



Crop Profile for Asparagus in Canada, 2018

Prepared by:
Pest Management Program
Agriculture and Agri-Food Canada



Agriculture and
Agri-Food Canada

Agriculture et
Agroalimentaire Canada

Canada

Third Edition - 2020

Crop Profile for Asparagus in Canada, 2018

Catalogue No.: A118-10/32-2018E-PDF

ISBN: 978-0-660-35592-4

AAFC No.: 13035E

Second Edition - 2017

Crop Profile for Asparagus in Canada, 2015

Catalogue No.: A118-10/32-2015E-PDF

ISBN: 978-0-660-24333-7

AAFC No.: 12737E

First Edition - 2014

Crop Profile for Asparagus in Canada, 2012

Catalogue No.: A118-10/32-2014E-PDF

ISBN: 978-1-100-22716-0

AAFC No.: 12207E

© Her Majesty the Queen in Right of Canada, represented by the Minister of Agriculture and Agri-Food (2014, 2017, 2020)

Electronic version available at www.agr.gc.ca/pmc-cropprofiles

Paru également en français sous le titre: « Profil de la culture de l'asperge au Canada, 2018 »

For more information reach us at www.agr.gc.ca or call us toll-free 1-855-773-0241.

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

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

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

For inquiries regarding the contents of the profile, please contact:

Crop Profiles Coordinator
Pest Management Centre
Agriculture and Agri-Food Canada
Building 57, 960 Carling Ave
Ottawa, ON, Canada K1A 0C6

aafc.pmcinfo-clainfo.aac@canada.ca

Contents

Crop Production.....	1
Industry Overview	1
Production Regions.....	2
Cultural Practices	3
Abiotic Factors Limiting Production	6
Frost Injury.....	6
Excessive Heat	6
Wind Damage.....	6
Hollow Stem.....	6
Diseases	7
Key issues	7
Asparagus Rust (<i>Puccinia asparagi</i>).....	12
Purple Spot or Stemphylium Blight (<i>Pleospora herbarum</i> , anamorph <i>Stemphylium vesicarium</i>)	13
Botrytis Bight or Grey Mould (<i>Botrytis cinerea</i>)	13
Fusarium Crown and Root Rot (<i>Fusarium oxysporum</i> f. sp. <i>asparagi</i> and other <i>Fusarium</i> spp.).....	14
Phytophthora Spear Rot (<i>Phytophthora megasperma</i> f. sp. <i>glycinea</i> and <i>P. cryptogea</i>).....	15
Virus diseases: Asparagus Virus I (AVI) and II (AVII), Tobacco Streak Virus (TSV), and Cucumber Mosaic Virus (CMV)	16
Insects and Mites	17
Key issues	17
Common Asparagus Beetle (<i>Crioceris asparagi</i>) and Spotted Asparagus Beetle (<i>Crioceris duodecimpunctata</i>)	22
Cutworms: Variegated Cutworm (<i>Peridroma saucia</i>), Dark-sided Cutworm (<i>Euxoa messoria</i>), White Cutworm (<i>E. scandens</i>), and Sandhill Cutworm (<i>E. detersa</i>).....	23
Asparagus Aphid (<i>Brachycorynella asparagi</i>).....	23
Alfalfa Plant Bug (<i>Adelphocoris lineolatus</i>)	24
Tarnished Plant Bug (<i>Lygus lineolaris</i>).....	25
Asparagus Miner (<i>Ophiomyia simplex</i>).....	25
Weeds	27
Key Issues	27
All Weeds	32
Resources	34
Integrated pest management / integrated crop management resources for production of asparagus in Canada ..	34
Provincial Contacts	35
Provincial and National Vegetable Grower Organizations	36
Appendix 1	37
References.....	38

List of Tables

Table 1. General production information in 2018	2
Table 2. Distribution of asparagus production by province, 2018	2
Table 3. General asparagus production and pest management schedule in Canada	5
Table 4. Occurrence of diseases in asparagus production in Canada ^{1,2}	8
Table 5. Adoption of disease management practices in asparagus production in Canada ¹	9
Table 6. Occurrence of insect pests in asparagus production in Canada ^{1,2}	18
Table 7. Adoption of insect pest management practices in asparagus production in Canada ¹	19
Table 8. Occurrence of weeds in asparagus production in Canada ^{1,2}	28
Table 9. Adoption of weed management practices in asparagus production in Canada ¹	29

Crop Profile for Asparagus in Canada

Asparagus (*Asparagus officinalis*) is a member of the Asparagaceae family. It is a perennial, monocotyledonous plant grown for its tender green shoots (spears) that are harvested in the spring. This crop is highly prized for its delicate flavour and tender texture. Asparagus is a source of vitamins A, B and C.

The culture of this crop dates back to 200 BC in the Mediterranean region. It was brought to North America by European settlers in the 1800's, and is now grown in most temperate regions of the world.

Asparagus breeding in Canada has progressed, in the past 20 years, to the point where all cultivars grown in Ontario are male hybrids. These hybrids have replaced many open-pollinated varieties planted in Canada. Male hybrid cultivars have been developed at the University of Guelph and have been registered with the Canadian Food Inspection Agency, starting with 'Guelph Millennium' in 2000, and more recently in 2017, with 'Guelph Evolution', 'Guelph Equinox' and 'Guelph Eclipse'. The new hybrids have an improved cold tolerance.

Crop Production

Industry Overview

Asparagus is best known as a fresh vegetable in the marketplace; however, this crop is also canned, frozen and pickled. The pickling of asparagus is mostly a cottage industry with limited markets. A small amount of white asparagus is also produced for specialty markets.

Total Canadian acreage was 2,239 ha in 2018 with a production of 8,518 metric tonnes and a farm gate value of \$38.1 million (Table 1). Total Canadian asparagus (fresh or chilled) exports grew by 5.4% to \$8.4 million in 2018 compared to previous year. Fresh or chilled asparagus imports remain stable at \$110.2 million, and prepared or preserved asparagus imports remained at \$1.5 Million in 2017.

Table 1. General production information in 2018

Canadian Production ¹	Asparagus
	8,518 metric tonnes 2,239 hectares (planted)
Total farm gate value ¹	\$38.1 million
Vegetable consumption ²	0.68 kg/ person (fresh)
	0.01 kg/ person (canned)
Exports ³	Fresh or chilled: \$8.35 Million
	Prepared or preserved: none
Imports ³	Fresh or chilled: \$110.18 Million
	Prepared or preserved: \$1.48 Million

¹Statistics Canada. Table 32-10-0365-01 (formerly CANSIM 001-0013) - Area, production and farm gate value of vegetables (database accessed 2019-03-06).

²Statistics Canada. Table 32-10-0054-01 (formerly CANSIM 002-0011) - Food available in Canada (database accessed: 2019-03-06).

³Statistics Canada. Canada International Merchandise Trade Database (accessed 2019-03-07): HS # 070920 - Asparagus, fresh or chilled; HS # 200560 - Asparagus, prepared or preserved (not frozen).

Production Regions

The acreage of asparagus grown in Ontario has remained stable at 1,561 ha, comprising 70% of the national acreage (Table 2). Quebec ranks second in area of production with 458 hectares or 21% of the national acreage, followed by Manitoba and British Columbia, both with 4% of the national acreage.

Table 2. Distribution of asparagus production by province, 2018¹

Production Regions	Area planted (hectares) (percentage)	Farm gate value (\$)
British Columbia	81 ha (4%)	\$0.86 Million
Alberta	18 ha (1%)	\$0.31 Million
Manitoba	97 ha (4%)	\$1.10 Million

...continued

Table 2. Distribution of asparagus production by province, 2018¹ (continued)

Production Regions	Area planted (hectares) (percentage)	Farm gate value (\$)
Ontario	1,561 ha (70%)	\$28.48Million
Quebec	458 ha (21%)	\$7.01 Million
Nova Scotia	20 ha (1%)	\$0.33 Million
Canada	2,239 ha	\$38.11 Million

¹Statistics Canada. Table 32-10-0365-01 (formerly CANSIM 001-0013) - Area, production and farm gate value of vegetables (database accessed 2019-03-06).

Cultural Practices

Asparagus is best suited to soils that are deep, well-drained, porous and friable, such as a deep sandy-loam or muck soil in some provinces. An organic matter content of at least three percent is ideal. Heavy soils are not suitable for growing asparagus as they can cause malformed spears, as can stony ground. In addition, heavy soils usually lack sufficient porosity for aeration and water drainage; asparagus plants do not like ‘wet feet’ which can contribute to disease problems. Asparagus is very deep-rooted, with roots reaching depths of three metres. For this reason, it is important that planting sites not have a hard-pan or a plough layer that will interfere with root development. As asparagus is an early season crop, sites with good air drainage that are less prone to frost are preferable for planting. Producers can choose to plant asparagus seeds, transplants or one-year old crowns, although the planting of seedlings or crowns is more conducive to obtaining a uniform stand. Seedlings may be started in the greenhouse in the early spring and transplanted at 10 to 14 weeks. Crowns are grown from seed sown into a nursery bed. Often, crowns are produced by asparagus growers who specialize in crown production. Planting is done as soon as possible in the spring after soil temperatures have reached 10°C. Asparagus crowns are planted in furrows 15 to 30 cm deep which are gradually filled-in as the asparagus plant becomes established. Plantations started with crowns may be harvested in the second year for a maximum of ten days and for on a longer period each following year as the plants mature. Plantations that are started with transplants will require an extra year to produce harvestable spears.

Both male and female clones of asparagus are available. The more recent asparagus cultivars introduced from the [University of Guelph Asparagus Breeding Program](#) and from Rutgers University in New Jersey, USA, are male hybrid cultivars. Since male hybrids cannot produce seeds, there is no chance for ‘volunteer’ asparagus seedlings to develop and become weeds, later competing for space, water and fertilizer. Male hybrids have been shown to be more productive than female hybrids, producing a higher percentage of #1 grade spears.

Asparagus plantings can be productive for 15 to 20 years, so considerable care is taken in site preparation. Troublesome perennial weeds are eliminated prior to planting. Additions of significant amounts of organic matter are also important in preparing the site. Based on soil

testing, fertility adjustments are done at this time and soil pH is adjusted through lime applications if necessary. The ideal pH range for asparagus is 6.5 to 6.8. Windbreaks can be established near new plantings to prevent soil erosion and sand blasting damage to the crop resulting from strong winds.

Table 3. General asparagus production and pest management schedule in Canada

Time of Year	Activity	Action
April	Plant care	Mowing of old fern stubble with rotary or flail mower; some producers may burn the canes, weather permitting, especially if previous year had disease damage (QC)
	Soil care	Application of broadcast fertilizer or disc-in lime
	Disease management	None
	Insect and mite management	None
	Weed management	Light disking prior to emergence of new shoots; application of pre-emergent herbicides
May	Plant care	Hand or machine-assisted harvest every two to three days; hand harvest is required in Quebec and more often, i.e. every day or every other day when weather is cooler
	Insect and mite management	Application of insecticide to control asparagus beetles, if necessary
	Weed management	Application of burn down herbicide to kill rye cover crops, if necessary
June	Plant care	Hand or machine-assisted harvest every two to three days; hand harvest is required in Quebec and more often, i.e. every day or every other day when weather is cooler
	Soil care	Broadcast application of nitrogen fertilizer immediately after harvest
	Disease management	Fungicide applications to control asparagus rust after last harvest
	Insect and mite management	Insecticide applications to control asparagus beetles and aphids, if necessary; in Quebec, insecticide is applied to control both asparagus beetle and spotted asparagus beetle, as needed
	Weed management	Application of post-emergent herbicides after last harvest
July	Disease management	Fungicide applications to control asparagus rust and purple spot or Stemphylium spot, if necessary
	Insect and mite management	Insecticide applications to control asparagus beetle or aphids, if necessary
	Weed management	Hand-hoeing, if necessary; in Quebec, local herbicide application or a light mechanical disking is done at the beginning of the month if row spacing is sufficiently wide to allow passage; mow rye planted between rows, if needed
August	Disease management	Fungicide applications to control asparagus rust and purple spot or Stemphylium spot, if necessary
	Insect and mite management	Monitoring for aphid infestations; application of insecticides, if necessary; not necessary in Quebec
September	Weed management	Seeding of rye cover crops, in some operations
October	Plant care	Clipping of ferns to 20 cm. for overwintering, in some operations; if snow cover is light in the area, no need for clipping to promote snow accumulation (QC)

Abiotic Factors Limiting Production

Frost Injury

Late spring frosts can damage early emerging spears resulting in yield loss. Affected spears develop a water-soaked appearance and become limp and furrowed as they thaw. The largest and most vigorous spears are the first to appear and if those are damaged by frost, a disproportionate amount of the yield can be lost. In addition, the development of new shoots by frost-injured crowns is often delayed. The removal of frost injured spears may reduce this delay but is an additional expense. An early fall frost can kill or severely injure the asparagus fern before the natural senescence process takes place. This reduces the movement of carbohydrates down to the crown. These carbohydrates are important for the overall survival of the plant and are especially critical for spear production the next season.

Excessive Heat

Extreme or unseasonably warm temperatures can bring on the asparagus growth too quickly for the usual harvest practices to keep pace. High temperatures in the spring may also shorten the harvest season, and can also reduce yield.

Wind Damage

Curvature of newly emerged asparagus stems can be caused by strong winds. Asparagus spears will curve into the prevailing wind because of reduced cell growth on the exposed side. Severely affected spears are usually culled while other, less injured spears are sold as 'seconds' at a reduced price. Strong winds can also cause sand blasting, which creates wounds on the tender asparagus shoots that serve as points of entry for disease.

Hollow Stem

Hollow stem can be a problem under growing conditions that promote rapid spear growth, typically being more prevalent in younger plantings. It is recognized as a problem during the harvest season, as it impacts the quality and potentially the marketability of the asparagus spears.

Diseases

Key issues

- The continued harmonization of pesticide registrations between Canada and the United States is very important to ensure Canadian growers remain competitive.
- There is a need for the registration of new fungicides with different modes of action than those currently registered, for the control of a number of diseases of asparagus.

Table 4. Occurrence of diseases in asparagus production in Canada^{1,2}

Disease	Ontario	Quebec
Asparagus rust		
Purple spot (Stemphylium spot)		
Fusarium crown and root rot		
Phytophthora spear rot		
Virus diseases		
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 pressure.		
Pest not present.		
Data not reported.		

¹Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec); the data reflect the 2018, 2017 and 2016 production years.

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

Table 5. Adoption of disease management practices in asparagus production in Canada¹

Practice / Pest		Asparagus rust	Fusarium crown and root rot; seedling blight	Phytophthora spear rot	Purple spot (Stemphylium spot)	Virus diseases
Avoidance	Varietal selection / use of resistant or tolerant varieties					
	Planting / harvest date adjustment					
	Rotation with non-host crops					
	Choice of planting site					
	Optimizing fertilization for balanced growth and to minimize stress					
	Minimizing wounding and insect damage to limit infection sites					
	Use of disease-free propagative materials (seed, cuttings 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					

...continued

Table 5. Adoption of disease management practices in asparagus production in Canada¹ (continued)

Practice / Pest		Asparagus rust	Fusarium crown and root rot; seedling blight	Phytophthora spear rot	Purple spot (Stemphylium spot)	Virus diseases
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					
Decision making tools	Economic threshold					
	Use of predictive model for management decisions					
	Crop specialist recommendation or advisory bulletin					
	Decision to treat based on observed disease symptoms					
	Use of portable electronic devices in the field to access pathogen / disease identification / management information					
Suppression	Use of diverse product modes of action for resistance management					
	Soil amendments and green manuring involving soil incorporation as biofumigants, to reduce pathogen populations					
	Use of biopesticides (microbial and non-conventional pesticides)					
	Controlled atmosphere storage					

...continued

Table 5. Adoption of disease management practices in asparagus production in Canada¹ (continued)

Practice / Pest		Asparagus rust	Fusarium crown and root rot; seedling blight	Phytophthora spear rot	Purple spot (Stemphylium spot)	Virus diseases
Suppression	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					
This practice is used to manage this pest by at least some growers in the province.						
This practice is not used by growers in the province to manage this pest.						
This practice is not applicable for the management of this pest.						
Information regarding the practice for this pest is unknown.						

¹Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec); the data reflect the 2018, 2017 and 2016 production years.

Asparagus Rust (*Puccinia asparagi*)

Pest Information

Damage: The first symptoms of rust infections are slightly raised, light green spots on stems and foliage in early summer. The spots develop into cream-coloured to reddish brown pustules that contain spores. Heavily infected plants die back prematurely in the fall, lose vigour and produce fewer spears the following spring. Spears are not directly affected as they are usually harvested before symptoms appear.

Life Cycle: Asparagus rust has a complex life cycle involving the production of four different spore types, all of which occur on asparagus. The disease overwinters in asparagus crop residues. New spores produced in crop residues in the spring are wind-blown onto emerging shoots where they cause infection. The early infections develop into cream-coloured pustules called aecia that release aeciospores that re-infect asparagus fern under suitable moisture conditions. Rust pustules called uredia develop at infection sites and release rust-coloured spores called urediospores. Urediospores may be released and cause new infections on asparagus from June until September under suitable weather conditions. Warm weather with heavy dew, fog, or light rainfall enhances rust development. Late in summer, telia develop in infected tissues and produce the overwintering black teliospores, completing the annual life cycle.

Pest Management

Cultural Controls: Spacing plants and rows to facilitate drying of the foliage will reduce the duration of foliar wetness and rust infectivity periods. Monitoring for rust after spears are harvested in the spring will enable timely treatments, if necessary, that will prevent the build-up of the disease in the field. The removal of crop debris by light disking of fields early in spring will help reduce the disease carry-over between seasons. Refer to *Table 5* for practices used by growers in Canada to manage asparagus rust.

Resistant Cultivars: Although currently available varieties have variable tolerance to rust, none are completely resistant.

Issues for Asparagus Rust

1. The continued harmonization of pesticide registrations between Canada and the United States is very important to ensure Canadian growers remain competitive.
2. There is a need for the registration of new fungicides in new chemical families, effective against rust to prevent the development of resistance by the pathogen.
3. There is a need for the development of new monitoring methods, including the use of spore traps, for monitoring rust disease in asparagus.

Purple Spot or Stemphylium Blight (*Pleospora herbarum*, anamorph *Stemphylium vesicarium*)

Pest Information

Damage: Purple spot can infect spears, stems and foliage of asparagus. Small purple lesions, one to two millimetres in diameter, develop on the spear. If numerous, the spears will not be marketable. Light brown lesions with purple margins develop on the fern and if severe can cause defoliation and dieback. Severe defoliation can result in a weakening of the plant and yield reductions the following season.

Life Cycle: This disease overwinters as pseudothecia (spore producing structures) on fern residue. Ascospores (sexual spores) are released during cool, moist weather in the early spring and are dispersed by wind, often landing on the windward side of asparagus spears where they cause primary infections. Wounds caused by sand blasting are common infection sites, but infections may also occur through stomata and directly through the epidermis. The resulting lesions give rise to conidia (asexual spores) that cause new infections throughout the summer.

Pest Management

Cultural Controls: The removal or burying of crop residue will help reduce disease carry-over between seasons. The use of cover crops such as rye will help to reduce wounds due to sand-blasting, which are important infection sites. Reduced tillage systems are less prone to sand blasting so asparagus produced under these systems can have a lower incidence of Stemphylium blight. Refer to *Table 5* for practices used by growers in Canada to manage purple spot.

Resistant Cultivars: None identified. More recent male hybrid cultivars may have less tolerance to Stemphylium blight.

Issues for Purple Spot

1. Studies are required to determine the impact of fungicides used for rust control on overall plant health and the development of purple spot.
2. Studies are required to establish an integrated approach to the control of purple spot.
3. There is the need for the registration of additional fungicides from new families to prevent / delay the development of resistance in purple spot pathogen.
4. Monitoring methods including the use of spore traps, need to be developed to aid in the control of purple spot.

Botrytis Bight or Grey Mould (*Botrytis cinerea*)

Pest Information

Damage: Botrytis infections result in tan lesions with dark borders and yellow halos on asparagus foliage. Under warm, humid conditions and extended periods of foliar wetness,

extensive blighting can develop. Crops with dense canopies and poor air circulation are more likely to develop severe disease symptoms. Newly emerged spears may become completely blighted, turning brown to black.

Life Cycle: Botrytis has a broad host range and is a common, invader of weakened or senescent plant tissues. Masses of grey–brown spores are produced in infected tissues and crop debris and are carried on air currents to susceptible tissues where they cause new infections. Botrytis also produces resting bodies called sclerotia that enable the long-term survival of the fungus and give rise to conidia that perpetuate the disease.

Pest Management

Cultural Controls: The elimination of infected crop residue will reduce a source of the fungus in the spring. Minimizing stresses and injuries caused by other diseases and pests will help reduce the development of botrytis blight.

Resistant Cultivars: None identified.

Issues for Botrytis Blight

1. There is a need for the registration of additional fungicides for the control of botrytis blight.

Fusarium Crown and Root Rot (*Fusarium oxysporum* f. sp. *asparagi* and other *Fusarium* spp.)

Pest Information

Damage: Fusarium crown and root rot affects plants scattered randomly throughout a field. The disease causes a brown, soft rot of the roots, reddish elliptical lesions on stems at or below the soil surface and rot of crowns. Ferns may become stunted and wilted and develop yellow to brown discoloration. Affected plants produce fewer spears, and thereby have reduced yields, and eventually may die. The presence of the disease shortens the productive life of an asparagus field. New asparagus crowns planted into fields with a history of Fusarium may become stunted, yellowish and die.

Life Cycle: Fusarium crown and root rot is a soil-borne disease. Fusarium invades asparagus roots and crowns directly through root tips or wounds caused by tillage, harvesting knives, insect feeding or sand blasting. *Fusarium oxysporum* f. sp. *asparagi* can persist in the soil as chlamydospores (resting spores). Stresses caused by drought, high weed competition and over-harvesting can weaken a plant and predispose it to Fusarium crown and root rot infections.

Pest Management

Cultural Controls: Since *Fusarium* spp. are present in most soils, crown rot is almost impossible to avoid. However, maintaining vigorous plants through careful management, including the

appropriate use of fertilizer and irrigation, preventing the over-harvesting of spears and generally avoiding stress on the crop, can minimize infection early in the life of asparagus crowns. Other disease management practices include minimizing stress by planting on appropriate sites, avoiding wounding by reducing tillage and avoiding soil compaction. As *Fusarium* can build-up in soils, fields that have not previously been planted to asparagus are best for new asparagus plantings. Refer to *Table 5* for practices used by growers in Canada to manage *Fusarium* crown and root rot.

Resistant Cultivars: None available

Issues for Fusarium Crown and Root Rot

1. Fields in which asparagus has been grown previously, generally cannot be replanted to asparagus for many years because of high levels of *Fusarium* in the soil. Research is required to establish management practices that will best reduce *Fusarium* levels in these fields and minimize the chances of *Fusarium* “rebounding” once asparagus is replanted.
2. There is the need for the development of integrated pest management approaches for the control of *Fusarium*,
3. There is a need for the registration of products that provide effective control of *Fusarium* crown rot.

Phytophthora Spear Rot (*Phytophthora megasperma* f. sp. *glycinea* and *P. cryptogea*)

Pest Information

Damage: Spears affected by *Phytophthora* develop light brown lesions near the soil line.

Affected spears become “hooked” as infected tissues cease to grow. Crown vigour and the productivity of an asparagus plant can be significantly reduced by *Phytophthora* infection.

Life Cycle: This disease is soil-borne and is more likely to develop under excessively wet conditions and in areas with heavy soils and poor drainage. The fungus persists in soil as oospores (thick-walled sexual spores). The oospores germinate to produce sporangia and motile zoospores which can infect root and crown tissues. Infection occurs through wounds such as those caused by sand blasting, insect damage and other physical injuries.

Pest Management

Cultural Controls: Sites with poor drainage and heavy soils are avoided when establishing new plantings to reduce the potential for the development of *Phytophthora* spear rot. Minimizing stresses such as the depletion of carbohydrate reserves of the crown through over-harvesting, will help reduce the impact of the disease on the asparagus. Refer to *Table 5* for practices used by growers in Canada to manage *Phytophthora* spear rot.

Resistant Cultivars: None identified.

Issues for Phytophthora Spear Rot

1. Phytophthora spear rot is difficult to diagnose in the field and may be causing more yield reduction than has been recognized. Improved approaches to field diagnosis of Phytophthora spear rot are required.
2. There is a need for harmonized fungicide registrations between the United States and Canada for the control of Phytophthora spear rot to ensure Canadian growers have access to the same pest management options as their competitors.

Virus diseases: Asparagus Virus I (AVI) and II (AVII), Tobacco Streak Virus (TSV), and Cucumber Mosaic Virus (CMV)

Pest Information

Damage: The presence of AVI and AVII viruses can decrease the longevity of an asparagus plantation, reducing plant height, productivity and vigor. Infected plants may be also more susceptible to Fusarium and other root pathogens. TSV virus causes stunting and small spears, resulting in yield loss.

Life Cycle: AVI virus is transmitted by leaf-feeding insects, such as aphids, from one plant to another but not often by the asparagus aphid. AVII virus can be transmitted by seeds or by pollen. AVI and CMV are both considered as non-persistent viruses, as they are not retained by leaf-feeding insects. Asparagus AVII virus is transmitted mechanically, by pollen, infected seeds or cutting knives. Little is known on TSV in asparagus.

Pest Management

Cultural Controls: Chemical control of asparagus aphid populations will not necessarily control the transmission of non-persistent viruses such as AVI or CMV. Planting virus-free seeds, transplants or crowns are good practices. Scouting for the presence of aphids in association with changes in plant vigour can be an indication of the presence of a viral infection. Refer to *Table 5* for practices used by growers in Canada to manage virus diseases.

Issues for Virus Diseases

None identified.

Insects and Mites

Key issues

- Conventional and non-conventional products, including biopesticides need to be registered for the control of several insect pests including asparagus beetles and plant bugs.
- There is a need for the registration of additional products approved for organic production for the control of insects in asparagus.
- The general effect and potential benefit of flower strips on the presence of natural pests and predators needs further studies.

Table 6. Occurrence of insect pests in asparagus production in Canada^{1,2}

Insect and mite	Ontario	Quebec
Asparagus beetles		
Common asparagus beetle		
Spotted asparagus beetle		
Variegated cutworm and other cutworms		
Asparagus aphid		
Tarnished plant bug		
Alfalfa plant bug		
Asparagus miner		
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 pressure.		
Pest not present.		
Data not reported.		

¹Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec); the data reflect the 2018, 2017 and 2016 production years.

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

Table 7. Adoption of insect pest management practices in asparagus production in Canada¹

Practice / Pest		Asparagus beetles	Asparagus aphid	Variegated cutworm and other cutworms	Tarnished plant bug	Asparagus miner
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 or 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 to drainage, use of raised beds, hilling, mounds, etc.)					
	End of season or pre-planting crop residue removal / management					

...continued

Table 7. Adoption of insect pest management practices in asparagus production in Canada¹ (continued)

Practice / Pest		Asparagus beetles	Asparagus aphid	Variegated cutworm and other cutworms	Tarnished plant bug	Asparagus miner
Prevention	Pruning out / removal of infested material throughout the growing season					
	Tillage / cultivation to expose soil insect pests					
	Removal of other hosts (weeds / wild plants / volunteer crops) in field and vicinity					
Monitoring	Scouting / trapping					
	Maintaining records to track pests					
	Soil analysis for pests					
	Weather monitoring for degree day modelling					
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of pests					
Decision making tools	Economic threshold					
	Use of predictive model for management decisions					
	Crop specialist recommendation or advisory bulletin					
	Decision to treat based on observed presence of pest at susceptible stage of life cycle					
	Use of portable electronic devices in the field to access pest identification / management information					
Suppression	Use of diverse pesticide modes of action for resistance management					
	Soil amendments and green manuring involving soil incorporation as biofumigants to reduce pest populations					

...continued

Table 7. Adoption of insect pest management practices in asparagus production in Canada¹ (continued)

Practice / Pest		Asparagus beetles	Asparagus aphid	Variegated cutworm and other cutworms	Tarnished plant bug	Asparagus miner
	Use of biopesticides (microbial and non-conventional pesticides)					
	Release of arthropod biological control agents					
	Preservation or development of habitat to conserve or augment natural controls (e.g. preserve natural areas and hedgerows, adjust crop swathing height)					
	Mating disruption through the use of pheromones					
	Mating disruption through the release of sterile insects					
	Trapping					
	Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)					
	Selection of pesticides that are soft on beneficial insects, pollinators and other non-target organisms					
Crop specific Practices	Hand picking insects (eggs, larvae, pupae or adults) from plants					
This practice is used to manage this pest by at least some growers in the province.						
This practice is not used by growers in the province to manage this pest.						
This practice is not applicable for the management of this pest.						
Information regarding the practice for this pest is unknown.						

¹Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec); the data reflect the 2018, 2017 and 2016 production years.

Common Asparagus Beetle (*Crioceris asparagi*) and Spotted Asparagus Beetle (*Crioceris duodecimpunctata*)

Pest Information

Damage: Injury to ferns and spears is caused by feeding by the adults of both species and the larvae of the common asparagus beetle. Feeding on spears can result in misshapen spears. Feeding on the ferns can reduce the vigour of the asparagus plant. Severe defoliation can occur and potentially cause reduced yields in subsequent crops. Eggs laid on the spears in the early spring are unsightly and can result in the spears being culled. Larvae of the spotted asparagus beetle feed only on berries, reducing seed production.

Life Cycle: In the early spring, the adults begin to feed and lay eggs on newly emerged asparagus spears. The eggs hatch in one to two weeks and larvae feed for three to four weeks. Pupation occurs at or just below the soil surface. New adults emerge in late July and give rise to a second generation, which matures by September and overwinters in crop residues.

Pest Management

Cultural Controls: Allowing a row of asparagus to produce ferns early in the season has been shown to function in an ‘attract and kill’ approach for asparagus beetles. With beetles concentrated on the row of more mature plants, the individual row can be sprayed, reducing numbers of beetles in the rest of the field during harvest. Natural predators can contribute to keeping the population of asparagus beetles in check. Refer to *Table 7* for practices used by growers to manage asparagus beetles.

Resistant Cultivars: None available.

Issues for Asparagus Beetles

1. Additional information is required on the proper timing and method of application of products, for effective control of asparagus beetles.
2. Studies are needed to develop a degree day prediction model for common asparagus beetle.

Cutworms: Variegated Cutworm (*Peridroma saucia*), Dark-sided Cutworm (*Euxoa messoria*), White Cutworm (*E. scandens*), and Sandhill Cutworm (*E. detersa*)

Pest Information

Damage: Cutworms feed on the growing tips of asparagus spears. Damaged spears are culled, reducing yield. Damage is more severe in early spring when spear growth is slow and there are fewer spears.

Life Cycle: Cutworms may overwinter as eggs, larvae or pupae (depending on species and location) or adult moths may be blown northward from the United States in the spring. The overwintered larvae resume feeding mostly at night in the spring and feed until early June before they pupate in the soil. Cutworm moths lay eggs from about late June until mid-August. The eggs hatch and the larvae feed on asparagus and a variety of weeds.

Pest Management

Cultural Controls: Control is needed if five percent or more of the spears are damaged by cutworms is observed in the field or on grading line. Controlling weeds in the fall or spring will make the asparagus planting less attractive as an egg-laying site. Refer to *Table 7* for practices used by growers to manage cutworms.

Resistant Cultivars: None identified.

Issues for Cutworms

None identified.

Asparagus Aphid (*Brachycorynella asparagi*)

Pest Information

Damage: Asparagus aphids are sap-sucking insects. They feed on asparagus ferns, injecting a toxin as they feed, causing the ferns to develop bushy, distorted growth called “witches brooms”. Feeding weakens the plants resulting in the production of numerous thin spears, yield losses the following season and eventual death of the plant under heavy infestations. Seedlings and newly established fields are more susceptible to injury. Aphids may also be vectors of virus diseases.

Life Cycle: The asparagus aphid overwinters as eggs on asparagus debris. Females hatch from the eggs and produce female nymphs which mature and give rise to subsequent generations of female aphids. Aphid populations build up quickly as aphids give birth to live young. The build-up of aphid populations is favoured by hot and dry weather. A generation of winged males is produced in the late summer and early fall. Following mating, females lay overwintering eggs, completing the cycle.

Pest Management

Cultural Controls: Lady bird beetles and other natural predators normally control aphid populations; however they may not provide complete control under hot, dry conditions that favour aphid population build-up. It is important to scout fields regularly throughout the growing season as aphid numbers can increase rapidly. To monitor for aphids, which are difficult to detect visually on the plant, ferns may be shaken over a light-coloured surface. Burning old ferns will destroy overwintering eggs. The elimination of crop debris in the fall will reduce the overwintering aphid population. Refer to *Table 7* for practices used by growers to manage asparagus aphid.

Resistant cultivars: None identified.

Issues for Asparagus Aphid

None identified.

Alfalfa Plant Bug (*Adelphocoris lineolatus*)

Pest Information

Damage: Plant bugs have piercing and sucking mouth parts through which they suck plant juices. The alfalfa plant bug injects toxins into the plant while feeding resulting in wrinkling and growth distortion of spears and even plant death under severe feeding pressure. Yield losses as high as 10 percent have been reported. Alfalfa plant bugs present in nearby alfalfa fields may migrate into asparagus plantings when the alfalfa fields are cut.

Life Cycle: Adult alfalfa plant bugs overwinter in plant debris. They emerge in mid-April to late-May and feed on asparagus spears. Eggs are laid on host-plants including many weed species. Nymphs emerge 10 days later. There are two generations per year.

Pest Management

Cultural Controls: Good weed control in and around the asparagus planting will make the asparagus planting less attractive to plant bugs. Eliminating crop debris will reduce overwintering sites.

Resistant Cultivars: None identified.

Issues for Plant Bugs

1. The development of an integrated approach to the management of plant bugs in asparagus is required, including the registration of conventional and non-conventional products.

Tarnished Plant Bug (*Lygus lineolaris*)

Pest Information

Damage: Tarnished plant bugs feed on a wide variety of ornamental and vegetable plants by means of piercing and sucking mouth parts. Tarnished plant bugs cause tip dieback injury to the asparagus fern and to newly emerged spears. Injury is caused by the feeding of both adults and nymphs.

Life Cycle: Tarnished plant bugs overwinter as adults in sheltered sites. Adults become active in mid to late April with the onset of warm weather and begin to feed and lay eggs on a variety of hosts. Following egg hatch, nymphs feed and develop through five instars, before becoming adults. There are at least two generations per year, with the 1st generation appearing about two months after the over-wintering adults become active.

Pest Management

Cultural Controls: Good weed control in and around the asparagus planting will make the asparagus planting less attractive to plant bugs. Eliminating crop debris will reduce overwintering sites. Refer to *Table 7* for practices used by growers to manage plant bugs.

Resistant Cultivars: None identified.

Issues for Tarnished Plant Bugs

1. The development of an integrated approach to the management of plant bugs in asparagus is required, including the registration of conventional and non-conventional products.

Asparagus Miner (*Ophiomyia simplex*)

Pest Information

Damage: Asparagus miners feed just under the epidermis of asparagus stems. Feeding injury is apparent as twisting mines at stem bases. Plants less than five years old are preferred hosts. Although serious plant injury does not usually occur, the insect is known to spread *Fusarium* diseases.

Life Cycle: In early June, adults lay eggs beneath the epidermis of asparagus stems. Adult flies are short-lived. The eggs hatch and the first generation larvae feed until mid-July. Following pupation (in crop residues or soil), adult flies emerge and lay eggs of the second generation in late July or August. Pupae of the second generation overwinter, with adult emergence in the spring.

Pest Management

Cultural Controls: The removal of crop residues in the fall eliminates an overwintering site of the insect. Refer to *Table 7* for practices used by growers to manage asparagus miner.

Resistant Cultivars: None available.

Issues for Asparagus Miner

1. The asparagus miner is increasing in Quebec. Studies are required to determine the impact of leafminer on crop growth and vigour and to establish an economic threshold.

Key Issues

- There is a need for the registration of herbicides with short pre-harvest intervals for the control of annual grasses, perennial broadleaf weeds and horsetail at harvest.
- There is a need for the registration of herbicides for the control of both annual and perennial weeds during the growing season.
- The residual effect of herbicides over several seasons is not known. More research is needed on the impact of repeated residual herbicide applications may have on crop growth.

Table 8. Occurrence of weeds in asparagus production in Canada^{1,2}

Weeds	Ontario	Quebec
Annual broadleaf weeds		
Annual grasses		
Perennial broadleaf weeds		
Perennial grasses		
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 pressure.		
Pest not present.		
Data not reported.		

¹Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec); the data reflect the 2018, 2017 and 2016 production years.

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

Table 9. Adoption of weed management practices in asparagus production in Canada¹

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
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				

...continued

Table 9. Adoption of weed management practices in asparagus production in Canada¹ (continued)

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Decision making tools	Economic threshold				
	Crop specialist recommendation or advisory bulletin				
	Decision to treat based on observed presence of weed at susceptible stage of development				
	Decision to treat based on observed crop damage				
	Use of portable electronic devices in the field to access weed identification / management information				
Suppression	Use of diverse herbicide modes of action for resistance management				
	Soil amendments and green manuring involving soil incorporation as biofumigants to reduce weed populations				
	Use of biopesticides (microbial and non-conventional pesticides)				
	Release of arthropod biological control agents				
	Mechanical weed control (cultivation / tillage)				
	Manual weed control (hand pulling, hoeing, flaming)				
	Use of stale seedbed approach				
	Targeted pesticide applications (banding, spot treatments, use of variable rate sprayers, etc.)				
	Selection of herbicides that are soft on beneficial insects, pollinators and other non-target organisms				

...continued

Table 9. Adoption of weed management practices in asparagus production in Canada¹ (continued)

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Crop specific practices	Use of cover crop (inter-row) (fall rye)				
New practices (by province)	Flaming (Quebec)				
This practice is used to manage this pest by at least some growers in the province.					
This practice is not used by growers in the province to manage this pest.					
This practice is not applicable for the management of this pest.					
Information regarding the practice for this pest is unknown.					

¹Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec); the data reflect the 2018, 2017 and 2016 production years.

All Weeds

Pest Information

Damage: Weeds compete with asparagus for light, water and nutrients. High weed populations during establishment of an asparagus field can result in non-uniform and weak stands and may impact yields in future years. In established crops, competition from perennial weeds can reduce the vigour of the planting. Annual weed problems may develop during the spring and early summer in the absence of a crop canopy and interfere with harvest operations. High populations of persistent perennial weeds, particularly field bindweed (*Convolvulus arvensis*) may require the removal of the asparagus planting.

Life Cycle: Annual weeds - Annual weeds complete their life cycle from seed germination through vegetative growth and flowering to seed production, in one year. Annual weeds produce large numbers of seeds that can remain viable in the soil for many years, germinating when conditions are suitable. Summer annuals germinate in the spring and die before the onset of winter. Winter annuals germinate in the fall and overwinter in a vegetative state, flower in the spring, form seeds and then die.

Perennial weeds - Perennial weeds are plants that live for many years. They spread by means of seeds, vegetative structures and the expansion of various types of root systems.

Pest Management

Cultural Controls: Due to the perennial nature of asparagus, it is important to select planting sites with low populations of annual and perennial weeds or to implement weed management practices in the years prior to planting. Cultural practices that result in a uniform and vigorous stand of asparagus will minimize problems due to weeds. The introduction of seeds and perennial, vegetative reproductive structures carried on equipment or in planting materials must be avoided. In young crops, light cultivation between rows and hand removal help reduce annual weed problems. Weed populations are continually monitored throughout the lifespan of the crop. Perennial weeds tend to become more problematic as the crop ages and may require physical removal. Tillage early in the year may be used to remove stubble left from the previous year and to eliminate overwintering weeds and weeds that are newly germinating. Some hand hoeing may be used to control annual grasses. A rye cover crop seeded into the asparagus crop in the fall and “burned –off” with herbicide in the spring, will serve to kill winter annuals present and reduce the germination of summer annual weeds. Tillage is not generally used where a rye cover crop is planted. Refer to *Table 9* for practices used by growers to manage weeds.

Issues for Weeds

1. There is the need for the registration of herbicides for the control of annual grasses during harvest.
2. Problems due to herbicide-resistant annual weeds are increasing. There is a need for the registration of new herbicides with different modes of action to combat weeds.

3. There is the need for the registration of herbicides for the control of annual broadleaf weeds during harvest.
4. There is the need for the registration of herbicides for the control of perennial grasses.
5. Some perennial weeds are only suppressed and not controlled by herbicides registered for asparagus (i.e., coltsfoot, horsetail). There is a need for the development of effective controls for these weeds.

Resources

Integrated pest management / integrated crop management resources for production of asparagus in Canada

Agriculture and Agri-Food Canada. (2018). *Statistical Overview of the Canadian Vegetable Industry 2017*. Crops and Horticulture Division. AAFC No: 12868E. ISSN: 1925-3796, AAFC No: 12868E.

http://www.agr.gc.ca/resources/prod/doc/pdf/VegRep_2017-eng.pdf

Agriculture and Agri-Food Canada. (2019). Canadian Food Inspection Agency. *Asparagus variety registrations*.

<http://www.inspection.gc.ca/english/plaveg/pbrpov/cropreport/aspe.shtml>

British Columbia Agriculture. *Field Vegetables. Production Guides*.

<https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables>

Centre de référence en agriculture et agroalimentaire du Québec. <http://www.craaq.qc.ca>

Health Canada, Pest Management Regulatory Agency.

<http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php>

Manitoba Agriculture. *Vegetable Crops. Production Information on Vegetable Crops*.

<https://www.gov.mb.ca/agriculture/crops/production/vegetable-crops.html>

Ontario Ministry of Agriculture, Food and Rural Affairs. Crop Publications.

<http://www.omafra.gov.on.ca/english/crops/publications.html>

Statistics Canada. Merchandise Trade.

<https://www150.statcan.gc.ca/n1/daily-quotidien/190306/t001a-eng.htm>

Provincial Contacts

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	British Columbia Ministry of Agriculture www.gov.bc.ca/al	Susan Smith susan.l.smith@gov.bc.ca	Caroline Bédard caroline.bédard@gov.bc.ca
Manitoba	Manitoba Agriculture http://www.gov.mb.ca/agriculture/	Vikram Bisht vikram.bisht@gov.mb.ca	Colleen Flynn colleen.flynn@gov.mb.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafr.gov.on.ca	Andrew Wylie andrew.wylie@ontario.ca	Jim Chaput jim.chaput@ontario.ca
Québec	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec www.mapaq.gouv.qc.ca	Melissa Gagnon melissa.gagnon@mapaq.gouv.qc.ca	Mathieu Côté mathieu.cote@mapaq.gouv.qc.ca

Provincial and National Vegetable Grower Organizations

Asparagus Farmers of Ontario: <http://asparagus.on.ca/>

Association des producteurs maraîchers du Québec: <https://apmquebec.com/en/index.sn/>

BC Potato and Vegetable Growers Association: <http://bcfresh.ca/associations/>

Canadian Federation of Agriculture: <https://www.cfa-fca.ca/>

Canadian Horticultural Council: <http://www.hortcouncil.ca>

Canadian Organic Growers: <https://www.cog.ca/>

Vegetable Growers Association of Manitoba: <http://www.vgam.ca/>

Ontario Fruit & Vegetable Growers Association: <http://www.ofvga.org>

Appendix 1

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

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

Presence	Occurrence information				Colour Code
Present	Data available	Frequency	Distribution	Pressure	
		Yearly - Pest is present 2 or more years out of 3 in a given region of the province.	Widespread - The pest population is generally distributed throughout crop growing regions of the province. In a given year, outbreaks may occur in any region.	High - If present, potential for spread and crop loss is high and controls must be implemented even for small populations.	Red
				Moderate - If present, potential for spread and crop loss is moderate: pest situation must be monitored and controls may be implemented.	Orange
				Low - If present, the pest causes low or negligible crop damage and controls need not be implemented.	Yellow
			Localized - The pest is established as localized populations and is found only in scattered or limited areas of the province.	High - see above	Orange
				Moderate - see above	White
				Low - see above	White
		Sporadic - Pest is present 1 year out of 3 in a given region of the province.	Widespread - as above	High - see above	Orange
				Moderate - see above	Yellow
				Low - see above	White
	Localized - as above		High - see above	Yellow	
		Moderate -see above	White		
		Low - see above	White		
	Data not available	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.			White
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.			Blue		
Not present	The pest is not present in commercial crop growing areas of the province, to the best of your knowledge.				Black
Data not reported	Information on the pest in this province is unknown. No data is being reported for this pest.				Grey

References

- Atlantic Provinces Agriculture Services Coordinating Committee. Advisory Committee on vegetable Crops. *Asparagus: Vegetable Crops Production Guide for the Atlantic Provinces*. <http://www.faa.gov.nl.ca/agrifoods/plants/pdf/asparagus.pdf>
- British Columbia Agriculture. Production Guides. *Asparagus*. <https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/vegetables/asparagus>
- Centre de référence en agriculture et agroalimentaire du Québec (CRAAQ). *SAGE Pesticides*. <https://www.sagepesticides.qc.ca/>
- Foster, Rick and Brian Flood. (1995). *Vegetable Insect Management - With Emphasis on the Midwest*. Meister Publishing Company, Willoughby, Ohio.
- Howard, J.R., Garland J.A. and Seaman W.J. (1994). *Diseases and Pests of Vegetable Crops in Canada*. The Canadian Phytopathological Society and Entomological Society of Canada.
- Ontario Ministry of Agriculture, Food and Rural Affairs. *Ontario Crop IPM: Asparagus: Viruses*. <http://www.omafra.gov.on.ca/IPM/english/asparagus/diseases-and-disorders/viruses.html>
- Ontario Ministry of Agriculture, Food and Rural Affairs. (2018). *Publication 838, Vegetable Crop Protection Guide*. <http://www.omafra.gov.on.ca/english/crops/pub838/p838order.htm>
- Ontario Ministry of Agriculture, Food and Rural Affairs. (2019). *Publication 75B, Guide to Weed Control: Horticulture Crops*. <http://www.omafra.gov.on.ca/english/crops/pub75/pub75toc.htm>
- Robb, A. R. (1984). *Physiology of asparagus (Asparagus officinalis) as related to the production of the crop*. New Zealand Journal of Experimental Agriculture Vol. 12(3): 251-260.
- Thornton, R.E. (1982). Washington State University. *Washington Asparagus Production Guide*. First edition. Bulletin # EB0997. https://openlibrary.org/works/OL12215944W/Washington_asparagus_production_guide
- University of California. Agriculture and Natural Resources. (2012). *Asparagus Pest Management Guidelines – Integrated Weed Management*. <https://www2.ipm.ucanr.edu/agriculture/asparagus/integrated-weed-management/>

University of Minnesota Extension. Commercial Fruit and Vegetable Production. Asparagus production Guide.
<https://conservancy.umn.edu/handle/11299/198098>