



# CROP PROFILE FOR ASPARAGUS IN CANADA, 2015

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# Preface

National crop profiles are developed under the [Pesticide Risk Reduction Program](#) (PRRP), a joint program of [Agriculture and Agri-Food Canada](#) (AAFC) and the [Pest Management Regulatory Agency](#) (PMRA). 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, 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 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.

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

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# Crop Profile for Asparagus in Canada

Asparagus (*Asparagus officinalis*) is a member of the family Asparagaceae. 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, tender texture and for some of its 'medicinal' properties. 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.

## Crop Production

### ***Industry Overview***

Asparagus is best known (and suited) 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 produced for specialty markets.

**Table 1. General production information**

Canadian Production (2015) <sup>1</sup>	6,939 metric tonnes 1,789 hectares (area planted)
Farm gate value (2015) <sup>1</sup>	\$28 million
Food available in Canada 2015 <sup>2</sup>	0.60 kg/ person
Exports (2015) <sup>3</sup>	1,330 metric tonnes (fresh) 0 metric tonnes (canned)
Imports (2013) <sup>3</sup>	18,180 metric tonnes (fresh) 450 metric tonnes (canned)

<sup>1</sup>Statistics Canada. Table 001-0013 - Area, production and farm gate value of vegetables, annual, CANSIM (database) (accessed 2017-10-04).

<sup>2</sup>Statistics Canada. Table 002-0011 - Food available in Canada, CANSIM (database) (accessed: 2017-10 -04).

<sup>3</sup>Statistics Canada. Table 002-0010 -Supply and disposition of food in Canada, annual CANSIM (database) (accessed 2017-10-04).

## ***Production Regions***

Seventy percent (1,259 ha) of the asparagus grown in Canada is grown in Ontario. Asparagus is also grown in Quebec (364 hectares or 20% of the national acreage) and British Columbia (91 hectares or 5%).

**Table 2. Distribution of asparagus production in Canada (2015)<sup>1</sup>**

Production Regions	Area planted 2015 (hectares)	Percent National Production
British Columbia	91	5%
Alberta	X <sup>2</sup>	X <sup>2</sup>
Saskatchewan	4	<1%
Manitoba	X <sup>2</sup>	X <sup>2</sup>
Ontario	1,259	70%
Quebec	364	20%
New Brunswick	X <sup>2</sup>	X <sup>2</sup>
Nova Scotia	F <sup>3</sup>	F <sup>3</sup>
Prince Edward Island	0	0%
Newfoundland and Labrador	0	0%
Canada	1,789	100%

<sup>1</sup>Statistics Canada. Table 001-0013 - Area, production and farm gate value of vegetables, annual, CANSIM (database) (accessed 2017-10-04).

<sup>2</sup>X Suppressed to meet the confidentiality requirements of the Statistics Act

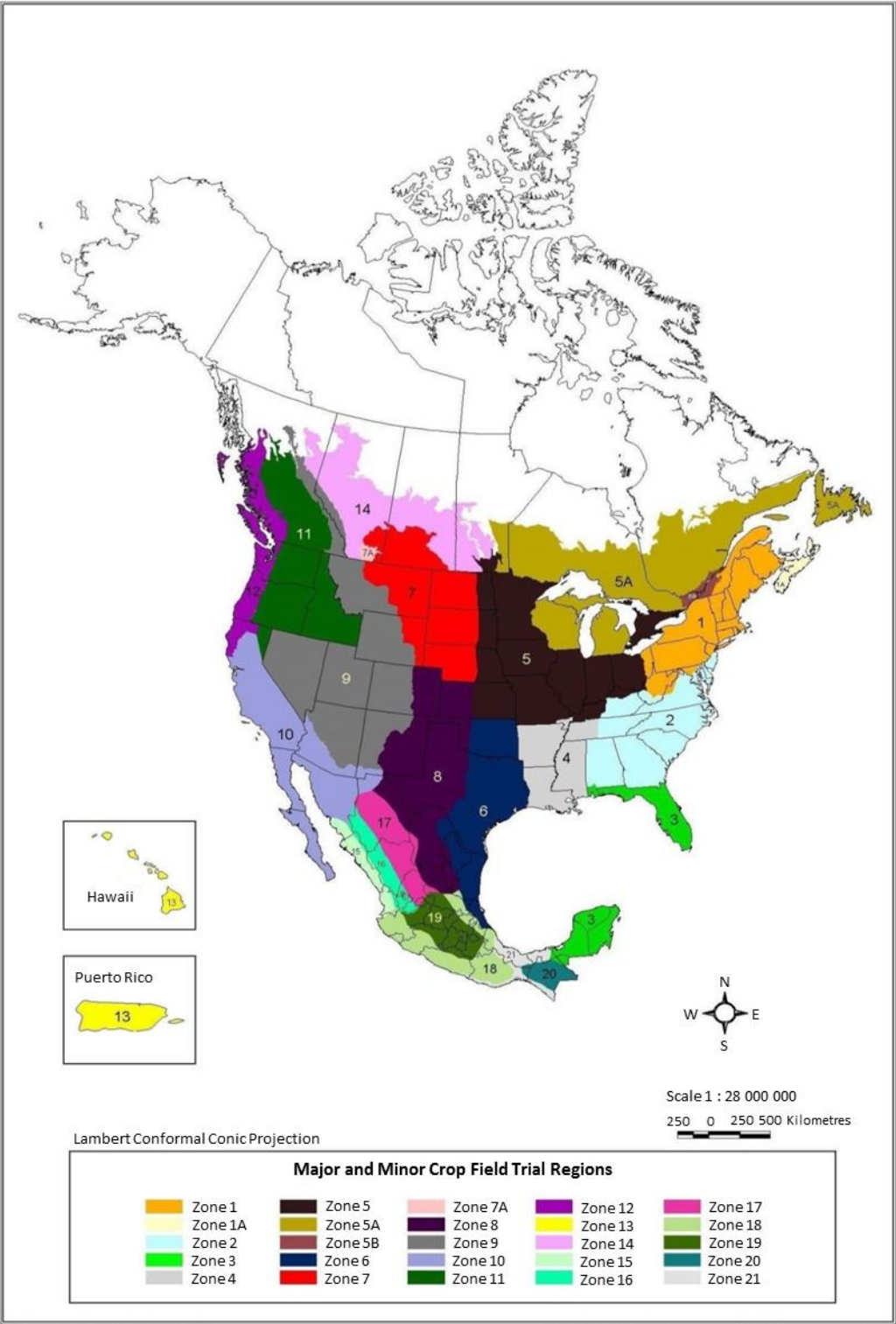
<sup>3</sup>F Too unreliable to be published

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

Major and minor crop field trial regions (figure1) were developed following stakeholder consultation and 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, 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](http://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



<sup>1</sup>Produced by: Spatial Analysis and Geomatics Applications, Agriculture Division, Statistics Canada, February 2001

## ***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. 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, seedlings 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 20 cm deep which are gradually filled-in as the asparagus plant becomes established. Plantations started with crowns may be harvested in the second year with the length of the harvest period becoming longer each year as the plants mature. Plantations that are started with seedlings will require an extra year to produce harvestable spears.

Both male and female clones of asparagus are available. The more recent asparagus introductions, from the University of Guelph Asparagus Breeding Program (<http://www.plant.uoguelph.ca/dwolyn>) and from Rutgers University in New Jersey, US are male hybrids. 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 females, 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
<b>April</b>	Plant care	Mowing of old fern stubble with rotary or flail mower
	Soil care	Application of broadcast fertilizer or disc-in lime
	Disease management	
	Insect and mite management	
	Weed management	Light disking prior to emergence of new shoots; application of pre-emergent herbicides
<b>May</b>	Plant care	Hand or machine-assisted harvest every two to three days
	Soil care	
	Disease management	
	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
<b>June</b>	Plant care	Hand or machine-assisted harvest every two to three days
	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, if necessary
	Weed management	Application of post-emergent herbicides after last harvest
<b>July</b>	Plant care	
	Soil care	
	Disease management	Fungicide applications to control asparagus rust
	Insect and mite management	Insecticide applications to control asparagus beetle or aphids, if necessary
	Weed management	Hand-hoeing, if necessary
<b>August</b>	Plant care	
	Soil care	
	Disease management	Fungicide applications to control asparagus rust
	Insect and mite management	Monitoring for aphid infestations; application of insecticides, if necessary
	Weed management	
<b>September</b>	Plant care	
	Soil care	
	Disease management	
	Insect and mite management	
	Weed management	Seeding of rye cover crops
<b>October</b>	Plant care	Clipping of ferns to 20 cm. for overwintering
	Soil care	
	Disease management	
	Insect and mite management	
	Weed management	

## ***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, also reducing 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 harmonization of fungicide registrations with the United States is important to ensure Canadian asparagus growers have access to the same pest management tools as American producers.
- There is a need for the registration of new fungicides for the control of a number of diseases of asparagus.
- Soils infested with fusarium crown rot cannot be replanted to asparagus for many years. Research is required on management practices that will reduce fusarium levels in these fields and minimize the chances of fusarium “rebounding” once asparagus is replanted.

**Table 4. Occurrence of diseases in asparagus production in Canada<sup>1,2</sup>**

Disease	Ontario	Quebec
Asparagus rust		
Botrytis blight (grey mould)		
Purple spot (stemphylium spot)		
Fusarium crown and root rot		
Phytophthora spear rot		
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.		

<sup>1</sup>Source: Asparagus stakeholders in reporting provinces.

<sup>2</sup>Refer to Appendix 1 for further information on colour coding of occurrence data.

**Table 5. Adoption of disease management practices in asparagus production in Canada<sup>1</sup>**

Practice / Pest		Asparagus rust	Fusarium crown and root rot; seedling blight	Phytophthora spear rot	Purple spot (stemphylium spot)
Avoidance	Resistant varieties				
	Planting / harvest date adjustment				
	Crop rotation				
	Choice of planting site				
	Optimizing fertilization				
	Reducing mechanical damage or insect damage				
	Thinning / pruning				
	Use of disease-free seed, transplants				
Prevention	Equipment sanitation				
	Mowing / mulching / flaming				
	Modification of plant density (row or plant spacing; seeding rate)				
	Seeding / planting depth				
	Water / irrigation management				
	End of season crop residue removal/ management				
	Pruning out / removal of infected material throughout the growing season				
	Tillage / cultivation				
	Removal of other hosts (weeds / volunteers / wild plants)				

...continued

**Table 5. Adoption of disease management practices in asparagus production in Canada<sup>1</sup> (continued)**

Practice / Pest		Asparagus rust	Fusarium crown and root rot; seedling blight	Phytophthora spear rot	Purple spot (stemphylium spot)
Monitoring	Scouting / trapping				
	Records to track diseases				
	Soil analysis				
	Weather monitoring for disease forecasting				
	Use of portable electronic devices in the field to access pest identification / management information				
	Use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				
Decision making tools	Economic threshold				
	Weather / weather-based forecast / predictive model				
	Recommendation from crop specialist				
	First appearance of pest or pest life stage				
	Observed crop damage				
	Crop stage				
Suppression	Pesticide rotation for resistance management				
	Soil amendments				
	Biopesticides				
	Controlled atmosphere storage				
	Targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				

...continued



**Table 5. Adoption of disease management practices in asparagus production in Canada<sup>1</sup> (continued)**

Practice / Pest		Asparagus rust	Fusarium crown and root rot; seedling blight	Phytophthora spear rot	Purple spot (stemphylium spot)
Crop specific practices	Avoidance of alternate hosts in crop rotation				
This practice is used by growersto manage this pest.					
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.					

<sup>1</sup>Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec).

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

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Target Site <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
<i>Bacillus subtilis</i> strain MBI600 (in growing medium)	microbial: <i>Bacillus</i> spp. and the fungicidal lipopeptides they produce	F6: lipid synthesis and membrane integrity	microbial disrupters of pathogen cell membranes	44	R	damping-off and root rot ( <i>Pythium</i> spp.)
<i>Bacillus subtilis</i> strain QST 713	microbial: <i>Bacillus</i> spp. and the fungicidal lipopeptides they produce	F6: lipid synthesis and membrane integrity	microbial disrupters of pathogen cell membranes	44	R	botrytis blight
<i>Bacillus subtilis</i> strain QST 713 (soil application)	microbial: <i>Bacillus</i> spp. and the fungicidal lipopeptides they produce	F6: lipid synthesis and membrane integrity	microbial disrupters of pathogen cell membranes	44	R	phytophthora root rot
<i>Trichoderma harzanium</i> Rifai strain KRL-AG2	biological	unknown	unknown	N/A	RE	suppression of root rot caused by <i>Pythium</i> spp., <i>Rhizoctonia</i> spp., and <i>Fusarium</i> spp.
azoxystrobin	methoxy-acrylate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	purple spot
chlorothalonil	chloronitrile (phthalonitrile)	multi-site contact activity	multi-site contact activity	M 05	RE	purple spot, rust
metam-potassium	methyl isothiocyanate generator	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	8F <sup>4</sup>	RE	weeds and germinating weed seeds, nematodes, soil-borne-diseases ( <i>Rhizoctonia</i> spp., <i>Pythium</i> spp., <i>Phytophthora</i> spp., <i>Verticillium</i> spp., <i>Sclerotinia</i> spp.)

...continued

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

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Target Site <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
metam-sodium	methyl isothiocyanate generator	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	8F <sup>4</sup>	RE	weeds, fungi, nematodes
metiram	dithiocarbamate and relatives	multi-site contact activity	multi-site contact activity	M 03	RE	rust
myclobutanil	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	rust
oriental mustard seed meal (oil) ( <i>Brassica juncea</i> )	diverse	not classified	unknown	N/ C	R	soil-borne <i>Pythium</i> spp. and <i>Fusarium</i> spp.
tebuconazole	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	rust
trifloxystrobin	oximino-acetate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	purple spot, rust

<sup>1</sup>Source: Pest Management Regulatory Agency label database ([www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php](http://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 August 28, 2017. The product label is the final authority on pesticide use and should be consulted for application information. Not all end-use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

<sup>2</sup>Source: Fungicide Resistance Action Committee. *FRAC Code List 2017: Fungicides sorted by mode of action (including FRAC code numbering)* ([www.frac.info/](http://www.frac.info/)) (accessed September 13, 2017).

<sup>3</sup>PMRA re-evaluation status: R - full registration, RE (yellow) - under re-evaluation, RES (yellow) - under special review and RES\* (yellow) - under re-evaluation and special review, as published in PMRA *Re-evaluation Note REV2017-18, Pest Management Regulatory Agency Re-evaluation and Special Review Workplan 2017-2022*, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA.

<sup>4</sup>Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 8.3; July 2017)* ([www.irac-online.org](http://www.irac-online.org)) (accessed September 14, 2017).

## 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 continually re-infect asparagus from June until September. Warm weather with heavy dew, fog, or light rainfall enhances rust development. Late in summer telia develop, producing 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. Adoption of disease management practices in asparagus production in Canada* 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.

**Control Products:** Refer to *Table 6. Fungicides and biofungicides registered for disease management in asparagus in Canada* for fungicides registered for the control of asparagus rust.

### *Issues for asparagus rust*

1. Pesticide registrations for asparagus rust need to be harmonized with the United States to ensure Canadian growers have access to the same pest management tools.
2. Further studies are required to establish the best approach to controlling rust on asparagus.

## **Botrytis blight (grey mold) (*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.

*Control Products:* Refer to Table 6. *Fungicides and biofungicides registered for disease management in asparagus in Canada* for fungicides registered for the control of botrytis blight.

### ***Issues for botrytis blight***

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

## **Purple spot (*Pleospora herbarum* ) (anamorph *Stemphylium vesicarium*)**

### ***Pest information***

*Damage:* Purple spot can infect spears, stems and foliage of asparagus. Small purple lesions one to two mm 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 (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 have lower incidences of stemphylium blight. Scouting for this disease begins immediately after harvest. Refer to *Table 5. Adoption of disease management practices in asparagus production in Canada* for practices used by growers in Canada to manage purple spot.

*Resistant Cultivars:* None identified.

*Control Products:* Refer to *Table 6. Fungicides and biofungicides registered for disease management in asparagus in Canada* for fungicides registered for the control of purple spot.

### ***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.

## **Fusarium crown and root rot (*Fusarium oxysporum* f.sp. *asparagi*, *F. moniliforme*)**

### ***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 discolouration 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 the field. Seedlings planted into fields with fusarium may become stunted and yellowed and may be killed.

*Life Cycle:* This 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. *F. 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.

### ***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 crowns. Other disease management practices include minimising 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. Adoption of disease management practices in asparagus production in Canada* for practices used by growers in Canada to manage fusarium crown and root rot.

**Resistant Cultivars:** None available

**Control Products:** Refer to *Table 6. Fungicides and biofungicides registered for disease management in asparagus in Canada* for fungicides registered for the control of fusarium crown and root rot.

### ***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.

## **Phytophthora spear rot (*Phytophthora asparagi*)**

### ***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. Adoption of disease management practices in asparagus production in Canada* for practices used by growers in Canada to manage phytophthora spear rot.

**Resistant Cultivars:** None identified.

*Control Products:* Refer to *Table 6. Fungicides and biofungicides registered for disease management in asparagus in Canada* for fungicides registered for the control of diseases caused by phytophthora.

<b><i>Issues for phytophthora spear rot</i></b>
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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.



## Insects and Mites

### Key issues

- The harmonization of pesticide registrations with the United States is important to ensure Canadian asparagus growers have access to the same pest management tools as American producers.
- The registration of reduced risk insecticides is required for the management of a number of insect pests on asparagus including asparagus beetles, plant bugs and thrips.

**Table 7. Occurrence of insect pests in asparagus production in Canada<sup>1,2</sup>**

Insect	Ontario	Quebec
Asparagus beetles		
Common asparagus beetle		
Spotted asparagus beetle		
Variegated cutworm and other cutworms		
Asparagus aphid		
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 importance.		
Data not reported.		

<sup>1</sup>Source: Asparagus stakeholders in reporting provinces.

<sup>2</sup>Refer to Appendix 1 for further information on colour coding of occurrence data.

**Table 8. Adoption of insect pest management practices in asparagus production in Canada<sup>1</sup>**

Practice / Pest		Asparagus beetles	Asparagus aphids	Variegated cutworm and other cutworms	Asparagus miner
Avoidance	Resistant varieties				
	Planting / harvest date adjustment				
	Crop rotation				
	Choice of planting site				
	Optimizing fertilization				
	Reducing mechanical damage				
	Thinning / pruning				
	Trap crops/ perimeter spraying				
	Physical barriers				
Prevention	Equipment sanitation				
	Mowing / mulching / flaming				
	Modification of plant density (row or plant spacing; seeding rate)				
	Seeding depth				
	Water / irrigation management				
	End of season crop residue removal / management				
	Pruning out/ removal of infested material throughout the growing season				
	Tillage / cultivation				
	Removal of other hosts (weeds/ volunteers/ wild plants)				

...continued

**Table 8. Adoption of insect pest management practices in asparagus production in Canada<sup>1</sup> (continued)**

Practice / Pest		Asparagus beetles	Asparagus aphids	Variegated cutworm and other cutworms	Asparagus miner
Monitoring	Scouting / trapping				
	Records to track pests				
	Soil analysis				
	Weather monitoring for degree day modelling				
	Use of portable electronic devices in the field to access pest identification /management information				
	Use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				
Decision making tools	Economic threshold				
	Weather / weather-based forecast / predictive model (eg. degree day modelling)				
	Recommendation from crop specialist				
	First appearance of pest or pest life stage				
	Observed crop damage				
	Crop stage				

...continued

**Table 8. Adoption of insect pest management practices in asparagus production in Canada<sup>1</sup> (continued)**

Practice / Pest		Asparagus beetles	Asparagus aphids	Variegated cutworm and other cutworms	Asparagus miner
Suppression	Pesticide rotation for resistance management				
	Soil amendments				
	Biopesticides				
	Release of arthropod biological control agents				
	Habitat management to enhance natural controls				
	Ground cover / physical barriers				
	Pheromones (eg. mating disruption)				
	Sterile mating technique				
	Trapping				
	Targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				
Crop specific Practices	Hand -picking insects (eggs, larvae, pupae or adults) from plants				
This practice is used by growers to manage this pest.					
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.					

<sup>1</sup>Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec).

**Table 9. Insecticides and bioinsecticides registered for insect management in asparagus production in Canada**

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
acetamiprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) competitive modulator	4A	R	asparagus aphid, asparagus beetle,
alkanolamine salts of fatty acids	not classified	unknown	N/A	R	aphids, mealybugs, spider mites, whiteflies, soft brown scale, psyllids, rose and pear slugs, earwigs
<i>Beauveria bassiana</i> strain <i>GHA</i>	biological	unknown	N/A	R	whiteflies, aphids, thrips
canola oil	not classified	unknown	N/A	R	aphids, mealybugs, mites, scales, whiteflies
carbaryl	carbamate	acetylcholinesterase (AChE) inhibitor	1A	RES	asparagus beetle, climbing cutworms
cypermethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	asparagus beetle
deltamethrin (eastern Canada and British Columbia)	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	asparagus beetle

...continued

**Table 9. Insecticides and bioinsecticides registered for insect management in asparagus production in Canada (continued)**

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
dimethoate	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	R	asparagus aphid
lambda-cyhalothrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	European asparagus aphid,
malathion	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	R	asparagus beetle
metam-sodium	methyl isothiocyanate generator	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	8F (IRAC)	RE	symphylans (garden centipede)
methyl bromide	alkyl halide	miscellaneous non-specific (multi-site) inhibitor	8A	PO	many insects, weeds, nematodes and other soil-borne pests
permethrin (asparagus transplants)	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	cutworms (army, black, dark-sided, pale western, red-backed, white)
potassium salts of fatty acids	not classified	unknown	N/A	R	aphids, mealybugs, spider mites, whiteflies, soft brown scale, psyllids, rose or pear slugs, earwigs, elm leafminer

...continued

**Table 9. Insecticides and bioinsecticides registered for insect management in asparagus production in Canada (continued)**

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
pyrethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	aphids, mealybugs, spider mites, whitefly, soft brown scale, psyllids, earwigs, beetles, caterpillars and other insects
spinetoram	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric modulator	5	R	asparagus beetle (suppression)
spinosad	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric modulator	5	R	asparagus beetle

<sup>1</sup>Source: Pest Management Regulatory Agency label database ([www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php](http://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 August 28, 2017. The product label is the final authority on pesticide use and should be consulted for application information. Not all end-use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

<sup>2</sup>Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 8.3; July 2017)* ([www.irac-online.org](http://www.irac-online.org)) (accessed Sept. 14, 2017).

<sup>3</sup>PMRA re-evaluation status: R - full registration, RE (yellow) - under re-evaluation, RES (yellow) - under special review and RES\* (yellow) - under re-evaluation and special review, as published in PMRA *Re-evaluation Note REV2017-18, Pest Management Regulatory Agency Re-evaluation and Special Review Workplan 2017-2022*, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA.

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

## 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. 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 within the berries, reducing seed production.

**Life Cycle:** Crop residues provide overwintering sites for adults of both species of beetles. 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.

### *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 8. Adoption of insect pest management practices in asparagus production in Canada* for practices used by growers to manage asparagus beetles.

**Resistant Cultivars:** None available.

**Control Products:** Refer to *Table 9. Insecticides and bioinsecticides registered for insect management in asparagus production in Canada* for insecticides registered for the control of asparagus beetles.

### *Issues for asparagus beetles*

1. There is a need for the registration of reduced risk pesticides for the management of asparagus beetles. As the crop is harvested daily, newly registered pesticides must have short pre-harvest intervals.



## **Variegated cutworm (*Peridroma saucia*) and other cutworms**

### ***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 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:* Refer to *Table 8. Adoption of insect pest management practices in asparagus production in Canada* for practices used by growers to manage cutworms.

*Resistant Cultivars:* None identified.

*Control Products:* Cutworm damage often first occurs at the field borders and can be minimized by spot spraying. Refer to *Table 9. Insecticides and bioinsecticides registered for insect management in asparagus production in Canada* for insecticides registered for the control of cutworms.

### ***Issues for cutworms***

None identified.

## **Asparagus aphid (*Brachycorynella asparagi*)**

### ***Pest information***

*Damage:* Asparagus aphids feed on ferns, injecting a toxin as they feed, causing the ferns to develop bushy, distorted growth. Feeding weakens the plants resulting in 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 that feed on aphids may not provide complete control especially 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 are shaken over a light coloured surface. The elimination of crop debris in the fall will reduce the overwintering aphid population. Refer to *Table 8. Adoption of insect pest management practices in asparagus production in Canada* for practices used by growers to manage asparagus aphid.

*Resistant cultivars:* None identified.

*Control Products:* Refer to *Table 9. Insecticides and bioinsecticides registered for insect management in asparagus production in Canada* for insecticides registered for the control of asparagus aphid.

### ***Issues for asparagus aphid***

1. It is difficult to scout for aphids and this pest is under-reported.

## **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% have been reported. Alfalfa plant bugs present in nearby alfalfa fields may migrate into asparagus plantings when the alfalfa fields are cut.

*Life Cycle:* The alfalfa plant bug overwinters 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. Nymphs hatch from the eggs and begin to feed. There are at least two generations per year, with the first generation appearing about two months after the overwintering 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.

*Resistant Cultivars:* None identified.

*Control Products:* None available.

### ***Issues for alfalfa plant bugs***

1. The development of an integrated approach to the management of plant bugs in asparagus is required, including the registration of reduced risk 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.

*Life Cycle:* In early June, adults lay eggs beneath the epidermis of asparagus stems. 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 8. Adoption of insect pest management practices in asparagus production in Canada* for practices used by growers to manage asparagus miner.

*Resistant Cultivars:* None available.

*Control Products:* None available

### ***Issues for asparagus miner***

None identified.

## **Weeds**

### ***Key Issues***

- There is a need for the harmonization of herbicide registrations with the United States to ensure Canadian growers have access to the same pest management tools.
- There is a need for the registration of herbicides with short pre-harvest intervals for the control of annual grasses at harvest.

**Table 10. Occurrence of weeds in asparagus production in Canada<sup>1,2</sup>**

Weed	Ontario	Quebec
<b>Annual grasses</b>		
Barnyard grass		
Crabgrass		
Foxtails		
<b>Annual broadleaf weeds</b>		
Canada fleabane		
Common chickweed		
Common ragweed		
Hemp-nettle		
Lamb's-quarters		
Redroot pigweed		
Wild buckwheat		
<b>Perennial grasses</b>		
Quackgrass		
<b>Perennial broadleaf weeds</b>		
Broad-leaved plantain		
Canada thistle		
Colt's-foot		
Common milkweed		
Dandelion		
Field bindweed		
Mouse-eared chickweed		
Perennial sow thistle		
Tufted vetch		
<b>Other weeds</b>		
Field horsetail		
Yellow nut sedge		
<b>Widespread yearly occurrence with high pest pressure.</b>		
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.		

<sup>1</sup>Source: Asparagus stakeholders in reporting provinces.

<sup>2</sup>Refer to Appendix 1 for further information on colour coding of occurrence data.

**Table 11. Adoption of weed management practices in asparagus production in Canada<sup>1</sup>**

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Avoidance	Planting / harvest date adjustment				
	Crop rotation				
	Choice of planting site				
	Optimizing fertilization				
	Use of weed-free seed				
Prevention	Equipment sanitation				
	Mowing / mulching / flaming				
	Modification of plant density (row or plant spacing; seeding)				
	Seeding / planting depth				
	Water / irrigation management				
	Weed management in non-crop lands				
	Weed management in non-crop years				
	Tillage / cultivation				
Monitoring	Scouting / field inspection				
	Field mapping of weeds / record of resistant weeds				
	Soil analysis				
	Use of portable electronic devices in the field to access pest identification/management information				
	Use of precision agriculture technology (GPS, GIS) for data collection and field mapping of pests				

...continued

**Table 11. Adoption of weed management practices in asparagus production in Canada<sup>1</sup> (continued)**

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
<b>Decision making tools</b>	Economic threshold				
	Weather / weather-based forecast / predictive model				
	Recommendation from crop specialist				
	First appearance of weed or weed growth stage				
	Observed crop damage				
	Crop stage				
<b>Suppression</b>	Pesticide rotation for resistance management				
	Soil amendments				
	Biopesticides				
	Release of arthropod biological control agents				
	Habitat / environment management				
	Ground cover/ physical barriers				
	Mechanical weed control				
	Targeted pesticide applications (banding, perimeter sprays, variable rate sprayers, GPS, etc.)				

...continued

**Table 11. Adoption of weed management practices in asparagus production in Canada<sup>1</sup> (continued)**

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Crop specific practices	Manual weeding				
New practices (by province)	Planting fall rye between the rows of asparagus (Quebec)				
This practice is used by growers to manage this pest.					
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.					

<sup>1</sup>Source: Asparagus stakeholders in reporting provinces (Ontario and Quebec).



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

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
2,4-D (eastern Canada only)	phenoxy-carboxylic-acid	synthetic auxin	4	RES	annual and perennial broadleaf weeds
diquat	bipyridylum	photosystem-I-electron diversion	22	R	annual weeds
diuron (established plantings only)	urea	inhibition of photosynthesis at photosystem II site A	7	R	annual and perennial weeds
fenoxaprop-P-ethyl (eastern Canada and British Columbia only)	aryloxyphenoxy-propionate 'FOP'	inhibition of acetyl CoA carboxylase (ACCase)	1	R	green foxtail, yellow foxtail, crabgrass, wild proso millet, fall panicum, old witchgrass, volunteer corn
fluazifop-P-butyl and S-isomer	aryloxyphenoxy-propionate 'FOP'	inhibition of acetyl CoA carboxylase (ACCase)	1	R	grass weeds
flumioxazin (dormant asparagus established for at least one year)	N-phenylphthalimide	inhibition of protoporphyrinogen oxidase (Protox, PPO)	14	R	redroot pigweed, green pigweed, common ragweed, common lamb's-quarters, green foxtail, hairy nightshade, dandelion, eastern black nightshade, kochia, Canada fleabane

...continued

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

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
glufosinate ammonium (eastern Canada and British Columbia) (stale seedbed, direct seeded, established beds after harvest)	phosphinic acid	inhibition of glutamine synthetase	10	R	annual weeds
glufosinate ammonium + glyphosate	phosphinic acid + glycine	inhibition of glutamine synthetase + inhibition of 5-enolpyruvyl-shikimate-3-phosphate synthase (EPSPS)	10 + 9	R + R	many herbaceous plants
glyphosate	glycine	inhibition of 5-enolpyruvyl-shikimate-3-phosphate synthase (EPSPS)	9	R	annual and perennial weeds, trees and woody brush
halosulfuron	sulfonylurea	inhibition of acetolactate synthase (ALS) or acetohydroxyacid synthase (AHAS)	2	R	nutsedge, broadleaf weeds
linuron	urea	inhibition of photosynthesis at photosystem II site A	7	RES*	annual weeds

...continued

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

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
mesotrione (established asparagus)	triketone	inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	27	R	lamb's-quarters, redroot pigweed, velvetleaf, wild mustard, common ragweed (suppression only)
metam-potassium	methyl isothiocyanate generator	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	8F <sup>5</sup>	RE	weeds, germinating weeds, nematodes, soil-borne diseases
metam-sodium	methyl isothiocyanate generator	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	8F5	RE	germinating weed seeds, perennial weeds (suppression), symphylans (garden centipede) soil-borne diseases, nematodes
methyl bromide (fumigant, pre-plant soil application)	alkyl halide <sup>4</sup>	miscellaneous non-specific (multi-site) inhibitor <sup>4</sup>	8A <sup>4</sup>	PO	insects, weeds, nematodes, other soil borne pests
metribuzin	triazinone	inhibition of photosynthesis at photosystem II site A	5	R	certain annual grasses and broadleaf weeds

...continued

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

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
mineral spirits	not classified	unknown	N/A	RE	seedling bluegrasses, chickweed, barnyard grass, other weeds
napropamide	acetamide	inhibition of mitosis	15	R	annual grasses and broadleaf weeds
paraquat	bipyridylum	photosystem-I-electron diversion	22	R	grasses and broadleaf weeds
S-metolachlor and R-enantiomer	chloroacetamide	inhibition of mitosis	15	RE	annual grasses and broadleaf weeds
sethoxydim	cyclohexanedione 'DIM'	inhibition of acetyl CoA carboxylase (ACCase)	1	R	annual grasses, wild oats, volunteer cereales, quackgrass
simazine and related triazines (established plantings only)	triazine	inhibition of photosynthesis at photosystem II site A	5	R	broadleaf weeds, annual grasses, most perennial species starting freshly from seed
sulfentrazone (crowns established for one or more years)	triazolinone	inhibition of protoporphyrinogen oxidase (Protox, PPO)	14	R	annual grasses and broadleaf weeds

...continued

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

Active Ingredient <sup>1</sup>	Classification <sup>2</sup>	Mode of Action <sup>2</sup>	Resistance Group <sup>2</sup>	Re-evaluation Status <sup>3</sup>	Targeted Pests <sup>1</sup>
terbacil (direct seeded asparagus and established beds)	uracil	inhibition of photosynthesis at photosystem II site A	5	R	annual weeds; partial control of quackgrass, horsenettle and yellow nutsedge
trifluralin (asparagus established three years or more)	dinitroaniline	microtubule assembly inhibition	3	R	certain annual grasses and annual broadleaf weeds

<sup>1</sup>Source: Pest Management Regulatory Agency label database ([www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php](http://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 September 1, 2017. The product label is the final authority on pesticide use and should be consulted for application information. Not all end-use products containing a particular active ingredient may be registered for use on this crop. The information in this table should not be relied upon for pesticide application decisions and use.

<sup>2</sup>Source: Weed Science Society of America (WSSA). Herbicide Mechanism of Action (MOA) Classification list (last modified August 16, 2017) <http://wssa.net> (accessed Sept. 13, 2017)

<sup>3</sup>PMRA re-evaluation status: R - full registration, RE (yellow) - under re-evaluation, RES (yellow) - under special review and RES\* (yellow) - under re-evaluation and special review, as published in PMRA *Re-evaluation Note REV2017-18, Pest Management Regulatory Agency Re-evaluation and Special Review Workplan 2017-2022*, DI (red) - discontinued by registrant, PO (red) - being phased out as a result of re-evaluation by the PMRA.

<sup>4</sup>Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 8.3; July 2017)* ([www.irac-online.org](http://www.irac-online.org)) (accessed Sept. 14, 2017).

## 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 a 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. 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. Annual weeds produce large numbers of seeds that can remain viable in the soil for many years, germinating when conditions are suitable.

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 vegetative structures, on equipment or in planting materials, from which perennial weeds can regenerate, 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 annuals. Tillage is not generally used where a rye cover crop is planted. Refer to *Table 11. Adoption of weed management practices in asparagus production in Canada* for practices used by growers to manage weeds.

**Control Products:** Refer to *Table 12. Herbicides and bioherbicides registered for weed management in asparagus production in Canada* for herbicides registered for the control of weeds.

<i>Issues for weeds</i>
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1. There is a need for the registration of herbicides with short pre-harvest intervals for the control of annual grasses during the harvest period.
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. Some perennial broadleaf weeds are only suppressed and not controlled by herbicides registered for asparagus.

## Resources

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

#### **Websites**

Agri-Reseau <http://www.agrireseau.qc.ca>

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

Ontario Ministry of Agriculture and Food. Ontario Crop IPM  
<http://www.omafr.gov.on.ca/IPM/english/>

Sage Pesticides. <http://www.sagepesticides.qc.ca/default.aspx>

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

#### **Publications**

Howard, J.R., Garland J.A. and Seaman W.J., 1994, *Disease and Pests of Vegetable Crops in Canada*. The Canadian Phytopathological Society and Entomological Society of Canada  
<http://phytopath.ca/>

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

Ontario Ministry of Agriculture, Food and Rural Affairs. *Publication 75, Guide to Weed Control 2016-17* <http://www.omafr.gov.on.ca/english/crops/pub75/pub75toc.htm>

Ontario Ministry of Agriculture and Food. *Ontario Vegetable Production Recommendations (2010-11) OMAF Publication 363*  
<http://www.omafr.gov.on.ca/english/crops/vegpubs/vegpubs.htm>

Ontario Ministry of Agriculture and Food. *Ontario Vegetable Crop Protection Guide (2014-15) OMAF Publication 838<sup>E</sup>; 2016 Supplement (838S)*  
<http://www.omafr.gov.on.ca/english/crops/vegpubs/vegpubs.htm>



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

<b>Province</b>	<b>Ministry</b>	<b>Crop Specialist</b>	<b>Minor Use Coordinator</b>
<b>Ontario</b>	Ontario Ministry of Agriculture, Food and Rural Affairs <a href="http://www.omafra.gov.on.ca">www.omafra.gov.on.ca</a>	Elaine Roddy <a href="mailto:elaine.rodny@ontario.ca">elaine.rodny@ontario.ca</a>	Jim Chaput <a href="mailto:jim.chaput@ontario.ca">jim.chaput@ontario.ca</a>
<b>Quebec</b>	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec <a href="http://www.mapaq.gouv.qc.ca">www.mapaq.gouv.qc.ca</a>	Pierrot Ferland <a href="mailto:pierrot.ferland@mapaq.gouv.qc.ca">pierrot.ferland@mapaq.gouv.qc.ca</a>	Luc Urbain <a href="mailto:luc.urbain@mapaq.gouv.qc.ca">luc.urbain@mapaq.gouv.qc.ca</a>

## ***National and Provincial Vegetable Grower Organizations***

### **Provincial**

Conseil Québécois de l'horticulture (CQH) <http://www.cqh.ca>

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

Ontario Asparagus Marketing Board <http://www.asparagus.on.ca>

### **National**

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

## 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, 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.

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 our knowledge.				Black
Data not reported	Information on the pest in this province is unknown. No data is being reported for this pest.				Grey

## References

- 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.
- Ohio State University. Ohio State University. *Bulletin #826 Asparagus Production, Management & Marketing*. <http://ohioline.osu.edu/b826/>
- Ontario Ministry of Agriculture, Food and Rural Affairs. Ontario CropIPM <http://www.omafra.gov.on.ca/IPM/english>
- University of California Agriculture and Natural Resources. Asparagus Pest Management Guidelines – Integrated Weed Management February 2012 <http://ipm.ucanr.edu/PMG/r7700111.html> (accessed April 21, 2017)
- University of Minnesota Extension. Commercial Fruit and Vegetable Production. Asparagus production Guide. <https://www.extension.umn.edu/garden/fruit-vegetable/asparagus-production-guide/index.html> (accessed Aug. 8, 2017)
- Washington State University Bulletin # EB0997. 1982. *Washington Asparagus Production Guide*. [https://openlibrary.org/works/OL12215944W/Washington\\_asparagus\\_production\\_guide](https://openlibrary.org/works/OL12215944W/Washington_asparagus_production_guide)
- 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
- Asparagus: Vegetable Crops Production Guide for the Atlantic Provinces <http://www.faa.gov.nl.ca/agrifoods/plants/pdf/asparagus.pdf> (accessed Feb 23, 2017)