebrate pests and control as needed. |

[1]The calendar of events as listed in Table 3 are for Ontario unless otherwise indicated. For British Columbia, the season is often 2 to 3 weeks ahead of Ontario.

[2]Dates are only averages and may vary depending upon weather conditions and site.

[3]Spray schedule will vary with temperature and precipitation.

# *Abiotic Factors Limiting Production*

## Temperature

In Canada, peaches and nectarines can be produced commercially in only 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

- There is concern about potential loss of older broad-spectrum fungicides (e.g. captan, chlorothalonil and select EBDC's) that are under re-evaluation by PMRA. The loss of these products will leave few options available for management of coryneum blight and peach leaf curl, and these older chemistries are also critical for resistance management programs for brown rot in stone fruits.

- There is a need for the registration of additional multi-site materials for improved fungicide rotations and resistance management.

- While many fungicides work best as protectants, there is a need to develop monitoring techniques and economic thresholds, and to investigate proper timing and /or combinations of sprays, to optimize management of brown rot, peach scab, peach leaf curl and powdery mildew. Prediction models for powdery mildew are also needed.

- Bacterial diseases cause serious damage in peach production and can result in premature decline of orchards. There is a need for registration of effective disease management products for bacterial spot and bacterial canker.

- Peach varieties with resistance to peach canker and plum pox virus are needed, as these will form the cornerstone of integrated disease management programs for these diseases.

- 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.

- There is a need for more organic/ biological-based pesticides to protect against blossom blight and brown rot in peaches, given the growing organic production in Ontario.

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

| Disease | British Columbia | Ontario |
|---|---|---|
| Brown rot | | |
| Bacterial spot | | |
| Peach scab | | |
| Peach leaf curl | | |
| Powdery mildew | | |
| Bacterial canker | | |
| Peach (perennial canker) | | |
| 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 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 importance. |
| Pest not present. |
| Data not reported. |

[1]Source: Peach stakeholders in reporting provinces (British Columbia and Ontario). The data reflect the 2014, 2015 and 2016 production years.

[2]Refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

**Table 5. Adoption of disease management practices in peach production in Canada[1]**

| Practice / Pest | | Brown rot | Powdery mildew | Peach scab | Perennial canker | Peach leaf curl |
|---|---|---|---|---|---|---|
| Avoidance | Varietal selection / use of resistant 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 or 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 | | | | | |
| | Use of precision agriculture technology (GPS, GIS) for data collection and mapping of diseases | | | | | |

… continued

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

| Practice / Pest | | 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 | | | | | |
| | 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 | | | | | |
| New practices (by province) | Timing of pruning (Ontario) | | | | | |

**This practice is used to manage this pest by at least some growers.**

**This practice is not used by growers to manage this pest.**

**This practice is not applicable for the management of this pest.**

**Information regarding the practice for this pest is unknown.**

**[1]Source: Peach stakeholders in reporting provinces (British Columbia and Ontario). The data reflect the 2014, 2015 and 2016 production years.**

## Brown Rot *(Monilinia fructicola)*

### *Pest Information*

*Damage*: The brown rot fungus also 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*: *M. 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 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.

*Resistant Cultivars*: Some varieties, including Babygold 5 and 7, Veecling and Harrow Diamond, are more susceptible than others.

### *Issues for Brown Rot*

1. Resistance to fungicides is an ongoing concern. Currently in Ontario, there is a heavy reliance on two classes of fungicides (groups 3 and 7) for which there is the potential for resistance development by the brown rot pathogen.
2. Additional cost-effective rotational materials are needed to allow for improved resistance management.
3. There is concern about losing older broad-spectrum fungicides (e.g. captan, chlorothalonil) that are under re-evaluation by PMRA. These older chemistries are critical for resistance management programs for brown rot in stone fruit.
4. 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 severely devitalize trees by defoliation and reduces 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. Affected peaches may be rejected by processors.

*Life Cycle*: Bacterial spot is of most concern in regions with annual rainfall greater than 50 cm. The disease 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 help 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. There is a need for the development and registration of bactericides for the control of bacterial spot. Growers are concerned about the potential for rejection of affected fruit by processors.
2. Recent research in Ontario and Pennsylvania is indicating that potassium silicate, summer copper sprays (specifically copper octanoate), and a *Bacillus subtilis* based product are potentially effective materials in reducing the infection rate of bacterial spot. Additional research is required to determine the best usage pattern should these materials become available for use in peach and nectarine production.

## Coryneum Blight *(Wilsonomyces carpophilus)*

### *Pest Information*

*Damage*: The 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.

## Peach Scab *(Cladosporium carpophilus)*

### *Pest Information*

*Damage*: Numerous, grey-green spots, about 2 to 3 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 rain splashed to fruit, foliage and growing twigs where they 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.

*Resistant Cultivars*: None identified.

### *Issues for Peach Scab*

1. There is a need for further studies on the biology of the pathogen under Ontario conditions and on cultivar susceptibility as there has been an increase in the prevalence of peach scab in Ontario orchards over the past three to four years.

## 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 leaf 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 ($10^{o}$ to $21^{o}$ C) and wet (>95% 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.

*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. Further studies on the use of fungicides for the management of peach leaf curl, including application timings, numbers of applications and product selection are needed.
3. The registration of new fungicides is required.
4. There is a concern that following the re-evaluation of chlorothalonil materials (e.g. Bravo/ Echo), there will be limited effective fungicide options for growers to target peach leaf curl.

## Powdery Mildew *(Podosphaera pannosa)*

### *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, with the surface becoming leathery and hard. As the fruit matures, it becomes more resistant to the fungus.

*Life Cycle*: Powdery mildew 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.

*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 the management of powdery mildew and for resistance management.
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.
3. 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 cherries, peach 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 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.

*Control Products*: There are no products registered for the control of bacterial canker on peach.

### *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 cincta* & *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 symptoms of 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 and wounds. 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.

*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 & borer control) to reduce the occurrence of perennial canker infections.

## 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 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/ green manure crops can reduce inoculum levels. Orchards should not be planted where susceptible crops have been planted previously. 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*

1. With the practice of planting low growing crops between the rows in young peach orchards becoming more popular, studies are required to determine whether some inter-planted crops (tomato, pepper, eggplant, strawberry or melon) can increase the potential for verticillium wilt in peaches.

## Crown Gall *(Agrobacterium tumefaciens)*

### *Pest Information*

*Damage*: The pathogen induces the formation of galls on the surface of roots or crown. 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 the roots and crown tissues. Peach, apricot, nectarine 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. spreads 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*

1. The development of a strategy for the management of trees affected by phytophthora root and crown rot is required.

## 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. PPV does not kill trees but can severely reduce yield and affect fruit quality. Disease symptoms can vary with host species and cultivars. 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*: PPV 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 (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. The screening and compensation program being conducted by the Canadian Food Inspection Agency (CFIA) and AAFC ended in 2016. There is a need for continued and routine monitoring of visual PPV symptoms in commercial orchards to quickly identify and properly manage potentially infected trees. There is a need to develop varieties resistant to plum pox virus as well as to develop a certified virus-free clean stock program.

## Rhizopus Rot (*Rhizopus* spp.)

### *Pest Information*

*Damage*: The disease causes a soft rot on 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 many peaches 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 entries 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 $^{o}$C.

### *Pest Management*

*Cultural Controls*: Storing fruit below 4$^{o}$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*

None identified.

## *Fungicides, bactericides and biofungicides registered for disease management in peach production in Canada*

Active ingredients registered for the management of **diseases** in peach are listed below in Table 6 *Fungicides, bactericides and biofungicides registered for disease management in* peach *production in Canada*. This table also provides registration numbers for products registered on peach containing these active ingredients in addition to information about chemical family and regulatory status. For guidance about active ingredients registered for specific **diseases**, the reader is referred to individual product labels on the PMRA label database https://www.canada.ca/en/health-canada/services/consumer-product-safety/pesticides-pest-management.html and to provincial crop production guides.

**Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Target Site[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|---|
| *Agrobacterium radiobacter*, strain K84 | 21106 | biological | N/A | unknown | unknown | R |
| *Bacillus subtilis*, strain QST 713 | 28549, 31666, 33035 | microbial: *Bacillus* spp. and the fungicidal lipopeptides they produce | 44 | F6: lipid synthesis and membrane integrity | microbial disrupters of pathogen cell membranes | R |
| BLAD polypeptide | 31782, 32139 | polypeptide (lectin) | BM01 | BM: biologicals with multiple modes of action | BM: multiple effects on cell wall, ion membrane transporters; chelating effects | R |
| boscalid | 30141 | pyridine-carboxamide | 7 | C2: respiration | complex II: succinate-dehydrogenase | R |
| boscalid + pyraclostrobin | 27985 | pyridine-carboxamide + methoxy-carbamate | 7 + 11 | C2: respiration + C3: respiration | complex II: succinate-dehydrogenase + complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) | R + R |
| canola oil | 32408 | diverse | N/C | not classified | unknown | R |
| captan | numerous products | phthalimide (electrophile) | M04 | multi-site contact activity | multi-site contact activity | R (RVD2018-12) |

…continued

**Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Target Site[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|---|
| chloropicrin (pre-plant soil fumigant) | 25863, 28715 | chloropicrin[4] | 8B[4] | miscellaneous non-specific (multi-site) inhibitor[4] | miscellaneous non-specific (multi-site) inhibitor[4] | R (REV2017-04, RVD2018-30) |
| chlorothalonil | 15723, 28900, 29225, 29306, 29355, 29356 | chloronitrile (phthalonitrile) | M | multi-site contact activity | multi-site contact activity | R (RVD2018-11) |
| copper hydroxide | 25901 | inorganic (electrophile) | M01 | multi-site contact activity | multi-site contact activity | R |
| copper octanoate | 31825 | inorganic (electrophile) | M01 | multi-site contact activity | multi-site contact activity | R |
| copper (present as copper oxychloride) | 13245, 19146 | inorganic (electrophile) | M01 | multi-site contact activity | multi-site contact activity | R |
| copper (present as copper sulphate) | 9934 | inorganic (electrophile) | M01 | multi-site contact activity | multi-site contact activity | R |
| cyprodinil | 25509 | anilino-pyrimidine | 9 | D1: amino acids and protein synthesis | methionine biosynthesis (proposed) (cgs gene) | RE |
| dodine | 28351 | guanidine | U12 | unknown mode of action | cell membrane disruption (proposed) | R |
| fenbuconazole | 27294 | triazole | 3 | G1: sterol biosynthesis in membranes | C14-demethylase in sterol biosynthesis (erg11/cyp51) | R |
| fenhexamid | 25900 | hydroxyanilide | 17 | G3: sterol biosynthsis in membranes | 3-keto reductase, C4-demethylation (erg27) | RE |
| ferbam | 20136, 20536 | dithiocarbamate and relatives (electrophile) | M03 | multi-site contact activity | multi-site contact activity | RE |

…continued

**Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Target Site[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|---|
| fludioxonil | 29528 | phenylpyrrole | 12 | E2: signal transduction | MAP/histidine- kinase in osmotic signal transduction (os-2, HOG1) | R (RVD2018-04) |
| fluopyram (nematicide) | 30509 | pyridinyl-ethyl-benzamide | 7 | C2: respiration | complex II: succinate-dehydrogenase | R |
| fluopyram + trifloxystrobin | 32107 | pyridinyl-ethyl-benzamide + oximino-acetate | 7 + 11 | C2: respiration + C3: respiration | complex II: succinate-dehydrogenase + complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) | R |
| fluxapyroxad | 30562, 30565, 31697 | pyrazole-4- carboxamide | 7 | C2: respiration | complex II: succinate-dehydrogenase | R |
| iprodione | 15213, 24709 | dicarboximide | 2 | E3: signal transduction | MAP/ histidine-kinase in osmotic signal transduction (os-1, Daf1) | R (RVD2018-16) |
| isofetamid | 31758 | phenyl-oxo-ethyl thiophene amide | 7 | C2: respiration | complex II: succinate-dehydrogenase | R |
| lime sulphur (calcium polysulphide) | 16465 | inorganic | M02 | multi-site contact activity | multi-site contact activity | R |

…continued

**Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Target Site[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|---|
| metconazole | 30401, 30402, 33081 | triazole | 3 | G1: sterol biosynthesis in membranes | C14-demethylase in sterol biosynthesis (erg11/cyp51) | R |
| methyl bromide | 9564, 19498 | alky halide[4] | 8A[4] | miscellaneous non-specific (multi-site) inhibitor[4] | miscellaneous non-specific (multi-site) inhibitor[4] | PO[5] |
| metrafenone | 29765 | benzophenone | U8 | unknown | actin disruption (proposed) | R |
| myclobutanil | 22399 | triazole | 3 | G1: sterol biosynthesis in membranes | C14-demethylase in sterol biosynthesis (erg11/cyp51) | R |
| oriental mustard seed meal (oil) (*Brassica juncea*) | 30263 | diverse | N/C | not classified | unknown | R |
| penthiopyrad | 30331 | pyrazole-4-carboxamide | 7 | C2: respiration | complex II: succinate-dehydrogenase | R |
| potassium bicarbonate | 28095, 31091 | diverse | N/A | not classified | unknown | R |
| propiconazole | numerous products | triazole | 3 | G1: sterol biosynthesis in membranes | C14- demethylase in sterol biosynthesis (erg11/cyp51) | R |
| pyraclostrobin | 27323 | methoxy-carbamate | 11 | C3: respiration | complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) | R |

…continued

**Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Target Site[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|---|
| quinoxyfen | 29755 | aryloxyquinoline | 13 | E1: signal transduction | signal transduction (mechanism unknown) | R |
| *Reynoutria sachalinensis* (extract) | 30199 | complex mixture, ethanol extract (anthraquinones resveratrol) | P05 | P5: host plant defence induction | anthraquinone elicitors | R |
| sulphur | 873, 14653, 16249, 16465, 18836, 29487, 31869, 32475 | inorganic (electophiles) | M02 | multi-site contact activity | multi-site contact activity | R |
| thiophanate-methyl | 12279, 25343, 27297, 31784, 32096 | thiophanate | 1 | B1: cytoskeleton and motor proteins | ß-tubuline assembly in mitosis | RE |
| thiram | 27556, 28220, 30548 | dithiocarbamate and relatives (electrophile) | M03 | multi-site contact activity | multi-site contact activity | RE |
| trifloxystrobin | 27527, 30427, 30619 | oximino-acetate | 11 | C3: respiration | complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) | R |
| triforine | 27686 | piperazine | 3 | G1: sterol biosynthesis in membranes | C14-demethylase in sterol biosynthesis (erg11/cyp51) | RE |

…continued

**Table 6. Fungicides and biofungicides registered for disease management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Target Site[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|---|
| ziram | 29140, 29685 | oximino-acetate | 11 | C3: respiration | complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) | R |

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). **The list includes all active ingredients registered as of October 11, 2018.** While every effort has been made to ensure all fungicides, bactericides and biofungicides registered in Canada on peach have been included in this list, some active ingredients or products may have been inadvertently omitted. 'Numerous products' is entered where there are more than ten products registered for an active ingredient. Not all end-use products containing a particular active ingredient may be registered for use on this crop. The product label is the final authority on pesticide use and should be consulted for application information. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Fungicide Resistance Action Committee. *FRAC Code List 2018: Fungicides sorted by mode of action (including FRAC code numbering).* February 2018. (www.frac.info/) (accessed August 20, 2018).

[3]PMRA re-evaluation status as published in Re-evaluation Note REV2018-06, Pest Management Regulatory Agency Re-evaluation and Special Review Work Plan 2018-2023 and other re-evaluation documents: R - full registration, RE (yellow) - under re-evaluation, RES (yellow) - under special review and RES* (yellow) - under re-evaluation and special review. Other codes include: DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA.

[4] Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 8.4; May 2018)* (excluding pheromones) (www.irac-online.org) (accessed August 23, 2018).

[5]As published by Government of Canada: *Notice to anyone engaged in the use of methyl bromide: June 2017 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/notice-use-methyl-bromide-june-2017.html*

## Insects and Mites

### Key issues

- The spotted wing drosophila (SWD) is a serious threat to all stone fruit crops. Permanent registrations of products currently available only through emergency use registrations are required for management of this pest. Additional research to discover and develop sustainable, long-term management strategies which are compatible with integrated pest management (IPM) programs is needed.

- There are concerns over the potential development of resistance to insecticides used for the management of a number of orchard pests including oriental fruit moth, plum curculio and obliquebanded leafroller. There is a need for the registration of alternative products with different modes of action and for continued education of growers regarding the proper timing of applications and need for rotation of products.

- Mating disruption approaches have been developed and are increasingly being used for management of pests including oriental fruit moth, obliquebanded leafroller and peach tree borers. There is a need for additional pest management tools, including monitoring and decision support tools and IPM compatible insecticides, to support and complement these mating disruption programs.

- There is a concern about the widespread use of mating disruption-based IPM programs may result in increased pest pressure from aphids, tarnished plant bug and San Jose scale. There is a need for the development of robust IPM strategies including monitoring, economic thresholds and both cultural and biological controls to address these pests.

- 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. Research is also needed to develop better monitoring methods and an economic threshold for peach silver mite.

- Pest management research into control strategies and orchard monitoring protocols for brown marmorated stink bug (BMSB) must be in place prior to this pest becoming a problem in commercial orchards. Permanent registrations of products currently available only through emergency use registrations are required for predictable access to control options for this pest.

…continued

### *Key issues (continued)*

- There is a need for the registration of products for the control of Comstock mealybug. There are concerns that this pest is a major vector of plant viruses in tree fruit and grapes and so careful monitoring and management of this pest is necessary for the on-going sustainability of different locally grown crops.

- It is important that both peach and nectarine be considered for new pesticide registrations.

## Table 7. Occurrence of insect and mite pests in peach production in Canada[1,2]

| Insect | British Columbia | Ontario |
|---|---|---|
| Oriental fruit moth | | |
| Plum curculio | | |
| Green peach aphid | | |
| Brown marmorated stinkbug | | |
| Tarnished plant bug | | |
| Mites | | |
| European red mite | | |
| Two-spotted spider mite | | |
| Peach silver mite | | |
| Comstock mealybug | | |
| San Jose scale | | |
| Japanese beetle | | |
| Oblique-banded leafroller | | |
| European earwig | | |
| Spotted wing drosophila | | |
| Western flower thrips | | |
| Borers | | |
| (Greater) peach tree borer | | |
| Lesser peach tree borer | | |
| Peach twig borer | | |
| American plum borer | | |
| Shothole borer | | |
| Ambrosia beetle | | |
| Spring feeding caterpillar complex | | |
| Red-banded leafroller | | |
| Variegated leafroller | | |
| Fruit tree leafroller | | |
| Eastern tent caterpillar | | |
| Forest tent caterpillar | | |
| Eyespotted bud moth | | |
| Gypsy 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 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 importance.

Pest not present.

Data not reported.

[1]Source: Peach stakeholders in reporting provinces (British Columbia and Ontario). The data reflect the 2014, 2015 and 2016 production years.

[2]Refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

**Table 8. Adoption of insect pest management practices in peach production in Canada[1]**

| Practice / Pest | | 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 and transplants) | | | | | |
| **Prevention** | Equipment sanitation | | | | | |
| | Canopy management (thinning, pruning, row or plant spacing, etc.) | | | | | |
| | Manipulating seeding / planting depth | | | | | |
| | Irrigation management (timing, duration, amount) to manage plant growth | | | | | |
| | Management of soil moisture (improvements in 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 / volunteers / wild plants) in field and vicinity | | | | | |
| **Monitoring** | Scouting / trapping | | | | | |
| | Maintaining records to track pests | | | | | |
| | Soil analysis for pests | | | | | |
| | Weather monitoring for degree day modelling | | | | | |
| | Use of precision agriculture technology (GPS, GIS) for data collection and mapping of pests | | | | | |

…continued

**Table 8. Adoption of insect pest management practices in peach production in Canada[1] (continued)**

| Practice / Pest | | Oriental fruit moth | Green peach aphid | Tarnished plant bug | Peach tree borer | Spotted wing drosophila |
|---|---|---|---|---|---|---|
| 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 | | | | | |
| | 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, etc.) | | | | | |
| | Mating disruption through the use of pheromones | | | | | |
| | Mating disruption through the release of sterile insects | | | | | |
| | Trapping | | | | | |
| | Targeted pesticide applications (banding, variable rate sprayers, spot treatments, etc.) | | | | | |
| | 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.**

**This practice is not used by growers to manage this pest.**

**This practice is not applicable for the management of this pest.**

**Information regarding the practice for this pest is unknown.**

**[1]Source: Peach stakeholders in reporting provinces (British Columbia and Ontario). The data reflect the 2014, 2015 and 2016 production years.**

## Oriental Fruit Moth (*Grapholita molesta*)

### *Pest Information*

*Damage*: Oriental fruit moth (OFM) larvae enter the terminal 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% of the total crop infested at harvest.

*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 peach, nectarine, plum, apple, cherry, apricot, pear and quince. Overwintered adult beetles attack fruit soon after it forms, making holes through the skin and feeding on the pulp next to the pit. Feeding adults cause the formation of bumps on the fruit. 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 the 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. There is a need for the registration of products which are not harmful to insect pollinators for the control of plum curculio.
2. Research is needed to develop better attractant lures so trapping methods can be more efficiently used to aid in early warning and timing of sprays.

## 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 prevents aphids from developing wings and migrating to other hosts, which can lead to substantial stress and stunting of nectarine and peach leaves, as well as direct damage to nectarine fruit. 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 may also serve as a vector of virus diseases such as plum pox.

*Life Cycle*: The green peach aphid, native to Europe, is an invasive pest of peach and nectarine throughout North America. It 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 they return to peaches where they mate, lay overwintering eggs and die.

### *Pest Management*

*Cultural Controls*: The wide host range and 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.

*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. With the adoption of mating disruption techniques for the oriental fruit moth and corresponding reduction in pesticide use, there may be a resurgence of aphid pests and an increase in the spread of the plum pox virus.
2. A management strategy is required for green peach aphids, including improved economic threshold levels that consider the overall impact on tree and fruit quality, the lower tolerance of nectarines due to direct fruit damage, and the potential of plum pox virus transmission.

## 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:* 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. 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 great concern regarding BMSB in Ontario and British Columbia. Although there has been no measurable crop loss to date, there are healthy colonies of the pest in proximity to main peach production areas. Careful monitoring and the development of control strategies remain of high importance. Positive identification of BMSB has been documented in Ontario peach orchards and during post-harvest.
2. The full registration of emergency products is essential for predictable access to management products for this pest and additional chemistries are required for proper chemical rotations to guard against the development of insecticide resistance within BMSB populations.

## 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 tarnished plant bug 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 tarnished plant bug (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 2 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.

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

### *Issues for Tarnished Plant Bug*

1. Effective management strategies that include alternative products, biological controls, cultural practices and possibly preferred host cover crops, are required to manage the resistance of TPB to commonly used insecticides. Currently, only group 3 materials (pyrethroids) are registered for use against TPB in Ontario.

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, 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. Overwintered 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 development being faster 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 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.

## Two-Spotted Spider Mite (*Tetranychus urticae*)

### *Pest Information*

*Damage*: Two-spotted 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*: Two spotted 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 5 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 Two-Spotted 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 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 for improved monitoring methods and economic thresholds for better decision making in the management of the peach silver mite.

## 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. Because 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*

1. There is a need for the registration of products for the control of Comstock mealybug. There are concerns that this pest is a major vector of plant viruses in tree fruit and grapes and so careful monitoring and management of this pest is necessary for the on-going sustainability of different locally grown crops.

## San Jose Scale *(Quadraspidiotus perniciosus)*

### *Pest Information*

*Damage*: 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. The potential for San Jose scale to become a major pest problem is a concern, due to potential shift in management approach for oriental fruit moth from broad spectrum insecticides to mating disruption techniques.

## 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, immature stages of Japanese beetle, overwinter in the soil. They resume feeding on plant roots in the spring, pupate and emerge as adult beetles in early July. As adults they feed on plant foliage and mate, with the adult females then returning to the soil to lay eggs. 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 present in all growing areas in Ontario and there is a risk for direct damage to fruit at high pressure locations. There is a need to develop economic thresholds and register additional chemistries that are effective and provide quick knockdown.

## 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, in the case of the obliquebanded leafroller results in small holes on fruits which may develop rot.

*Life Cycle*: The obliquebanded leafroller, a two generation per year species, 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 (Table 9).

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

### *Issues for Leafrollers*

1. Pest resistance to pyrethroid insecticides has been well documented in apple and pear, and careful monitoring is required to watch for migration of these resistant populations into stone fruit orchards. IPM-compatible, cost-effective products are required to support both IPM and advanced mating disruption programs.

## European Earwig *(Forficula auricularia)*

### *Pest Information*

*Damage*: Earwigs damage peaches by boring into injured, ripening and over-ripened 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 reduced risk products for the control of European earwigs.

## Spotted Wing Drosophila (*Drosophila suzukii*)

### *Pest Information*

*Damage:* Spotted wing drosophila (SWD) is known to infest raspberry, blackberry, blueberry, strawberry, cherry, peach, nectarine, apricot and plum as well as numerous wild hosts. Although its presence has been confirmed in peach production areas, to date there have been no reports of fruit damage directly related to SWD. 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, spotted wing drosophila mate and lay eggs under the skin of ripening fruit. Larvae feed and develop within the fruit. The entire life cycle from egg, through larval and pupal stages to adult, varies between 7 days at 28˚C to 50 days at 12˚C. Due to the short generation time and extended period of egg laying by adults, there can be several, 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 the chances of the fly infesting the fruit and reduce sources of continued infestations. Flies can be monitored using apple-cider vinegar traps.

*Resistant Cultivars:* None identified.

### *Issues for Spotted Wing Drosophila*

1. Spotted wing drosophila is a serious threat to all stone fruit crops. Registrations of reduced risk insecticides are required for long term control of this pest. Short pre-harvest intervals are essential as this pest targets fruit that are close to harvest.
2. There is a need for the development of beneficial management practices which include proper management of fruit culls in and around orchards. There is evidence that SWD populations can dramatically increase where abundant degrading fruits are present.

## Western Flower Thrips (*Frankliniella occidentalis*)

### *Pest Information*

*Damage*: Scarring by Western flower thrips (WFT) develops on the surface of fruit as a result of feeding by thrips, starting from pink through shuck fall stages of fruit development. The scars enlarge as the fruit grows.

*Life Cycle*: Western flower thrips feeds 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 thrips.

*Resistant Cultivars*: None identified.

### *Issues for Western Flower Thrips*

1. There is a need for further investigation of the presence of this pest in peach/ nectarine orchards during bloom and fruit set periods. There are concerns that some of the fruit surface damage often identified as cold damage is actually from thrips.

## 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 a few inches (5-7 cm) above the soil line to a few inches 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 clear wing moths, present from mid to late summer, lay eggs on the lower trunk and in cracks in the soil near peach trees. Following hatching, the larvae bore into the lower trunk and begin to feed. The larvae overwinter in feeding tunnels, completing 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.

*Resistant Cultivars*: None identified.

### *Issues for Peach Tree Borer*

1. There is a need to register alternative control products to endosulfan (registration expired in 2016) that are compatible with and can be used to support mating disruption programs.
2. There is no longer regional trapping being conducted in Ontario for peach tree borers. As a result, it has been difficult to accurately time insecticide applications targeting this pest. There is a need for additional resources to better track peach tree borer populations, 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 hatching, 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 (Table 9). 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 need to register alternative control products to endosulfan (registration expired in 2016) that are compatible with and can be used to support mating disruption programs.
2. There is no longer regional trapping being conducted in Ontario for lesser peach tree borers. As a result, it has been difficult to accurately time insecticide applications targeting this pest. There is a need for additional resources to better track lesser peach tree borer populations, 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*: The pest 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*: The flight of male moths can be monitored through the use of pheromone traps to optimize timing of sprays to control larvae. 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 in a week during the first and the second generations.

*Resistant Cultivars*: None identified.

***Issues for Peach Twig Borer***

1. 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. This insect 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 goes often 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 caused by mechanical damage, diseases, sunscald, or winter injury. Larvae are greyish-green to greyish-purple in colour. They are usually found 1.2 m (4 feet) above ground. Their head capsule, prothoracic shield and anal plate are yellow to brown in colour. The first instar larva is 0.25 mm long and the last instar is about 18-25 mm long. Pupae develop within silken cocoons about 11-12 mm long in the frass left under the bark.

***Pest Management***

*Cultural Controls*: Latex white paint applied on the 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 Borers: Peach bark beetle (*Phloeotribus liminaris*)

### *Pest Information*

*Damage*: Peach growers in the Niagara region have reported orchard tree loss as a result of infestation by tiny wood boring beetles which usually attack stressed fruit trees. The peach bark beetle (*Phloeotribus liminaris*), is a "shot hole borer" that attacks *Prunus* species (peach, cherry and plum), which is present in some provinces of eastern Canada and the United States. However, several species of shot hole borers exist, not just the peach bark beetle. This pest is not a new comer, as report of its presence date back from the 1900s. This type of borer leaves many exit and entrance holes obvious on the outside of infested limbs giving a shot hole effect.

*Life Cycle*: The peach bark beetle is a tiny brown beetle (1.5-2 mm long). Adults are active at night and seldom seen during the day. Females can lay 20-50 eggs in a couple of days. First generation eggs hatch in late May or early June and larval development is completed in 4 to 5 weeks. Second generation larvae begin to hatch in late July or early August and develop until sometime in mid-October when they enter diapause. The 3rd through 7th instar larvae can overwinter and finish their development in the spring. Pupae of overwintering generation may be found from April to early June.

### *Pest Management*

*Cultural Controls*: The type of injury caused by these beetles is very different from infestation by lesser and greater peach tree borers, which are the larvae of day flying clearwing moths, and the strategy used to monitor and manage them may be different.

*Resistant Cultivars*: None identified.

### *Issues for Shothole Borers*

None identified.

## Ambrosia Beetles: Granulate Ambrosia Beetle *(Xylosandrus crassiusculus) and others*

### *Pest Information*

*Damage*: During the past few years, many species of Ambrosia beetles were identified in orchards of southwestern Ontario. 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.). Among the surveyed species in Ontario, the granulate ambrosia beetle (GAB) is a concern as it is already a serious pest in tree nurseries and fruit trees in the US. This fungus alone does not kill a healthy tree as it will often recover from a light infestation of ambrosia beetles. However, trees affected by ambrosia beetles may exhibit sudden wilting and death, or delayed emergence in spring. Branches and stems of affected

trees may wilt and die, and larger branches can become riddled with galleries subject to breakage. There is also a concern that these beetles could be a vector for pathogens.

*Life Cycle*: Female GAB range between 2.1–2.9 mm in length and are about 1.2 mm wide. This species has three larval instars. 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 consisting of conidia and sprout cells that is only produced in association with the beetles and is required for proper development of the larvae and pupae which feed on the ambrosia fungus within the gallery. GAB overwinter as adults, primarily females, within their galleries. It may have up to three generations per year within warmer US climates.

***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. These logs must be removed and destroyed before any new adults emerge. Pruning out infested branches, dead or dying trees and burning or shredding these 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***

None identified.

## 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 Gypsy Moth (*Lymantria 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.

## *Insecticides, miticides and bioinsecticides registered for the management of insect and mite pests in peach production in Canada*

Active ingredients registered for the management of **insects and mites** in peach are listed below in Table 9 *Insecticides, miticides and bioinsecticides registered for the management of insect and mite pests in peach production in Canada*. This table also provides registration numbers for products registered on peach and nectarine containing these actives in addition to information about chemical family and regulatory status. For guidance about active ingredients registered for specific **insects and mites**, the reader is referred to individual product labels on the PMRA label database https://www.canada.ca/en/health-canada/services/consumer-product-safety/pesticides-pest-management.html and to provincial crop production guides.

**Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Re-evaluation Status (re-evaluation decision document)[3] |
|---|---|---|---|---|---|
| (E,E)-8,10-dodecadien-1-ol + 1-dodecanol + 1-tetradecanol | 31589 | not classified | N/A | pheromone - behavioral mating disruption for codling moth | R |
| (E,E)-8,10-dodecadien-1-ol + 1-dodecanol + 1-tetradecanol + Z-8-dodecen-1-yl acetate + E-8-dodecen-1-yl acetate + Z-8-dodecen-1-ol | 29352 | not classified | N/A | pheromone - behavioral mating disruption for codling moth, oriental fruit moth and lesser appleworm | R |
| (E, E)-8, 10-dodecadien-1-ol + 1-dodecanol + 1-tetradecanol + Z-11-tetradecen-1-yl acetate + Z-9-tetradecen-1-yl acetate + Z-11-tetradecen-1-ol + Z-11-tetradecenal | 28814 | not classified | N/A | pheromone - behavioral mating disruption for codling moth and leafroller moths | R |
| (Z,Z)-3,13-octadecadien-1-yl acetate + (E,Z)-2,13-octadecadien-1-yl acetate + (Z,Z)-3,13-octadecadien-1-ol + (E,Z)-2,13-octadecadien-1-ol | 30589 | not classified | N/A | pheromone - behavioral mating disruption for dogwood borer (*Synanthedon scitula*) | R (RVD2018-28) |

…continued

**Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Re-evaluation Status (re-evaluation decision document)[3] |
|---|---|---|---|---|---|
| (Z,Z)-3,13 octadecadien-1-yl acetate + (E,Z)-3,13 octadecadien-1-yl acetate | 27141, 30042 | not classified | N/A | pheromone - behavioral mating disruption for peach borer and apple clearwing moth | R |
| Z-8-dodecen-1-yl acetate + E-8-dodecen-1-yl acetate + Z-8-dodecen-1-ol | 31419 | not classified | N/A | pheromone - behavioral mating disruption for oriental fruit moth | R |
| *Bacillus thuringiensis* subsp. *Aizawai*, strain ABTS-1857 | 31557 | neonicotinoid | 4A | nicotinic acetylcholine receptor (nAChR) competitive modulator | R |
| *Bacillus thuringiensis* subsp. *Kurstaki*, strain ABTS-351 | 11252, 26508 | *Bacillus thuringiensis* and the insecticidal proteins they produce | 11A | microbial disruptor of insect midgut membranes | R |
| *Bacillus thuringiensis* subsp. *Kurstaki*, strain EVB113-19 | 26854, 27750, 32425 | *Bacillus thuringiensis* and the insecticidal proteins they produce | 11A | microbial disruptor of insect midgut membranes | R |
| acetamiprid | 27128 | neonicotinoid | 4A | nicotinic acetylcholine receptor (nAChR) competitive modulator | R |
| bifenazate | 27925 | bifenazate | 20D | mitochondrial complex III electron transport inhibitor | R |

…continued

**Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Re-evaluation Status (re-evaluation decision document)[3] |
|---|---|---|---|---|---|
| canola oil | 32408, 32819 | not classified | N/A | unknown | R |
| carbaryl | 22339 | carbamate | 1A | acetylcholinesterase (AChE) inhibitor | R |
| chlorantraniliprole | 28981 | diamide | 28 | ryanodine receptor modulator | R |
| clofentezine | 21035 | clofentezine | 10 | mite growth inhibitor | R |
| clothianidin | 29382, 29384 | neonicotinoid | 4A | nicotinic acetylcholine receptor (nAChR) competitive modulator | RES* |
| cyantraniliprole | 30895 | diamide | 28 | ryanodine receptor modulator | R |
| cyclaniliprole | 32862, 32889 | diamide | 28 | ryanodine receptor modulator | R |
| cypermethrin | 15738, 28795, 30316, 32563 | pyrethroid, pyrethrin | 3A | sodium channel modulator | R (RVD2018-22) |
| deltamethrin | 22478, 25573, 32446 | pyrethroid, pyrethrin | 3A | sodium channel modulator | R (RVD2018-27) |
| dimethoate | 8277, 9382, 9807, 25651 | organophosphate | 1B | acetylcholinesterase (AChE) inhibitor | R |

…continued

**Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Re-evaluation Status (re-evaluation decision document)[3] |
|---|---|---|---|---|---|
| ferric sodium EDTA | 28774 | not classified | N/A | unknown | R |
| flonicamid | 29796 | flonicamid | 29 | chlordotonal organ modulator - undefined target site | R |
| flupyradifurone | 31452 | butenolide | 4D | nicotinic acetylcholine receptor (nAChR) competitive modulator | R |
| imidacloprid | 24094, 28475, 28726, 29048 | neonicotinoid | 4A | nicotinic acetylcholine receptor (nAChR) competitive modulator | RES* |
| iron (present as ferric phosphate) used as bait | 27085, 27096, 30025 | not classified | N/A | unknown | R (RVD2018-23) |
| kaolin | 27469 | not classified | N/A | unknown | R |
| lambda-cyhalothrin | 24984, 26837, 29052, 32427 | pyrethroid, pyrethrin | 3A | sodium channel modulator | RE |
| lime sulphur or calcium polysulphide | 16465 | not classified | N/A | unknown | R |
| malathion | 4590, 8372 | organophosphate | 1B | acetylcholinesterase (AChE) inhibitor | R |

…continued

**Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Re-evaluation Status (re-evaluation decision document)[3] |
|---|---|---|---|---|---|
| methoxyfenozide | 27786 | diacylhydrazine | 18 | ecdysone receptor agonist | R |
| mineral oil | 9542, 14981, 18709, 21655, 23370, 27666, 28124, 29768, 33099 | not classified | N/A | unknown | R |
| novaluron | 28515, 28881 | benzoylurea | 15 | inhibitor of chitin biosynthesis, type 0 | R |
| permethrin | 14882, 16688, 24071, 24175, 28877, 29886 | pyrethroid, pyrethrin | 3A | sodium channel modulator | RE |
| phosmet | 23006, 29064 | organophosphate | 1B | acetylcholinesterase (AChE) inhibitor | RE |
| potassium salts of fatty acids | 27886, 28146, 31433 | not classified | N/A | unknown | R |
| pyridaben | 25135 | METI acaricide and insecticide | 21A | mitochondrial complex I electron transport inhibitor | RE |
| spinetoram | 28777, 28778 | spinosyn | 5 | nicotinic acetylcholine receptor (nAChR) allosteric modulator | R |

…continued

**Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Re-evaluation Status (re-evaluation decision document)[3] |
|---|---|---|---|---|---|
| spinetoram + sulfoxaflor | 31442 | spinosyn + sulfoximine | 5 + 4C | nicotinic acetylcholine receptor (nAChR) allosteric modulator + nicotinic acetylcholine receptor (nAChR) competitive modulator | R + R |
| spinosad | 26835, 27825, 30382 | spinosyn | 5 | nicotinic acetylcholine receptor (nAChR) allosteric modulator | RE |
| spirodiclofen | 28051 | tetronic and tetramic acid derivative | 23 | inhibitor of acetyl CoA carboxylase | R |
| spirotetramat | 28953, 28954 | tetronic and tetramic acid derivative | 23 | inhibitor of acetyl CoA carboxylase | R |
| sulfoxaflor | 30826 | sulfoximine | 4C | nicotinic acetylcholine receptor (nAChR) competitive modulator | R |
| sulphur | 14653, 18836, 29487, 31869, 32475 | sulphur | N/A | unknown | R |
| thiram (repellent) | 13258 | dithiocarbamate and relatives (electrophile) | M03 | multi-site contact activity | RE |

…continued

**Table 9. Pesticides and biopesticides registered for the management of insect and mite pests in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Group[2] | Resistance Group[2] | Mode of Action[2] | Re-evaluation Status (re-evaluation decision document)[3] |
|---|---|---|---|---|---|
| **Storage Treatment** | | | | | |
| methyl bromide | 9564, 19498 | alkyl halide | 8A | miscellaneous non-specific (multi-site) inhibitor | PO[5] |

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). **The list includes all active ingredients registered as of October 11, 2018.** While every effort has been made to ensure all insecticides, miticides and biopesticides registered in Canada on peach have been included in this list, some active ingredients or products may have been inadvertently omitted. 'Numerous products' is entered where there are more than ten products for an active ingredient. Not all end-use products containing a particular active ingredient may be registered for use on this crop. The product label is the final authority on pesticide use and should be consulted for application information. The information in this table should not be relied upon for pesticide application decisions and use.

[2] Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 8.4; May 2018)* (excluding pheromones) (www.irac-online.org) (accessed Aug. 23, 2018).

[3]PMRA re-evaluation status as published in Re-evaluation Note REV2018-06, Pest Management Regulatory Agency Re-evaluation and Special Review Work Plan 2018-2023 and other re-evaluation documents: R - full registration, RE (yellow) - under re-evaluation, RES (yellow) - under special review and RES* (yellow) - under re-evaluation and special review. Other codes include: DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA.

[4]Source: Fungicide Resistance Action Committee. *FRAC Code List 2017: Fungicides sorted by mode of action (including FRAC code numbering)* (www.frac.info/ ) (accessed September 13, 2017).

[5]As published by Government of Canada: *Notice to anyone engaged in the use of methyl bromide: June 2017 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/notice-use-methyl-bromide-june-2017.html*

# Weeds

## Key Issues

- There is concern that heavy reliance on glyphosate herbicides has led to increased prevalence of resistance in numerous weed species including Canada fleabane, some thistle species and henbit. There is a need for registrations of additional contact herbicides that will reduce reliance on glyphosate-based herbicides.

- Reduced-risk residual herbicides with low environmental impact and which can be soil applied, are required. There is a need to investigate additional pre-emergent residual herbicides that are safe to use around young plantings in all tree fruit commodities.

- There is a need for research into innovative weed management methods including flaming, mulches, use of cultivators and for research and development of an integrated weed management program in peaches.

- There is a need to assess environmental impacts of both conventional and alternative weed management tools and approaches.

## Table 10. Occurrence of weeds in peach production in Canada[1,2]

| Weed | 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 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 pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.

Pest not present.

Data not reported.

[1]Source: Peach stakeholders in reporting provinces (British Columbia and Ontario). The data reflect the 2014, 2015 and 2016 production years.

[2]Refer to Appendix 1 for a detailed explanation of colour coding of occurrence data.

**Table 11. Adoption of weed management practices in peach production in Canada[1]**

| Practice / Pest | | 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 or 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 | | | | |
| Monitoring | Scouting / field inspection | | | | |
| | Maintaining records of weed incidence including herbicide resistant weeds | | | | |
| | Use of precision agriculture technology (GPS, GIS) for data collection and mapping of weeds | | | | |
| Decision making tools | Economic threshold | | | | |
| | Crop specialist recommendation or advisory bulletin | | | | |
| | 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 | | | | |

…continued

**Table 11. Adoption of weed management practices in peach production in Canada[1] (continued)**

| Practice / Pest | | Annual broadleaf weeds | Annual grass weeds | Perennial broadleaf weeds | Perennial grass weeds |
|---|---|---|---|---|---|
| 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 | | | | |
| | Biopesticides (microbial and non-conventional pesticides) | | | | |
| | Release of arthropod biological control agents | | | | |
| | Mechanical weed control (cultivation / tillage) | | | | |
| | Manual weed control (hand pulling, hoeing, flaming) | | | | |
| | Use of stale seedbed technique | | | | |
| | Targeted pesticide applications (banding, spot treatments, variable rate sprayers, etc.) | | | | |
| | Selection of herbicides that are soft on beneficial insects, pollinators and other non-target organisms | | | | |
| New practices (by province) | Use of long-residual pre-emergent herbicides | | | | |

**This practice is used to manage this pest by at least some growers.**

**This practice is not used by growers to manage this pest.**

**This practice is not applicable for the management of this pest.**

**Information regarding the practice for this pest is unknown.**

**[1]Source: Peach stakeholders in reporting provinces (British Columbia and Ontario). The data reflect the 2014, 2015 and 2016 production years.**

## Weeds

### *Pest Information*

*Damage*: A 50% 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. Losses can be as high as 50% depending on the rootstocks and weeds involved. Perennial weeds that have been established for several years can become very large and consequently be very competitive.

*Life Cycle*: Most arable land is infested with weed seeds at all times. 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.

*Annual weeds:* 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, produce a rosette of leaves in the fall and flower the second year. 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*: 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:* Perennials are plants that live for many years. They spread through the expansion of various types of root systems and other vegetative means and also 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 that has been killed, 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.

*Resistant Cultivars*: None available.

***Issues for Weeds***

1. There is concern that heavy reliance on glyphosate herbicides has led to resistance in Canada fleabane, select thistle species, henbit and other plant species. Weed species that are tolerant to glyphosate are becoming more prevalent. There is a need to register additional contact herbicides that are effective on a large range of broadleaf weeds and grasses in order to reduce the use of glyphosate.
2. The registration of herbicides of new chemical groups is required for resistance management.
3. Reduced risk replacements are required for soil-applied, residual herbicides with harsh environmental profiles (toxicity to soil biota, tendency for leaching, ground water contamination and soil persistence).
4. The development of an integrated approach to weed management in peaches is required.
5. There is a need for the development and assessment of the environmental impact of innovative methods of weed control in peaches such as flaming, development and use of low cost mulches and mulch application and cultivators.
6. There is a need to investigate additional pre-emergent residual herbicides that are safe to use around young plantings in all tree fruit commodities.

## *Herbicides and bioherbicides registered for weed management in peach and nectarine production in Canada*

Active ingredients registered for the management of **weeds** in peach and nectarine are listed in *Table 12 Herbicides and bioherbicides registered for weed management in* peach and nectarine *production in Canada*. This table also provides registration numbers for products registered on peach and nectarine containing these actives in addition to information about chemical family and regulatory status. For guidance about active ingredients registered for specific **weeds**, the reader is referred to individual product labels on the PMRA label database https://www.canada.ca/en/health-canada/services/consumer-product-safety/pesticides-pest-management.html and to provincial crop production guides.

**Table 12. Herbicides and bioherbicides registered for weed management in peach production in Canada**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Family[2] | Resistance Group[2] | Site of Action[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|
| 2,4-D (present as dimethylamine salt) | 5931, 17511, 26163, 29248, 31332 | phenoxy-carboxylic-acid | 4 | synthetic auxin | RES |
| ammonium salt of fatty acids | 30012, 30515 | not classified | N/A | unknown | R |
| bentazon (present as sodium salt) | 12221, 32661, 32827, 33011 | benzothiadiazinone | 6 | inhibition of photosynthesis at photosystem II site B | R |
| carfentrazone-ethyl | 28573, 33127 | triazolinone | 14 | inhibition of protoporphyrinogen oxidase (Protox, PPO) | R |
| dichlobenil | 12533 | nitrile | 20 | inhibition of cell wall synthesis site A | R |
| fluazifop-p-butyl | 21209 | aryloxyphenoxy-propionate 'FOP' | 1 | inhibition of acetyl CoA carboxylase (ACCase) | R |
| flumioxazin | 29231, 29235 | N-phenylphthalimide | 14 | inhibition of protoporphyrinogen oxidase (Protox, PPO) | R |

... continued

**Table 12. Herbicides and bioherbicides registered for weed management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Family[2] | Resistance Group[2] | Site of Action[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|
| glufosinate ammonium | 23180, 28532, 32860 | phosphinic acid | 10 | inhibition of glutamine synthetase | R |
| glyphosate (present as dimethylamine salt) | 28840, 28977, 29774, 29775, 30319, 30516, 31090 | glycine | 9 | inhibition of 5-enolypyruvyl-shikimate-3-phosphate synthase (EPSPS) | R |
| glyphosate (present as isopropylamine salt) | 31913, 32181 | glycine | 9 | inhibition of 5-enolypyruvyl-shikimate-3-phosphate synthase (EPSPS) | R |
| glyphosate (present as potassium salt) | numerous products | glycine | 9 | inhibition of 5-enolypyruvyl-shikimate-3-phosphate synthase (EPSPS) | R |
| glyphosate (present as isopropylamine and potassium salts) | 32228, 32532, 33029, 33030 | glycine | 9 | inhibition of 5-enolypyruvyl-shikimate-3-phosphate synthase (EPSPS) | R |
| indaziflam | 30220, 30221, 30451, 32803, 32804 | unknown | 29 | inhibition of cell wall synthesis site C | R |
| linuron | 15544, 16279, 16363, 20193, 21353 | urea | 7 | inhibition of photosynthesis at photosystem II site A (different behavior from group 5) | RES* |
| methyl bromide (fumigant, pre-plant soil application) | 19498 | alky halide[4] | 8A[4] | miscellaneous non-specific (multi-site) inhibitor[4] | PO[5] |
| metribuzin | numerous products | triazinone | 5 | inhibition of photosynthesis at photosystem II site A | R |

…continued

**Table 12. Herbicides and bioherbicides registered for weed management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Family[2] | Resistance Group[2] | Site of Action[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|
| S-metolachlor and R-enantiomer | 25728, 25729, 29347, 32847 | chloroacetamide | 15 | inhibition of mitosis | RE |
| pendimethalin | 29542 | dinitroaniline | 3 | microtubule assembly inhibition | R |
| paraquat | 8661, 33125 | bipyridylium | 22 | photosystem-I-electron diversion | R |
| rimsulfuron | 30057 | sulfonylurea | 2 | inhibition of acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) | R |
| sethoxydim | 24835 | cyclohexanedione 'DIM' | 1 | inhibition of acetyl CoA carboxylase (ACCase) | R |
| simazine and related triazines | 16370 | triazine | 5 | inhibition of photosynthesis at photosystem II site A | R |
| terbacil | 10628, 30082 | uracil | 5 | inhibition of photosynthesis at photosystem II site A | R |

…continued

**Table 12. Herbicides and bioherbicides registered for weed management in peach production in Canada (continued)**

| Active Ingredient[1] | Product Registration Numbers[1] | Chemical Family[2] | Resistance Group[2] | Site of Action[2] | Re-evaluation Status (Re-evaluation Decision Document)[3] |
|---|---|---|---|---|---|
| trifluralin | 23933, 28289 | dinitroaniline | 3 | microtubule assembly inhibition | R |

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). **The list includes all active ingredients registered as of October 11, 2018.** While every effort has been made to ensure all herbicides, bioherbicides and plant growth regulators registered in Canada on peach have been included in this list, some active ingredients or products may have been inadvertently omitted. 'Numerous products' is entered where there are more than ten products for an active ingredient. Not all end-use products containing a particular active ingredient may be registered for use on this crop. The product label is the final authority on pesticide use and should be consulted for application information. The information in this table should not be relied upon for pesticide application decisions and use.

[2]Source: Weed Science Society of America (WSSA). Herbicide Site of Action Classification list (last modified August 16, 2017) http://wssa.net (accessed August 23, 2018)

[3]PMRA re-evaluation status as published in Re-evaluation Note REV2018-06, Pest Management Regulatory Agency Re-evaluation and Special Review Work Plan 2018-2023 **and other re-evaluation documents**: R - full registration, RE (yellow) - under re-evaluation, RES (yellow) - under special review and RES* (yellow) - under re-evaluation and special review. Other codes include: DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA.

[4] Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 8.4; May 2018)* (www.irac-online.org) (accessed August 23, 2018).

[5]As published by Government of Canada: *Notice to anyone engaged in the use of methyl bromide: June 2017 https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/notice-use-methyl-bromide-june-2017.html*

## Vertebrate Pests

Deer, birds, rabbits, mice (voles), woodchucks (groundhogs) and bears can damage peach and nectarine orchards. Damage includes direct feeding on fruit, injury to trees by feeding on buds or broken tree limbs, girdling of the bark, feeding on roots, as well as a possible bacterial contamination of fruit by bird droppings and subsequent food safety issues.

Chemical control, in the form of rodenticide baits, is an option for mice. Repellents to keep deer and bear away include ammonium soaps and putrescent whole egg solids.

The control of most vertebrate pests is based on a combination of cultural practices and preventative techniques in a season-long management strategy to reduce economic losses. Keeping orchard grass short and herbicide strips between orchard rows free of weeds will reduce damage by mice. Mowing of the orchard sod also makes it easier for predators such as foxes and hawks to hunt voles. Removing straw, weeds and sod from around the base of trunks reduces habitat for rodents and discourages mouse establishment. Picking up fruit that has fallen to the ground in the fall discourages deer and rabbits. Wire mesh tree guards will help prevent voles from girdling trees. Yellow tapes or streamers act as a visual repellent for birds and can be used in conjunction with noisemakers, such as cracker or whistler shells, propane exploders or electronic alarms. The broadcasting of distress calls and the use of scarecrows and predator models, such as hawk-shaped kites, will repel birds. Woven wire fencing or electric fencing will help keep deer and bears out of orchards.

# Resources

## Integrated Pest Management & Integrated Crop Management (IPM/ ICM) Resources for Peach Production in Canada

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

Health Canada, Pest Management Regulatory Agency
http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php

Ontario Ministry of Agriculture, Food and Rural Affairs, Crop Publications.
http://www.omafra.gov.on.ca/english/crops/publications.html

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

Ontario Ministry of Agriculture, Food and Rural Affairs. *Publication 360, Guide to Fruit Production - 2016-17,* 310 pp. http://www.omafra.gov.on.ca/english/crops/pub360/p360toc.htm

## *Provincial Crop Specialists and Provincial Minor Use Coordinators*

| Province | Ministry | Crop Specialist | Minor Use Coordinator |
|---|---|---|---|
| **British-Columbia** | British Columbia Ministry of Agriculture<br>www.gov.bc.ca/al | Maria Jeffries<br>Plant Health Coordinator<br><br>Maria.Jeffries@gov.bc.ca | Caroline Bédard<br>caroline.bédard@gov.bc.ca |
| **Ontario** | Ontario Ministry of Agriculture, Food and Rural Affairs<br>www.omafra.gov.on.ca | Hannah Fraser<br>Entomologist<br>Horticulture – OMAFRA<br>ag.info.omafra@ontario<br><br>Amanda Green – Tree Fruit Specialist/ OMAFRA<br>ag.info.omafra@ontario.ca<br><br>Wendy McFadden-Smith, Tender Fruit and Grape IPM Specialist<br>wendy.mcfadden-smith@ontario.ca | Jim Chaput<br>jim.chaput@ontario.ca |

## *National and Provincial Fruit Grower Organizations*

**Provincial:**

British Columbia Fruit Growers Association: (www.bcfga.com)

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

Ontario Tender Fruit Growers: (http://www.ontariotenderfruit.ca/)

Ontario Tender Fruit Producers Marketing Board: (https://ontariofresh.ca/profile/ontario-tender-fruit-producers-marketing-board)

**National:**

Canadian Horticultural Council: (www.hortcouncil.ca)

Canada Organic Trade Association: (https://www.ota.com/canada-ota/about-cota)

# 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 province is provided in Tables 4, 7 and 10 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="12">Present</td><td rowspan="10">Data available</td><td>Frequency</td><td>Distribution</td><td>Pressure</td><td>Colour Code</td></tr>
<tr><td rowspan="6">Yearly - Pest is present 2 or more years out of 3 in a given region of the province.</td><td rowspan="3">Widespread - The pest population is generally distributed throughout crop growing regions of the province. In a given year, outbreaks may occur in any region.</td><td>High - If present, potential for spread and crop loss is high and controls must be implemented even for small populations.</td><td>Red</td></tr>
<tr><td>Moderate - If present, potential for spread and crop loss is moderate: pest situation must be monitored and controls may be implemented.</td><td>Orange</td></tr>
<tr><td>Low - If present, the pest causes low or negligible crop damage and controls need not be implemented.</td><td>Yellow</td></tr>
<tr><td rowspan="3">Localized - The pest is established as localized populations and is found only in scattered or limited areas of the province.</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="6">Sporadic - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="3">Widespread - as above</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>Yellow</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="3">Localized - as above</td><td>High - see above</td><td>Yellow</td></tr>
<tr><td>Moderate -see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="2">Data not available</td><td colspan="3">Not of concern: The pest is present in commercial crop growing areas of the province but is causing no significant damage. Little is known about its population distribution and frequency in this province; however, it is not of concern.</td><td>White</td></tr>
<tr><td colspan="3">Is of concern: The pest is present in commercial crop growing areas of the province. Little is known about its population distribution and frequency of outbreaks in this province and due to its potential to cause economic damage, is of concern.</td><td>Blue</td></tr>
<tr><td>Not present</td><td colspan="4">The pest is not present in commercial crop growing areas of the province, to the best of your knowledge.</td><td>Black</td></tr>
<tr><td>Data not reported</td><td colspan="4">Information on the pest in this province is unknown. No data is being reported for this pest.</td><td>Grey</td></tr>
</table>

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