CROP PROFILE FOR SWEET CORN IN CANADA, 2015

PREPARED BY:
Pesticide Risk Reduction Program
Pest Management Centre
Agriculture and Agri-Food Canada

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Canada

Third Edition - 2018
Crop Profile for Sweet Corn in Canada, 2015
Catalogue No. A118-10/14-2015E-PDF
ISBN: 978-0-660-24794-6
AAFC No. 12751E

Second Edition - 2014
Crop Profile for Sweet Corn in Canada, 2012
Catalogue No. A118-10/14-2014E-PDF
ISBN: 978-1-100-24676-5
AAFC No. 12214E

First Edition – 2006
Crop Profile for Sweet Corn in Canada
Catalogue No.: A118-10/14-2006E-PDF

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

Paru également en français sous le titre: « Profil de la culture du maïs sucré au Canada, 2015 »

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 under the Pesticide Risk Reduction Program (PRRP), a program of Agriculture and Agri-Food Canada (AAFC). The national crop profiles provide baseline information on crop production and pest management practices and document the pest management needs and issues faced by growers. This information is developed through extensive consultation with stakeholders.

Information on pest management practices and pesticides is provided for information purposes only. No endorsement of any pesticide or pest control technique, 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 sweet corn the reader is referred to provincial crop production guides and provincial ministry websites listed in the Resources Section at the end of the profile.

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

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

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

Pesticide Risk Reduction Program
Pest Management Centre
Agriculture and Agri-Food Canada
Building 57, 960 Carling Ave
Ottawa, ON, Canada K1A 0C6
pmc.cla.info@agr.gc.ca

Contents

List of Tables and Figure

Crop Profile for Sweet Corn in Canada

Corn (*Zea mays*) is a member of the grass (*Poaceae*) family. It has been grown as a farm crop for more than 800 years. The crop is generally considered to have originated from a grassy weed commonly found in Central and South America. Plant selection by native farmers resulted in changes in the genetic makeup of the species over time. Immigrant European farmers who grew corn in the United States and adjacent areas of southern Canada continued this process. Two types of corn emerged from this genetic selection, field corn and sweet corn. Today, field corn is mainly used as animal feed or for industrial uses while sweet corn, with its higher sugar content, is used for human consumption. This sweet trait resulted from a mutation in the starchy gene (*su*) which is commonly found in field corn. Two other genes that have been identified and contribute to the sweetness of corn are the surgary extender gene (*se*) and shrunken or supersweet gene (*sh2*). Modern sweet corn varieties have combinations of the *su, se* and *sh2* genes and other genes governing flavour, resulting in varieties with differing levels of sweetness (and shelf life).

Sweet corn is consumed both as a fresh vegetable and processed product. When used as a fresh crop, sweet corn must be refrigerated immediately and moved to market quickly in order to retain its sweet quality, which means fresh sweet corn is rarely exported to other countries.

Sweet corn is one of the major field grown vegetable crops in Canada, with a farm gate value of $77.5 million in 2015, placing it third in vegetable crop value behind carrots and tomatoes. Annual Canadian sweet corn production ranges between 200,000 and 250,000 metric tonnes. Sweet corn is grown in all provinces on close to 20,000 hectares of land, making it the most extensively planted vegetable in Canada.

Crop Production

Industry Overview

Harvested sweet corn is purchased by consumers in four markets: fresh, baby corn (often frozen), frozen and canned. While sweet corn is commonly seen in late summer and early fall as a fresh product in grocery stores and country markets, only about 25 percent of the sweet corn grown in Canada is used for this end. Baby corn, which is hand harvested two days after the silks appear, makes up a small portion of sweet corn sales. The majority of sweet corn is used for processing as a frozen or canned product. Sweet corn is also made into breakfast cereal, bread, snack foods and corn syrup. It is also used to make bourbon or whisky.

Table 1. General production information

Canadian production (2015)[1]	220,000 metric tonnes 19,246 hectares
Farm gate value (2015)[1]	$77.5 million
Sweet corn available for consumption in Canada 2015[2]	3.21 kg/ person (fresh)
	0.95 kg/person (canned)
	0.34 kg/person (frozen)
Export (2015)[3]	$34.9 million (fresh and frozen)
	19,166 metric tonnes (fresh and frozen)
Imports (2015)[3]	$63.9 million (fresh and frozen)
	55,501 metric tonnes (fresh and frozen)

[1]Statistics Canada. Table 001-0013 - Area, production and farm gate value of vegetables, annual CANSIM (database) (accessed: 2017-10-17).
[2]Statistics Canada. Table 002-0011 - Food available in Canada, annual (kilograms per person, per year unless otherwise noted), annual CANSIM (database) (accessed: 2017-10-17).
[3]Source: Agriculture and Agri-Food Canada. Statistical Overview of the Canadian Vegetable Industry 2015 AAFC No. 12583E-PDF.

Production Regions

Sweet corn is grown in all regions of Canada, with the majority of production occurring in Ontario (8,903 ha or 46.3 percent of the national acreage) and Quebec (7,309 ha or 38 percent of the national acreage). Significant production of sweet corn also occurs in the provinces of British Columbia (1,039 ha or 5.4 percent of the national acreage) and Alberta (1,401 ha or 7.3 percent) (Table 2).

Table 2. Distribution of sweet corn production in Canada (2015)[1]

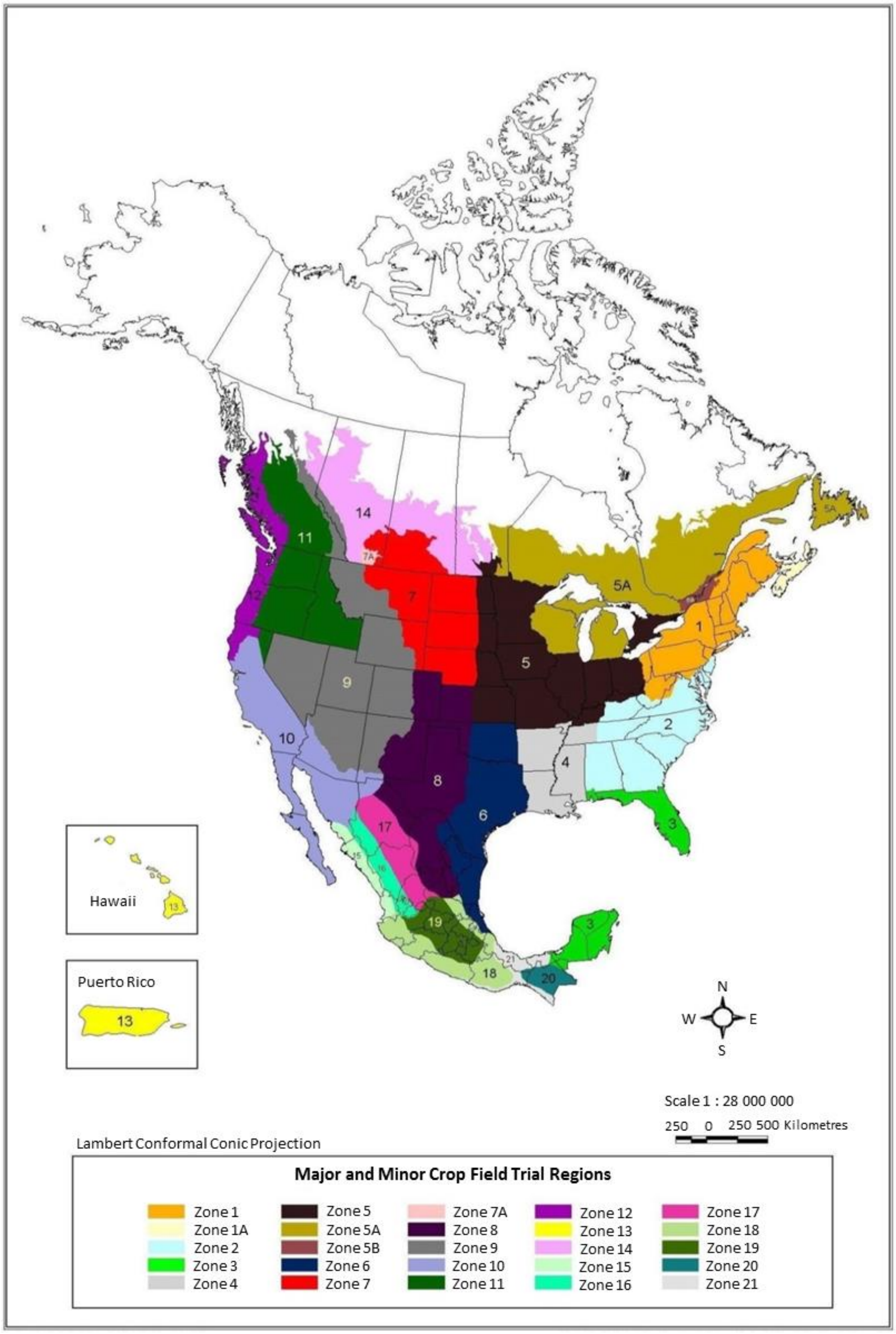
Production Regions	Seeded area (hectares)	Percent national production
British Columbia	1,039	5.4%
Alberta	1,401	7.3%
Saskatchewan	56	0.3%
Manitoba	219	1.1%
Ontario	8,903	46.3%
Quebec	7,309	38%
New Brunswick	129	0.7%
Nova Scotia	170	0.9%
Prince Edward Island	F[2]	F[2]
Newfoundland and Labrador	F[2]	F[2]
Canada	19,246	100%

[1]Source: Statistics Canada, Table 001-0013 - Area, production and farm gate value of vegetables, annual CANSIM (database) (accessed 2017-10-17).
[2] 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).

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



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

Cultural Practices

Sweet corn can be grown on most soil types but the crop does best on well-drained soils or soils that are effectively tile drained. Sandy soils warm faster in spring and are more suitable for early plantings, whereas for late season production, clay and loamy soils, which hold more water, are more suitable. Avoiding growing sweet corn in rotation after field corn will help reduce possible insect and disease carryover in the soil. For corn production, soil pH is maintained between 6.2 and 6.5. Most corn requires supplemental nitrogen, either through biological amendments, such as manure or from synthetic fertilizers or from a combination of both. Generally, nitrogen applications can be timed to match the needs of the growing corn. Usually a portion of the nitrogen is applied at the time of planting, with the remainder side-dressed or top-dressed when the corn is about a foot in height.

Seed selection is critical to match maturity and adaptability to local soil and climatic conditions. Sweet corn is planted throughout the spring and early summer to ensure a constant harvest supply throughout the summer and early fall. Seeding depths are adjusted based on the soil temperature and texture, and may be anywhere from two to seven cm.

Pollination is extremely important in the production of sweet corn and for optimum performance, a variety is grown in isolation from other varieties with incompatible genotypes. For example, pollen from field corn can make the sweet corn starchy. The pollination of *sh2* varieties by *su* and *se* types will also result in starchiness.

The number of days from planting to maturity varies among corn varieties; most sweet corn varieties are ready for harvest about 18 to 21 days after 50 percent silk, or about 16 to18 days after full silk.

The use of cover crops may be an important tool in sustainable field vegetable production, with many cover crops recognized to provide benefits in suppression of nematodes, weeds and other pests, as well as improving soil tilth and optimizing nutrient cycling. A tool to assist growers make scientifically sound cover crop choices is available for field vegetable production. This Cover Crops Decision tool (http://decision-tool.incovercrops.ca/) can be used for sweet corn production.

Table 3. Sweet corn production and pest management schedule in Canada

Time of Year	Activity	Action
May	Plant care	Seeding in medium-heavy, well drained , loamy soil with organic matter , with an average pH of 6.2 to 6.5 and when soil temperature reaches a minimum of 10^{o}C
	Soil care	Fertilization and cultivation
	Disease management	Late planting in warm soil, using disease tolerant or resistant varieties
	Insect and mite management	Late, shallow planting in warm soil
	Weed management	Cultivation and eliminating weeds from within as well as the perimeter of fields; use of cover crops
June	Plant care	Second successive planting (three weeks after first planting)
	Soil care	Use of mulch for moisture retention
	Disease management	Monitoring and spraying when necessary
	Insect and mite management	Monitoring and spraying when necessary
	Weed management	Cultivation and eliminating weeds from within as well as the perimeter of field
July	Plant care	Third successive planting (three weeks after second planting)
	Soil care	None
	Disease management	Monitoring and spraying when necessary
	Insect and mite management	Monitoring and spraying when necessary
	Weed management	Limited activity
August	Plant care	First harvest
	Soil care	None
	Disease management	Monitoring and spraying when necessary
	Insect and mite management	Monitoring and spraying when necessary
	Weed management	Limited activity
September	Plant care	Second harvest
	Soil care	None
	Disease management	Monitoring and spraying when necessary
	Insect and mite management	Monitoring and spraying when necessary
	Weed management	Limited activity

…continued

Table 3. Sweet corn production and pest management schedule in Canada (continued)

Time of Year	Activity	Action
October	Plant care	Third harvest
	Soil care	None
	Disease management	Monitoring and spraying when necessary
	Insect and mite management	Monitoring and spraying when necessary
	Weed management	Limited activity

Abiotic Factors Limiting Production

Herbicide Injury

Injury can occur from herbicide applications during the growing season (on sensitive varieties), herbicide carryover from the previous season or drift from a nearby field. Environmental conditions and application timing also have an effect on the incidence of herbicide injury. Typical symptoms include chlorosis or yellowing of leaves and distorted growth of foliage. Herbicide injury can range from slight stunting of plants to complete kill.

Low Temperature and Frost Injury

Low temperature injury can occur early or late in the growing season when temperatures are around the freezing point. Symptoms of injury include irregularly shaped or oddly curled leaves with chlorotic areas. Young leaves turn a light brown to yellow. This injury may be confused with herbicide injury. Plants can recover after mild low temperature injury, as new leaves form. Lethal low temperatures cause leaves to wilt, collapse, develop a water soaked appearance and die. Injured plants become defoliated with secondary shoots and leaves forming. Yields are reduced. Low areas in fields are prone to low temperature injury. The risk of low temperature injury is reduced if planting is delayed in the spring.

Hail Injury

Hail may destroy the exposed leaves but will not damage the growing point if it is below the soil surface. In these cases, the hail damage usually results in very little reduction in the final yield. During tassel and ear development, loss of all of the unfurled leaves due to hail may result in a 10 to 20 percent reduction in final yield. Complete leaf loss at this stage results in complete loss of yield. Loss of leaves from hail at grain filling results in unfilled kernels, usually at the tip of the ear.

Nutrient or Moisture Deficiency

At flowering, the number of kernels that develop silks is determined. Nutrient or moisture deficiency (and injury from hail or insects) at this stage may seriously reduce the number of kernels that develop.

Diseases

Key issues

None identified.

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

Disease	British Columbia	Alberta	Ontario	Quebec
Seed rot / seedling blight				
Anthracnose				
Common rust				
Northern corn leaf blight				
Stewart's wilt				
Common smut				
Head smut				
Root 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.

[1]Source: Sweet corn stakeholders in reporting provinces.
[2]Refer to Appendix 1 for further information on colour coding of occurrence data.

Table 5. Adoption of disease management practices in sweet corn production in Canada[1]

Practice / Pest		Common smut	Seed rot and seedling blight	Common rust	Northern corn leaf blight	Stewarts wilt
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 sweet corn production in Canada[1] (continued)

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

This practice is used by some growers to manage this pest. (Green)

This practice is not used by growers to manage this pest. (Red)

This practice is not applicable for the management of this pest. (White)

Information regarding the practice for this pest is unknown. (Grey)

[1]Source: Sweet corn stakeholders in reporting provinces (Ontario and Quebec).

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Seed Treatments						
azoxystrobin + fludioxonil, + metalaxyl-M and S-isomer + thiabendazole (commercial seed treatment only)	methoxy-acrylate + acylanine + benzimidazole	C3: respiration + A1:nucleic acis synthesis = B1:cytoskeleton and motor proteins	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) + RNA polymerase I + ß-tubuline assembly in mitosis	11 + 4 + 1	R + RE + R + R	seed rot, damping-off and seedling blight (seed- and soilborne *Pythium* spp., *Rhizoctonia* spp. and *Fusarium* spp.; *Aspergillus* spp., and *Penicillium* spp.)
Bacillus firmus strain I-1582	not classified	not classified	not classified	NC	R	nematodes (needle, root lesion, root knot) (partial suppression)
Bacillus amyloliquefaciens strain MBI 600	microbial: *Bacillus* spp. and the fungicidal lipopeptides they produce	F6: lipid synthesis and membrane integrity	microbial disrupters of pathogen cell membranes	44	R	seedling diseases (*Rhizoctonia solani* and *Fusarium* spp.) (partial suppression)
carbathiin + thiram	pyrazole-4 carboxamide + triazole dithiocarbamate and relatives	C2 respiration + multi-site contact activity	complexe II: succinate dehydrogenase + multi-site contact activity	7 + M 03	R + RE	damping-off, seed decay, seedborne head smut
difenoconazole + metalaxyl-M and S-isomer (commercial seed treatment only)	triazole + acylalanine	G1: sterol biosynthesis in membranes + A1: nucleic acid synthesis	C14-demethylase in sterol biosynthesis (erg11/cyp51) + RNA polymerase I	3 + 4	RES + R	general seed rots, seedling blight, seedling root rot, damping-off (*Pythium* spp., *Fusarium* spp.), penicillium three-leaf dieback

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Seed Treatments						
fludioxonil (commercial seed treatment only)	phenylpyrrole	E2: signal transduction	MAP/histidine-kinase in osmotic signal transduction (os-2, HOG1)	12	RE	seedborne and soilborne diseases (*Fusarium* spp., *Rhizoctonia* spp. *Aspergillus* spp., *Penicillium* spp.)
fludioxonil + metalaxyl-M and S-isomer (commercial seed treatment only)	phenylpyrrole + aclalanine	E2: signal transduction + A1:nucleic acids synthsis	MAP/histidine-kinase in osmotic signal transduction (os-2, HOG1) + RNA polymerase I	12 + 4	RE + R	seedborne and soilborne diseases (*Pythium* spp., *Fusarium* spp., *Rhizoctonia* spp. *Aspergillus* spp., *Penicillium* spp.)
ipconazole	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	seed, seedling and soilborne diseases (*Aspergillus* spp., *Cladosporium* spp., *Fusarium* spp., *Penicillium* spp., *Rhizoctonia solani*, *Rhizopus* spp.)
mandestrobin	methoxy-acetamide	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	seed rots, seedling blight and seedling root rot (*Rhizoctonia solani*, *Fusarium* spp.)
metalaxyl + metconazole (commercial seed treatment only)	acelalanine + triazole	A1: nucleic acid synthesis + G1: sterol biosynthesis in membranes	RNA polymerase I + C14-demethylase in sterol biosynthesis (erg11/cyp51)	4 + 3	R + R	seed rot, damping-off (*Fusarium* spp., *Pythium* spp., *Rhizoctonia solani*)

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Seed Treatments (continued)						
metalaxyl + penflufen + prothioconazole	acelalanine + pyrazole-4-carboxamide + triazolinthione	A1: nucleic acid synthesis + C2: respiration + G1: sterol biosynthesis in membranes	RNA polymerase I + complex II: succinate-dehydrogenase + C14-demethylase in sterol biosynthesis (erg11/cyp51)	4 + 7 + 3	R + R + R	seed rot, damping-off (*Fusarium* spp., *Pythium* spp., *Rhizoctonia solani*, *Cladosporium* spp., *Aspergillus* spp.), seed rot and damping-off (*Penicillium* spp.) (suppression)
metalaxyl + trifloxystrobin (commercial seed treatment only)	acylalanine + oximino-acetate	A1: nucleic acid synthesis + C3: respiration	RNA polymerase I + complexe III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	4 + 11	R + R	seed rots, preemergent damping-off (*Fusarium* spp.)
metalaxyl-M and S-isomer	acylalanine	A1: nucleic acid synthesis	RNA polymerase I	4	R	seed decay, damping-off, seedling blight (*Pythium* spp.)
metconazole	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	seed rot, damping-off (*Fusarium* spp., *Rhizoctonia solani*)
penflufen (commercial or on-farm seed treatment)	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydrogenase	7	R	seed rot and preemergence damping-off (soil-borne *Rhizoctonia solani*)

….continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Seed Treatments (continued)						
metalaxyl + penflufen + prothioconazole	acelalanine + pyrazole-4-carboxamide + triazolinthione	A1: nucleic acid synthesis + C2: respiration + G1: sterol biosynthesis in membranes	RNA polymerase I + complex II: succinate-dehydrogenase + C14-demethylase in sterol biosynthesis (erg11/cyp51)	4 + 7 + 3	R + R + R	seed rot, damping-off (*Fusarium* spp., *Pythium* spp., *Rhizoctonia solani*, *Cladosporium* spp., *Aspergillus* spp.), seed rot and damping-off (*Penicillium* spp.) (suppression)
metalaxyl + trifloxystrobin (commercial seed treatment only)	acylalanine + oximino-acetate	A1: nucleic acid synthesis + C3: respiration	RNA polymerase I + complexe III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	4 + 11	R + R	seed rots, preemergent damping-off (*Fusarium* spp.)
metalaxyl-M and S-isomer	acylalanine	A1: nucleic acid synthesis	RNA polymerase I	4	R	seed decay, damping-off, seedling blight (*Pythium* spp.)
metconazole	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	seed rot, damping-off (*Fusarium* spp., *Rhizoctonia solani*)
penflufen (commercial or on-farm seed treatment)	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydrogenase	7	R	seed rot and preemergence damping-off (soilborne *Rhizoctonia solani*)

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Seed Treatments (continued)						
penflufen + trifloxystrobin	pyrazole-4-carboxamide + oximino-acetate	C2: respiration + C3: respiration	complex II: succinate-dehydrogenase + complexe III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	7 + 11	R + R	seed decay and damping-off (*Rhizoctonia solani*)
penthiopyrad (seed treatment)	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydrogenase	7	R	damping-off, seedling blight, seed rot, and root rot (*Fusarium* spp., *Rhizoctonia solani*)
pyraclostrobin	methoxy-carbamate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	seed rot (*Rhizoctonia solani*)
picoxystrobin	methoxy-acrylate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	damping-off, seedling blight, seed rot, and root rot (*Fusarium* spp., *Rhizoctonia solani*)
prothioconazole (commercial seed treatment only)	triazolinthione	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	seed rot and damping-off (*Fusarium* spp., *Cladosporium* spp., *Aspergillus* spp.), seed rot and damping off (*Penicillium* spp.) (suppression)
sedaxane (commercial seed treatment only)	pyrazole-4-carboxamide	C: respiration	complex II: succinate-dehydrogenase	7	R	seed decay, seedling blight and damping-off (*Rhizoctonia solani)*

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Seed Treatments (continued)						
tebuconazole (commercial seedreatment only)	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	seed rot and preemergence damping-off (*Fusarium* spp.), soilborne and seedborne head smut
thiophanate-methyl	thiophanate	B1: cytoskeleton and motor proteins	ß-tubuline assembly in mitosis	1	RE	seedborne *Penicillium oxalicum*, *Penicillium* spp.
thiram	dithiocarbamate and relatives	multi-site contact activity	multi-site contact activity	M 03	RE	seed decay, seedling blight, damping-off
trifloxystrobin (commercial seed treatment only)	oximino-acetate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	seed decay and damping-off (*Fusarium* spp.)
triticonazole (commercial seed treatment only)	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	seed rot and seedling blight (*Rhizoctonia solani*, et *Fusarium* spp.), damping off (*Fusarium* spp.), head smut
Foliar Treatments						
azoxystrobin	methoxy-acrylate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	rust, northern corn leaf blight, southern corn leaf blight, eyespot, grey leaf spot

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Foliar Treatments (continued)						
azoxystrobin + benzovindiflupyr	methoxy-acrylate + pyrazole-4-carboxamide	C3: respiration + C2:respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene) + complex II: succinate dehydrogenase	11 + 7	R + R	rust, northern corn leaf blight, southern corn leaf blight, eyespot, grey leaf spot
azoxystrobin + propiconazole	methoxy-acrylate + triazole	C3: respiration + G1: sterol biosynthesis in membranes	complex III: cytochrome bc1 (ubiquinol oxisdase) at Q0site (cyt b gene) + C14- demethylase in sterol biosynthesis (erg11/cyp51)	11 + 3	R + R	rust, northern corn leaf blight, southern corn leaf blight, eyespot, grey leaf spot, anthracnose leaf blight (suppression)
benzovindiflupyr	pyrazole-4-carboxamide	C2: respiration	complex II: succinate dehydrogenase	7	R	rust, grey leaf spot
benzovindiflupyr + propiconazole	pyrazole-4-carboxamide + triazole	C2: respiration + G1: sterol biosynthesis in membranes	complex II: succinate dehydrogenase + C14-demethylase in sterol biosynthesis (erg11/cyp51)	7 + 3	R + R	eyespot, grey leaf spot, rust, northern corn leaf blight, northern corn leaf spot, southern corn leaf blight
chlorothalonil	chloronitrile (phthalonitrile)	multi-site contact activity	multi-site contact activity	M 05	RE	common rust
ethaboxam	ethylamino-thiazole-carboxamide	B3: cytoskeleton and motor proteins	ß-tubulin assembly in mitosis	22	R	seed rot and pre-emergence damping-off (*Pythium* spp.)

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Foliar Treatments (continued)						
fluopyram	pyridinyl-ethyl-benzamide	C2: respiration	complex II: succinate-dehydrogenase	7	R	powdery mildew
fluoxastrobin	dihydro-dioxazine	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	common rust, southern corn leaf blight, grey leaf spot, northern corn leaf blight (suppression)
fluxapyroxad	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydrogenase	7	R	grey leaf spot, eyespot
fluxapyroxad + pyraclostrobin	pyrazole-4-carboxamide + methoxy-carbamate	C2: respiration + C3: respiration	complex II: succinate-dehydrogenase + complex III:cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	7 + 11	R + R	common rust, grey leaf spot, northern corn leaf blight, eyespot (suppression)
metalaxyl	acylalanine	A1: nucleic acids synthesis	RNA polymerase I	4	R	seedling blights and seed rots (*Pythium* spp.)
metconazole	triazole	G1: sterol biosynthesis in membranes	C14-demethylase in sterol biosynthesis (erg11/cyp51)	3	R	fusarium and gibberella ear rots (suppression)
metconazole + pyraclostrobin	triazole + methoxy-carbamate	G1: sterol biosynthesis in membranes + C3: respiration	C14-demethylase in sterol biosynthesis (erg11/cyp51) + complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	3 + 11	R + R	anthracnose, common rust, grey leaf spot, northern corn leaf blight, eyespot

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Foliar Treatments (continued)						
penthiopyrad	pyrazole-4-carboxamide	C2: respiration	complex II: succinate-dehydrogenase	7	R	common rust, grey leaf spot (suppression)
pyraclostrobin	methoxy-carbamate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	common rust, grey leaf spot
picoxystrobin	methoxy-acrylate	C3: respiration	complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	11	R	northern corn leaf blight
propiconazole	triazole	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	rusts, northern corn leaf blight, southern corn leaf blight, helminthosporium leaf spot, eyespot, grey leaf spot
propiconazole + trifloxystrobin	triazole+ oximino-acetate	G1: sterol biosynthesis in membranes + C3: respiration	C14- demethylase in sterol biosynthesis (erg11/cyp51) + complex III: ytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	3 + 11	R + R	rusts, eyespot, northern blight

…continued

Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Target Site[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Foliar Treatments (continued)						
prothioconazole	triazolinthione	G1: sterol biosynthesis in membranes	C14- demethylase in sterol biosynthesis (erg11/cyp51)	3	R	rusts, eyespot, northern blight, grey leaf spot, fusarium and gibberella ear rots and stalk rot (suppression), stalk rot (*Colletotrichum* spp.) (suppression)
prothioconazole + trifloxystrobin	triazolinthione + oximino-acetate	G1: sterol biosynthesis in membranes + C3: respiration	C14- demethylase in sterol biosynthesis (erg11/cyp51) + complex III: ytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	3 + 11	R + R	common rust, southern corn rust, eyespot, northern corn leaf blight, grey leaf spot
Soil Fumigants						
oriental mustard seed meal (oil) (*Brassica juncea*)	diverse	not classified	unknown	NC	R	suppression of root knot nematode, verticillium wilt, soilborne *Pythium* spp., *Fusarium* spp. and *Phytophthora capsici*

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of July 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.

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

[3]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.

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

Seed Rot, Seedling Blight and Root Rot (*Pythium* spp., *Fusarium* spp., *Diplodia* spp., *Penicillium* spp., *Aspergillus* spp. and *Rhizoctonia* spp.)

Pest Information

Damage: Symptoms of seed rot and seedling blight include rotting of seed prior to germination, slow and uneven emergence in the spring and the failure of the seedlings to emerge from the soil. Affected seedlings are prone to stunting and wilting. During cool, wet springs, seed rot and seedling blight can cause extensive crop losses. Symptoms caused by the seedling rot agents differ: *Pythium* spp. damage is characterised by dark, water-soaked lesions on seed, seedling and roots; *Fusarium* spp. infections result in white, purple or pink lesions; *Rhizoctonia* spp, cause sunken, elongated reddish-brown lesions on hypocotyls and roots and *Diplodia* spp. cause greyish-white lesions on roots. *Penicillium* spp., *Fusarium* spp. and *Aspergillus* spp. may be associated with stored seed, and can cause spoilage or initiate disease when the seed is planted in subsequent years.

Life Cycle: The pathogens causing seed rots and seedling blights are commonly found in all soils and often on seeds. Disease occurs primarily in poorly drained soils during periods of cold, wet weather, when soil temperatures are below 15°C. *Penicillium* spp. and *Fusarium* spp. are frequently found on the seed and are often prevalent on ‘supersweet’ cultivars where seeds appear shrunken and are often cracked, conditions which favour colonization by penicillium. *Fusarium* spp. and *Diplodia* spp. are also resident in corn residue. Seed and root rotting pathogens typically overwinter in soils and/ or plant debris, and are able to persist for several years.

Pest Management

Cultural Controls: Planting injury-free seed on well drained sites in warm soil with correct placement of fertilizer, can help to reduce the impact of these pathogens. Crop rotations with non-cereal crops can help reduce pathogen populations in the soil. Additional management practices for seed rots and seedling blight are listed in *Table 5. Adoption of disease management practices in sweet corn production in Canada**Error! Reference source not found.**.

Resistant Cultivars: None available.

Control Products: Refer to *Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada* for fungicides registered for the control of seed rot and seedling blight in sweet corn.

Issues for Seed Rot and Seedling Blight

None identified.

Anthracnose (*Colletotrichum graminicola*)

Pest Information

Damage: Symptoms caused by *C. graminicola* appear as oval lesions with brown centres and purple-brown borders that first develop on lower leaves and then progress to upper leaves. Lesions may join to form streaks along midribs or leaf margins. The injury resembles frost damage and can eventually kill the plant.

Life Cycle: The pathogen overwinters as mycelium within seed and corn residue. This disease is prevalent during warm, wet years when conidia are spread by splashing rain or wind, and infect leaves and stalks.

Pest Management

Cultural Controls: Removal of corn residue and rotations may help reduce disease pressure.

Resistant Cultivars: None identified.

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

Issues for anthracnose

None identified.

Northern Corn Leaf Blight (*Exserohilum turcicum)*

Pest information

Damage: Northern corn leaf blight causes large, grey-green, elliptical lesions on the lower leaves. Lesions may coalesce and kill the entire leaf. Spores produced in the lesions often appear as concentric rings, giving the spot a target-like appearance. The disease is more problematic on corn that has a longer growing season.

Life Cycle: E. turcicum overwinters in corn debris. In the spring, conidia may also be wind-blown long distances northward from the United States to corn fields where they cause infection and lesion development. Conidia produced in the lesions are spread by splashing rain and can re-infect the crop thus producing additional cycles of the disease. Northern corn leaf blight is more severe during extended wet, cool and humid weather. Heavy dews also favour disease development.

Pest Management

Cultural Controls: Tillage helps reduce crop residues and the amount of inoculum present in the spring. Crop rotation with non-host crops may also reduce disease incidence early in the season. Additional management practices for northern corn leaf blight are listed in *Table 5. Adoption of disease management practices in sweet corn production in Canada***Error! Reference source not found.**.

Resistant Cultivars: Cultivars with resistance are available.

Control Products: Refer to *Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada* for fungicides registered for the control of northern corn leaf blight in sweet corn.

Issues for Northern Corn Leaf Blight

None identified.

Common Rust (*Puccinia sorghi*)

Pest Information

Damage: Puccinia sorghi causes chlorotic flecks on the leaf surface, husks, leaf sheaths and stalks which eventually give rise to reddish – brown pustules in which urediniospores develop. Early infections cause the most severe symptoms. Entire leaves can die when infection is severe. Severe leaf damage can result in delayed maturity and yield losses.

Life Cycle: The fungus produces several different spore types, but only the brick-red urediniospores are important in Canada's northern climate. The pathogen overwinters on corrn in the southern United States. Urediniospores are carried northward by wind and infect corn crops in Canada in the spring. Once established in the crop, new infections occur approximately every 14 days. Thus, later plantings of sweet corn can be faced with high spore populations as a result of infection of early planted crops. Rust is favoured by wet seasons with high humidity and warm temperatures.

Pest Management

Cultural Controls: Cultural practices, such as crop rotation and cultivation have no impact on the development of rust, since it does not survive in crop residue. Early planting allows the crop to escape severe infection, since spores blown in from the United States arrive too late to cause severe damage. Additional management practices for common rust are listed in *Table 5. Adoption of disease management practices in sweet corn production in Canada*.

Resistant Cultivars: Some varieties are resistant to rust.

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

Issues for Common Rust

1. There is a need for sweet corn varieties with improved resistance to rust, in particular late maturing varieties.

Common Smut (*Ustilago maydis*)

Pest Information

Damage: Common smut can affect all plant parts above ground, causing growths on tassels, nodes, and ears of the growing corn plant, and render the infected ears unmarketable. Growths on the ears will develop into dark masses of spores covered by a white or greyish membrane. The pathogen may kill young plants. Large galls may cause plants to be barren and stunted.

Life Cycle: The pathogen overwinters as teliospores in soil, crop residues or in contaminated seed, where it can survive for several years. Teliospores give rise to sporidia which cause new infections in susceptible corn in the spring. Intercellular growth of the fungus stimulates the production of galls. The galls rupture at maturity, releasing teliospores. The disease is common when conditions are dry and temperatures are between 26 and 34 °C. Spores are spread locally by wind and can spread from field to field on contaminated farm equipment. Injuries caused by hail, insects or other means are often entry sites for smut infection.

Pest Management

Cultural Controls: Avoiding mechanical or herbicide injury to plants and maintaining balanced soil fertility may help reduce the incidence of this disease. Regular monitoring, especially if insect or weather damage has occurred and removing infected plants from the field may prevent further spread of the disease. Long crop rotations involving non-host crops may help reduce disease severity. Additional management practices for common smut are listed in *Table 5. Adoption of disease management practices in sweet corn production in Canada*.

Resistant Cultivars: Most corn hybrids have some resistance to common smut.

Control Products: There are no seed treatments or foliar fungicides available for management of common smut.

Issues for Common Smut

1. There is a need for improved cultural approaches and chemical controls for common smut in sweet corn.

Head Smut (*Sporisorium holci-sorghi*)

Pest Information

Damage: Tassels and ears become covered with compact masses of black spores which are encased in a greyish membrane, structures called sori. The membrane will readily rupture to release the powdery dark spores. Affected ears are misshapen, do not produce kernels and may be aborted. Plants may also become significantly dwarfed. Yield is reduced as a result of head smut infections.

Life Cycle: The fungus can persist up to ten years in the soil and on seed as teliospores. Germinating teliospores infect seedlings and establish a systemic infection. Sori are produced on developing ears and tassels and give rise to new teliospores. The fungus is favoured by dry conditions and temperatures between 21 and 28°C. The disease is spread locally by wind, on contaminated machinery and in contaminated manure.

Pest Management

Cultural Controls: The incidence of head smut can be reduced through a long crop rotation and by preventing spore dissemination on contaminated seed, manure, and farm equipment. Avoiding nitrogen deficient-soils may also reduce incidence of head smut.
Resistant Cultivars: Resistant varieties of corn are available.
Control Products: Refer to *Table 6. Fungicides and biofungicides registered for disease management in sweet corn in Canada* for fungicides registered for the control of head smut in sweet corn.

Issues for head smut

1. There is a need for improved cultural approaches and chemical controls for head smut in sweet corn.

Stewart's Wilt - Bacterial Blight (*Erwinia stewartii*)

Pest Information

Damage: Plants infected as seedlings usually wither and die. Plants which survive are stunted, have abnormal ears and often have bleached or dead tassels. Other symptoms caused by this bacterium are long, pale green streaks on leaves generally following leaf veins, sometimes leading to senescence of the leaf. Commercial hybrids are often infected, but significant yield reductions are rare. Corn plants become more resistant to this disease as they mature.
Life Cycle: Several insects are capable of transmitting the bacterium, but the corn flea beetle (*Chaetocnema pulicaria*) is the primary vector. The bacterium survives in the gut of overwintering flea beetles, and is transmitted to the new crop when flea beetles begin feeding. Warm winter temperatures result in a high survival rate of insects and therefore a higher incidence of disease in the spring.

Pest Management

Cultural Controls: Avoiding high levels of nitrogen and phosphorus can help reduce disease incidence, while high levels of calcium and potassium may decrease disease severity. Controlling the flea beetle and managing weeds to remove alternate hosts of the beetle will help to reduce transmission of the disease. Plowing under crop debris and crop rotation may also help reduce this disease. Additional management practices for Stewart's wilt are listed in Table 5. Adoption of disease management practices in sweet corn production in Canada.

Resistant Cultivars: Resistant hybrids are available.

Control Products: There are no bactericides registered for the direct control of Stewart's wilt. However insecticide applications can be effective in reducing the flea beetle vector. Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for insecticides registered for control of flea beetles.

Issues for Stewart's Wilt

None identified.

Insects and Mites

Key issues

- Neonicotinoid seed treatments are the main controls for seedcorn maggot and wireworm. There is great concern over the potential loss of these chemicals due to concerns about harmful impacts on non-target insect species. There is a need for the development of new seed treatments that are not harmful to beneficial and non-target organisms and for resistance management.
- The registration of new products with different modes of action is required for the control of European corn borer and corn earworm and for resistance management.
- There is concern that the brown marmorated stinkbug (BMSB) may become a pest in sweet corn. Further work is required to develop management approaches for BMSB should this pest become a problem.

Table 7. Occurrence of insect pests in Canadian sweet corn production[1,2]

Insect	British Columbia	Alberta	Ontario	Quebec
Seedcorn maggot				
Flea beetles				
Corn flea beetle				
Corn rootworms				
Northern corn rootworm				
Western corn rootworm				
Aphids				
Corn leaf aphid				
Oat-birdcherry aphid				
Brown marmorated stinkbug				
European corn borer				
Corn earworm				
Fall armyworm				
Cutworms				
Black cutworm				
Dark-sided cutworm				
Glassy cutworm				
Sandhill cutworm				
Wireworm				
White grubs				
European chafer				
June beetle				
Sap beetles				
Slugs				

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.

[1]Source: Sweet corn stakeholders in reporting provinces.

[2]Refer to Appendix 1 for further information on colour coding of occurrence data.

Table 8. Adoption of insect pest management practices in sweet corn production in Canada[1]

	Practice / Pest	Seedcorn maggot	Corn rootworm	Corn leaf aphid	European corn borer	Wireworm
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 sweet corn production in Canada[1] (continued)

Practice / Pest		Seedcorn maggot	Corn rootworm	Corn leaf aphid	European corn borer	Wireworm
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 sweet corn production in Canada[1] (continued)

Practice / Pest		Seedcorn maggot	Corn rootworm	Corn leaf aphid	European corn borer	Wireworm
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.)					

This practice is used by some 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.

[1]Source: Sweet corn stakeholders in reporting provinces (Ontario and Quebec).

Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Seed Treatments					
clothianidin	neonicotinoid	nicotinic acetylcholine receptor (nAChR) competitive modulator	4A	RES*	corn rootworm (northern and western), corn flea beetle, black cutworm, seed corn maggot, wireworm, white grubs (larvae of European chafer, May/June beetle, Japanese beetle)
cyantraniliprole (commercial seed treatment only)	diamide	ryanodine receptor modulator	28	R	cutworm, wireworms, European chafer,
thiamethoxam	neonicotinoid	nicotinic acetylcholine receptor (nAChR) competitive modulator	4A	RES*	wireworms, European chafer, seed corn maggot, corn flea beetles, corn rootworms
Foliar Treatments					
acetamiprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) competitive modulator	4A	R	aphids
Bacillus thuringiensis subspecies *kurstaki strains ABTS-351 and EVB113-19*	*Bacillus thuringiensis* and the insecticidal proteins they produce	microbial disruptor of insect midgut membranes	11A	R	European corn borer

…continued

Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Foliar Treatments (continued)					
chlorantraniliprole + lambda-cyhalothrin	diamide + pyrethroid, pyrethrin	ryanodine receptor + sodium channel modulator	28 + 3A	R + RE	European corn borer, corn earworm, western bean cutworm, armyworm
deltamethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	western bean cutworm, European corn borer, corn earworm
imidacloprid	neonicotinoid	nicotinic acetylcholine receptor (nAChR) competitive modulator	4A	RES*	wireworms, corn flea beetle
lambda-cyhalothrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	cutworms, fall armyworm, armyworm, European corn borer, corn earworm, western bean cutworm
methomyl	carbamate	acetylcholinesterase (AChE) inhibitor	1A	RE	corn earworm, European corn borer, aphids, brown marmorated stink bug (suppression)

…continued

Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Foliar Treatments (continued)					
novaluron	benzoylurea	inhibitor of chitin biosynthesis, type 0	15	R	corn earworm
permethrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	European corn borer, corn earworm, corn sap beetle, fall armyworm
potassium salts of fatty acids	not classified	unknown	N/A	R	aphids, spider mites, whiteflies
spinosad	spinosyn	nicotinic acetylcholine receptor (nAChR) allosteric modulator	5	R	European corn borer
spiromesifin	tetronic and tetramic acid derivative	inhibitor of acetyl CoA carboxylase	23	R	banks grass mite, two-spotted spider mite, aphids

…continued

Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
Soil application					
chlorpyrifos	organophosphate	acetylcholinesterase (AChE) inhibitor	1B	RE	black cutworm, darksided cutworm, redbacked cutworm
ferric phosphate	not classified	unknown	N/A	R	slugs, snails
ferric sodium ethylenediamine tetra acetic acid (EDTA)	Not classified	unknown	N/A	R	slugs, snails
tefluthrin	pyrethroid, pyrethrin	sodium channel modulator	3A	RE	corn rootworms, black cutworm, wireworms, seed corn maggot

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of July 31, 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.

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

[3]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.

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

Seed Corn Maggot (*Delia platura*)

Pest Information

Damage: Newly hatched maggots feed inside the seed, where they destroy the germ. Feeding injury also provides entry sites for soil organisms that cause rot. Damage results in poor stands. The most severe damage usually occurs to spring crops planted too deeply into cool, wet, high organic-content soil.

Life Cycle: Seed corn maggots overwinter as pupae in the soil. Adult flies emerge in the spring and lay eggs in moist soil where there is an abundance of decaying plant material. Larvae feed on germinating seed. The entire life cycle may be completed in three weeks resulting in many generations per year.

Pest Management

Cultural Controls: Since this insect is attracted to soil humus, ploughing heavily manured land early in the fall to make it less attractive to egg laying adults the following spring may reduce pest populations. Delaying planting until the soil is warm enough for rapid germination, and planting shallowly can help reduce damage. Natural enemies of seed corn maggot including rove and carabid beetles, nematodes and entomopathogens may reduce populations of this insect. Additional management practices for seed corn maggot are listed in *Table 8. Adoption of insect pest management practices in sweet corn production in Canada.*

Resistant Cultivars: None available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for seed corn maggot management in sweet corn.

Issues for Seed Corn Maggot

1. Neonicotinoid seed treatments are the main insecticide controls for seedcorn maggot. There is great concern over the potential loss of these chemicals due to concerns about harmful impacts on non-target species. There is a need for the development of new seed treatments that are not harmful to pollinators and other non-target organisms. It is important that new materials belong to different chemical groups for resistance management.

Cutworms - Black Cutworm (*Agrotis ipsilon*), Darksided Cutworm (*Exodus messoria*), Glassy Cutworm (*Euxoa messoria*), and Sandhill Cutworm (*Euxoa detersa*)

Pest Information

Damage: Although sporadic, cutworms can cause major damage to corn crops. Cutworm larvae feed on foliage and cut stems of seedlings at or below the soil level. Damage is most severe on young plants at the two to five leaf stage.

Life Cycle: Depending on species, cutworms overwinter as eggs, partially grown larvae or pupae in soil or may be blown up from overwintering sites in the United States. Cutworms can have one or more generations per year, with the greatest crop damage the result of first generation feeding. Following egg hatch in spring, larvae feed on foliage, developing through six to seven instars prior to pupating in the soil and emerging as adults.

Pest Management

Cultural Controls: Controlling weeds in the field and surrounding areas will reduce egg-laying by cutworm moths. Avoiding planting crops following sod or in low lying, wet, grassy areas, may help reduce black cutworm numbers. Ploughing in the fall will reduce overwintering populations. Fields can be monitored for cutworms early in the season by visually checking for damage. Pheromone traps may be used to monitor the flights of male moths and establish the period of egg-laying. The pest has many natural enemies, including birds, braconid wasp parasites and predaceous ground beetles that may help keep cutworm numbers down.

Resistant Cultivars: None available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for control products available for cutworm management.

Issues for Cutworms

None identified.

Corn Leaf Aphid (*Rhopalosiphum maidis*)

Pest Information

Damage: The aphid feeds on the tassels, ears and upper leaves of corn plants. Feeding can weaken and dwarf the plant and lead to desiccation of leaves, reduced pollination, and poor kernel fill causing reduced yield. The aphid also secretes honey dew on tassels and silks, which supports the development of black sooty moulds reducing marketability of ears.

Life Cycle: The corn leaf aphid does not overwinter in Canada, but blows in from the United States during the growing season. Aphids can reproduce without mating and bear live young, so populations can increase very quickly, especially during hot, dry weather. Infestations often begin deep in the leaf whorl, where aphids have food and a moist environment. Aphid populations die in the fall.

Pest Management

Cultural Controls: Practices which encourage natural predator populations, such as avoiding the use of broad-spectrum insecticides can be of benefit as these beneficial species can help in keeping aphid populations low. Early planting may help minimize the build-up of aphid populations and feeding damage. Additional management practices for corn leaf aphid are listed in *Table 8. Adoption of insect pest management practices in sweet corn production in Canada*.

Resistant Cultivars: None available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for corn leaf aphid management in sweet corn.

Issues for Corn Leaf Aphid

1. There is a need for the registration of reduced risk insecticides for the management of aphids in sweet corn and for resistance management in regions where aphids pose problems.
2. Greater understanding of the feeding activities of aphids and improved monitoring methods and economic thresholds are required for improved management decisions.

Corn Flea Beetle (*Chaetocnema pulicaria*)

Pest Information

Damage: In the spring, larvae feed on corn roots, while adult flea beetles chew small holes in the cotyledons and young leaves. Heavy feeding will skeletonize young plants which can result in plant death. Flea beetles are a vector of the Stewart's wilt pathogen which can cause losses even when damage from the beetle itself is not significant.

Life Cycle: Flea beetles overwinter in the soil in grassy areas and emerge in early spring to lay eggs at the base of small corn plants or grass seedlings. Upon hatching the larvae feed on host plant roots. Next generation adults emerge following pupation and are present from mid-summer until frost. Flea beetle populations are reduced by cold winter temperatures.

Pest Management

Cultural Controls: Burial of crop residue in the fall will help to remove habitat for the flea beetles and will help reduce spring populations.

Resistant cultivars: None available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for corn flea beetles in sweet corn.

Issues for Corn Flea beetles

1. This insect is of concern due to its potential to transmit Stewart's wilt.

European Corn Borer (ECB) (*Ostrinia nubilalis*)

Pest Information

Damage: ECB larvae feed on leaves initially and then bore into stems after the second instar. As they mature, larvae tunnel through stalks and ears, and cause early breakage of tassels and stalks and poor ear development. Infestations of larvae in ears are the major concern in sweet corn, since not only are infested ears unsuited for sale as fresh-market produce, but small larvae may remain in kernels of sweet corn used for processing. Where two generations of ECB are known to occur, the second generation larvae cause the greatest damage.

Life Cycle: The ECB exists as strains having one, two or a partial third generation. This insect overwinters as mature larvae in corn stubble and residues. Adult moths begin to emerge in late spring reaching a peak in early summer (mid-June). The moths lay eggs on the underside of leaves. After hatching, larvae develop through five larval instars, feeding for 20 to 30 days until they mature. Cool, rainy weather during June and July reduces infestations because it reduces egg-laying and washes the tiny, hatching borers off plants.

Pest Management

Cultural Controls: Avoiding other host plants for ECB such as potatoes and bean, in rotation with corn and managing weeds in the field may help reduce populations. Shredding plant debris after harvest, ploughing in the fall and disking in the spring can eliminate a large portion of the overwintering larvae. Sweet corn hybrids with pest resistance have been developed through biotechnology. Genes from the bacterium *Bacillus thuringiensis* (Bt) have been inserted into some varieties of sweet corn, giving the corn insecticidal properties. The release of tiny wasps (*Trichogramma* sp.) into the field several times during the season may help, as the wasps parasitize corn borer eggs and prevent them from hatching. Additional management practices for European corn borer are listed in *Table 8. Adoption of insect pest management practices in sweet corn production in Canada.*

Resistant Cultivars: Resistant cultivars are available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for ECB management in sweet corn.

Issues for European Corn Borer

1. The registration of new products with different modes of action is required for the control of ECB and for resistance management.

Corn Earworm (*Heliothis zea*)

Pest Information

Damage: The corn earworm feeds in the silks, then on the kernels of sweet corn in the top third of the ear. Silks are sometimes destroyed before pollination is complete. Moulds may invade the larval feeding sites. Damage caused by *H. zea* reduces marketability of ears.

Life Cycle: Corn earworm moths are carried into Canada each year on winds from the southern United States and Mexico. Infestations are difficult to predict and the protective husks on the ears make the insect difficult to detect or control. The moths may arrive any time from early to late summer. Adults lay eggs singly on fresh silk and occasionally on the husks of developing ears. Each female can produce as many as 1,000 eggs that hatch in two to ten days, depending on temperature. Young caterpillars feed on the silks and eventually work their way down to the kernels. Larvae pupate after feeding for two to four weeks although sweet corn is often harvested before pupation occurs.

Pest Management

Cultural Controls: Infestations can be avoided with early planting using early maturing varieties. Harvesting the crop before mid-August helps reduce the risk of earworm damage. Low levels of natural control result from cannibalism by larvae, parasitism of eggs and larvae and from a number of predaceous insects and birds. Pheromone traps can be used to monitor the population of this insect as a management decision aid.

Resistant Cultivars: None identified.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for corn earworm management in sweet corn.

Issues for Corn Earworm

1. The corn earworm is acquiring resistance to a number of insecticides. The development of resistance must be closely monitored. It is very important that growers follow proper pesticide rotations to slow the development of resistance and prolong the life of available pest management tools.
2. The registration of new products with different modes of action, including products suitable for use in organic systems, is required for the control of the corn earworm and for resistance management.

Fall Armyworm (*Spodoptera frugiperda*)

Pest Information

Damage: The fall armyworm affects late crops, causing defoliation as it feeds on leaves. Tassels may also be damaged. Yield loss becomes more significant as larval feeding progresses to the ear shanks of more mature plants.

Life Cycle: Fall armyworms overwinter in the southern United States and northern Mexico and are carried north to Canada on wind currents in the spring. Eggs are laid in leaves or leaf sheaths and larvae are present from late spring to early summer, maturing within 20 days to pupate just below the soil surface. There is one generation per year as this insect dies with fall frost.

Pest Management:

Cultural Controls: The use of early maturing cultivars and monitoring leaf whorls in August and September to assess the stage of infestation and identify control methods if needed, can help minimize the impact of this insect.

Resistant Cultivars: None available.

Chemical Controls: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for fall armyworm management in sweet corn.

Issues for Fall Armyworm

None identified.

Brown Marmorated Stink Bug (BMSB) (*Halyomorpha halys*)

Pest Information

Damage: The BMSB has not yet been identified as a pest in crops in Canada, but has caused significant crop injury in other jurisdictions where it is established in agricultural crops. This insect has a broad host range including tree fruit, berries, grapes, ornamentals, grain crops, tomatoes, peppers and sweet corn. Injury is caused by feeding of adults and nymphs. The insect injects saliva containing digestive enzymes into the plant and ingests the liquefied plant material. Each feeding puncture results in crop injury. In corn, feeding results in shrivelling and discoloration of developing kernels and can provide entry sites for moulds.

Life Cycle: The insect spreads through natural means and also as a “hitchhiker” in cargo and vehicles. It has been intercepted in a number of provinces over the years and established populations have been identified in several counties in Ontario. Established populations have also been detected in several urban centres in Ontario where the BMSB is considered a “nuisance” pest as it frequently enters structures in the fall seeking overwintering sites. In jurisdictions where it is an established crop pest, it readily moves between host crops throughout the growing season. BMSB overwinter as adults. In the spring, adults feed for several weeks then mate and lay eggs on host plants. Both nymphs and adults move and feed on a wide variety of host plants. The insect develops through five nymphal instars before molting to become the winged adult stage. Adults are long-lived and females may lay several hundred eggs over an extended period of time. This may result in overlapping generations. In the fall, the adults move back to protected overwintering sites.

Pest Management

Cultural Controls: Monitoring for the insect may be done through aggregation pheromones and by scouting. Although thresholds have not been established, small numbers of nymphs and adults can cause considerable damage in a growing season. Late maturing varieties as well as later plantings may sustain less damage, as the pest may be more attracted to other plants later in the season. Insect species which parasitize BMSB eggs may help reduce the population of this insect.

Resistant cultivars: None available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for pesticides registered for brown marmorated stink bug management in sweet corn.

Issues for brown marmorated stink bug

1. There is concern that the brown marmorated stink bug may become a pest in sweet corn. Further work is required to develop management approaches for BMSB should this pest become a problem.
2. There is a need for the registration of reduced risk insecticides for the control of brown marmorated stink bug so that growers have tools available to them should this pest become a problem.

Corn Rootworms – Northern corn rootworm (*Diabrotia barberi*) and Western corn rootworm (*Diabrotia virgifera*)

Pest Information

Damage: Northern and western corn rootworms feed on corn silks and on the pollen of corn and other plants. When beetles, are numerous, pollination may be affected to the point that ears bear only scattered kernels or none at all, causing economic damage especially to late planted or late-maturing cultivars. In severe infestations, feeding on foliage will result in long silver streaks on the lower epidermis. Larvae feed on roots, reducing plant vigor and predisposing plants to lodging and stem curvature. Feeding sites may become entry points for stalk rot, ear rot and fusarium root rot pathogens.

Life Cycle: Both species of rootworm overwinter as eggs which hatch between May and June. Newly hatched larvae feed for three to four weeks on small corn roots, then tunnel into larger roots, eventually leaving roots to pupate in the soil. Adults emerge early July, gather on corn to feed on the silks, leaf tissue, tassels and pollen and mate and lay eggs in the soil near corn plants late in the summer and early fall.

Pest Management

Cultural Controls: Non-host crops grown in rotation with corn may help reduce the population of this insect. Practices that favour corn growth and the use of deep rooted corn hybrids will help reduce the damage caused by this pest. Early planting allows silks to develop before peak rootworm beetle feeding. There are a few ground beetle and mite species found in soils that feed on rootworm eggs, larvae and pupae, although these natural enemies are generally not effective at reducing numbers. Additional management practices for corn rootworms are listed in *Table 8. Adoption of insect pest management practices in sweet corn production in Canada*.

Resistant Cultivars: Resistant cultivars are available

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for corn rootworm management in sweet corn.

Issues for Corn Rootworm

1. A variant of the corn rootworm has been found in soybean fields in Ontario and the United States. Continued monitoring is required to determine the presence and distribution of the soybean variant of corn rootworm.
2. There is a need for the registration of additional reduced risk pesticides for the management of corn rootworm.

White grubs - European Chafer (*Rhizotrogus_majalis*) and June Beetle (*Phyllophaga* spp.)

Pest Information

Damage: Corn is most susceptible to injury at the seedling stage. White grubs feed on the roots of susceptible plants and cause stunting, wilting and death.

Life Cycle: European chafer has a one year life cycle. Adults lay eggs in soil in mid-late summer. Eggs hatch and the larvae (grubs) feed on plant roots in the fall, overwinter and feed again in spring. Pupation occurs in early summer. June beetles have a three year life cycle. Adult June beetles lay eggs in the soil in late spring. After hatching the larvae remain in the soil to feed and overwinter. Pupation occurs in the third year and adults emerge the following spring. June beetle grubs are present in the soil throughout the growing season and are most common in soils following pasture, turf and other perennial crops.

Pest Management

Cultural Controls: Fields can be monitored in the spring or fall prior to seeding corn. Avoiding planting corn in fields with high populations of white grubs may help reduce damage from these insects. Cultivation prior to planting will expose grubs to natural predators. Rotation with crops other than legumes or corn may help reduce the population of these insects.

Resistant cultivars: None available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for white grub management in sweet corn.

Issues for White Grubs

None identified.

Sap Beetles (Nitidulidae)

Pest Information

Damage: Adult sap beetles are attracted to and feed on over-ripe and damaged fruit. In corn, adults feed on kernels damaged by other insects, birds or raccoons.

Life Cycle: Sap beetles overwinter as adults under crop residue and in other protected sites. Eggs are laid in the spring in crop debris in which the larvae develop. Following pupation, adult beetles appear from early to mid-summer. There is one generation per year.

Pest Management

Cultural Controls: The elimination of crop residues from the field will reduce overwintering sites and food sources for larvae, and reduce the sap beetle population.

Resistant cultivars: None available.

Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada, fo*r products registered for sap beetle management in sweet corn.

Issues for Sap Beetles

None identified.

Slugs (Various Species)

Pest Information

Damage: Feeding by slugs results in ragged holes and skeletonization of leaves. The impact of feeding is more severe on young plants. Slug damage is more prevalent in years with cool wet springs.

Life Cycle: Slugs overwinter as adults or eggs. Both immature and adult slugs are active at night and feed on plant material. Slugs are very susceptible to desiccation and are more active during cool, moist weather.

Pest Management

Cultural Controls: Elimination of crop residues which provide protection for slugs, and tillage which exposes slugs to dehydration and predators, can help to reduce slug populations.

Resistant cultivars: None available.
Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for slug management in sweet corn.

Issues for slugs

None identified.

Wireworms (*Agriotes* spp. and *Limonius* spp.)

Pest Information

Damage: Wireworms burrow into seeds, roots and underground stems of plants, causing poor seed germination and weakened and distorted plants that often die or are non-productive. Damaged plants occur in a random pattern in the field.
Life Cycle: This insect overwinters as larvae or adult beetles in the soil. Adults lay eggs in the spring near roots of grasses, also hosts for this pest. The larval stage may persist from two to five years before pupation in the soil and emergence of the adult stage. Larvae move through the soil to feed, and will migrate deep into soil in the fall before returning to feed on corn roots and plants the following spring.

Pest Management

Cultural Controls: As wireworms are attracted to pasture and grassland, avoiding planting corn in a field the year after breaking sod may help reduce wireworm damage to the corn crop. Cultivation to expose larvae to predators can help reduce populations. Wireworm populations may be monitored in the fall or early spring using bait stations or by field inspection in the spring, as an aid in field selection for wireworm susceptible corps like sweet corn.
Resistant cultivars: None available.
Control Products: Refer to *Table 9. Insecticides and bioinsecticides registered for the management of insect pests in sweet corn production in Canada* for products registered for wireworm management in sweet corn.

Issues for Wireworm

1. Neonicotinoid seed treatments are the main approach to the control of wireworm. There is great concern over the potential loss of the neonicotinoid seed treatments due to concerns of toxicity to non-target species. There is a need for the development of new seed treatments in different chemical families that do not pose a risk to beneficial and other non-target species and that can be used for resistance management.

Weeds

Key Issues

- There is concern over the development of resistance of weeds to some families of chemical herbicides.
- There is a need for the registration of herbicides in different chemical families for resistance management.

Table 10. Occurrence of weeds in Canadian sweet corn production[1,2]

Weed	Brtish Columbia	Alberta	Ontario	Quebec
Annual broadleaf weeds				
Cocklebur				
Common ragweed				
Eastern black nightshade				
Lady's-thumb				
Lamb's quarters				
Purslane				
Redroot pigweed				
Wild buckwheat				
Mustards (various species)				
Corn spurry				
Annual grasses				
Barnyard grass				
Crabgrass				
Smooth crab grass				
Large crabgrass				
Fall panicum				
Foxtail				
Proso millet				
Wild oats				
Witch grass				
Proso millet				

…. continued

Table 10. Occurrence of weeds in Canadian sweet corn production[1,2] (continued)

Weed	Brtish Columbia	Alberta	Ontario	Quebec
Perennial weeds				
Quackgrass				
Canada thistle				
Dandelion				
Field bindweed				
Field horsetail				
Mouse-eared chickweed				
Perennial sow thistle				
Tufted vetch				
Yellow nutsedge				

Widespread yearly occurrence with high pest pressure.

Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.

Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.

Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.

Pest is present and of concern, however little is known of its distribution, frequency and importance.

Pest not present.

Data not reported.

[1]Source: Sweet corn stakeholders in reporting provinces.

[2]Refer to Appendix 1 for further information on colour coding of occurrence data.

Table 11. Adoption of weed management practices in sweet corn production in Canada[1]

	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 sweet corn production in Canada[1] (continued)

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Decision making tools	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				
Suppression	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.)				
Crop specific practices	Herbicide banding				
	Use of cover crops				
	Use of fall green manure crops				

This practice is used by some 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.

[1]Source: Sweet corn stakeholders in reporting provinces (Ontario and Quebec).

Table 12. Herbicides and bioherbicides registered for the control of weeds in sweet corn production in Canada

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
2,4-D	phenoxy-carboxylic-acid	synthetic auxin	4	RES	annual and perennial broadleaf weeds
atrazine	triazine	inhibition of photosynthesis at photosystem II site A	5	R	broadleaf weeds, wild oats
atrazine + bentazon (not for use in the province of British Columbia)	triazine + benzothiadiazinone	inhibition of photosynthesis at photosystem II site A + inhibition of photosynthesis at photosystem II site B	5 + 6	R + R	annual broadleaf weeds, yellow nutsedge
atrazine + mesotrione + s-metolachlor and R-enantiomer + bicyclopyrone (eastern Canada only)	triazine + triketone + chloroacetamide	inhibition of photosynthesis at photosystem II site A + inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD) + inhibition of mitosis	5 + 27 + 15 + 27	R + R + RE + R	annual weeds
atrazine + S-metolachlor and R enantiomer	triazine + chloroacetamide	inhibition of photosynthesis at photosystem II site A + inhibition of mitosis	5 + 15	R + RE	yellow nutsedge, annual grasses, annual broadleaf weeds

…continued

Table 12. Herbicides and bioherbicides registered for the control of weeds in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
atrazine + dimethenamid-P (not for use in the province of British Columbia)	triazine + chloroacetamide	inhibition of photosynthesis at photosystem II site A + inhibition of mitosis	5 + 15	R + R	annual grasses, annual broadleaf weeds
bentazon (bendioxide)	benzothiadiazinone	inhibition of photosynthesis at photosystem II (site B)	6	R	many broadleaf weeds, yellow nutsedge, cleavers, stork's bill, volunteer canola
bicyclopirone	triketone	inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	27	R	common ragweed, redroot pigweed, lambsquarters, velvetleaf, eastern black nightshade and triazine and Group 2 tolerant biotypes of these weeds; proso millet (early season suppression)
bromoxynil	nitrile	inhibition of photosynthesis at photosystem II site B	6	RES	green smartweed, pale smartweed, lady's-thumb, bluebur, kochia, cow cockle, velvet leaf, common ragweed, pigweed, triazine resistant ragweed, coclebur, Russian thistle, wild mustard, stinkweed, American nightshade, wild buckwheat, common buckwheat, lamb's-quarters, Tartary buckwheat, common groundsel
bromoxynil + MCPA	nitrile + phenoxy-carboxylic-acid	inhibition of photosynthesis at photosystem II site B + synthetic auxin	6 + 4	RES + R	many annual broadleaf weeds, Canada thistle, perennial sow-thistle

…continued

Table 12. Herbicides and bioherbicides registered for the control of weeds in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
carfentrazone-ethyl	triazolinone	inhibition of protoporphyrinogen oxidase (Protox, PPO)	14	R	broadleaf weeds
dimethenamid-P	chloroacetamide	inhibition of mitosis	15	R	foxtail (green, yellow, giant), crabgrass (smooth, large), old witchgrass, barnyard grass, fall panicum, redroot pigweed, eastern black nightshade, yellow nutsedge
dimethenamid-P + saflufenacil	chloroacetamide + pyrimidinedione	inhibition of mitosis + inhibition of protoporphyrinogen oxidase (Protox, PPO)	15 + 14	R + R	barnyard grass, common ragweed, crabgrass (smooth, large), eastern black nightshade, fall panicum, foxtail (green, yellow, giant), lamb's-quarters, redroot pigweed, yellow nutsedge, old witchgrass, velvetleaf, wild buckwheat, wild mustard
diquat (stale seedbed)	bipyridylium	photosystem-I-electron diversion	22	R	annual weeds, perennial grass (suppression)
glyphosate	glycine	inhibition of 5-enolypyruvyl-shikimate-3-phosphate synthase (EPSPS)	9	R	most herbaceous plants

…continued

Table 12. Herbicides and bioherbicides registered for the control of weeds in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
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*	most annual grasses, broadleaf weeds
MCPA (present as amine salts: diethanolamine, dimethylamine or mixed amines; potassium or sodium salts; acid or ester)	phenoxy-carboxylic-acid	synthetic auxin	4	R	most broadleaved weeds
mesotrione	triketone	inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	27	R	lamb's-quarters, wild mustard, redroot pigweed, common ragweed (suppression), velvetleaf
mesotrione + s-metolachlor and R enantiomer (eastern Canada only)	triketone + chloroacetamide	inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD) + inhibition of mitosis	27 + 15	R + RE	annual grasses and broadleaf weeds

…continued

Table 12. Herbicides and bioherbicides registered for the control of weeds in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
nicosulfuron	sulfonylurea	inhibition of acetolactate synthase (ALS) or acetohydroxyacid synthase (AHAS)	2	R	barnyard grass, fall panicum, foxtail (green, yellow), old witchgrass, quackgrass
paraquat	bipyridylium	photosystem-I-electron diversion	22	R	grasses and broadleaf weeds
pyraflufen-ethyl	phenylpyrazole	inhibition of protoporphyrinogen oxidase (Protox, PPO)	14	R	broadleaf weeds
salflufenacil	pyrimidindione	inhibition of protoporphyrinogen oxidase (Protox, PPO)	14	R	broadleaf weeds
simazine and related triazines	triazine	inhibition of photosynthesis at photosystem II site A	5	R	broadleaf weeds, annual grasses, most perennial species starting freshly from seed
s-metolachlor and R-enantiomer	chloroacetamide	inhibition of mitosis	15	RE	annual grasses and broadleaf weeds

…continued

Table 12. Herbicides and bioherbicides registered for the control of weeds in sweet corn production in Canada (continued)

Active Ingredient[1]	Classification[2]	Mode of Action[2]	Resistance Group[2]	Re-evaluation Status[3]	Targeted Pests[1]
tembotrione (eastern Canada and Manitoba only)	triketone	inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	27	R	annual broadleaf weeds, annual grasses
topramezone	triketone	inhibition of 4-hydroxyphenyl-pyruvate-dioxygenase (4-HPPD)	27	R	annual grasses and broadleaf weeds

[1]Source: Pest Management Regulatory Agency label database (www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/label-etiq-eng.php). The list includes all active ingredients registered as of August 3, 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.

[2]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).

[3]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.

[4] Source: Insecticide Resistance Action Committee. *IRAC MoA Classification Scheme (Version 8.3; July 2017)* (www.irac-online.org) (accessed Sept. 13, 2017).

All Weeds

Pest Information

Damage: Weeds compete with the crop for light, water and nutrients. If not controlled, they can reduce sweet corn growth and yield depending on the density of weed populations and the time of emergence of the weed relative to the crop. The critical stage for damage is early in the growing season. Annual grasses cause significant problems in sweet corn production because of their fast growth. Grass weeds are very tolerant to extremes in moisture and temperature once established.

Life cycle:

Annual weeds: Annual weeds complete their life cycle from seed germination through vegetative growth and flowering to seed production in one year, producing large numbers of seeds. Some weed seeds remain viable in the soil for many years, germinating when conditions are suitable. They can be very difficult to eliminate from infested fields and they require control prior to seed-set due to their prolific seeding

Perennial weeds: Perennials weeds live for many years. They spread through seeds, through the expansion of various types of root systems and by other vegetative means. Perennial grass weeds tend to have extensive creeping root systems, which frequently produce shoots that will then produce a new plant. Most perennial grass weed seeds will germinate within a year, but some may remain viable in the soil for twenty years or more.

Pest Management

Cultural Controls:

Annual weeds: Measures to reduce difficult to control weeds can be implemented before planting. Planting cover crops such as winter cereals can suppress weed growth following crop harvest as well as minimize erosion over the winter. Rotating between broadleaf and grassy crops provides a chance to control broadleaf weeds in grassy crops and grassy weeds in broadleaf crops with selective herbicides. It is important to know the history of the weed infestation in a field prior to planting so that heavily infested fields can be avoided. The use of clean, certified seed reduces the introduction of new weed seeds. Cleaning equipment between fields will prevent the transport of weed seeds to other fields. Deploying harvesting techniques that minimize seed loss the year prior to growing the crop can lead to reduced populations of volunteer crops. Fall tillage prior to freeze-up may reduce the annual weed seed population but this practice can leave the soil prone to erosion. For some annual broadleaf weeds, mowing of field edges will reduce the weed seed set and minimize spread into the filed. Annual grasses can be very difficult to eliminate from infested fields and require control prior to seed-set due to their prolific seeding. Monitoring for annual weeds during the first two to three weeks after weed emergence will support informed decisions regarding post-emergent controls. Effective management programs involve the use of all available control strategies including preventative, cultural, mechanical, and chemical control methods.

Perennial weeds: Perennial weed management is difficult in sweet corn, particularly after the crop has been planted. Field scouting, done the season prior to planting, is important in the development of control strategies. Crop rotation can disrupt perennial weed life cycles by allowing a variety of control options and cultural practices that discourage normal weed growth. Minimizing tillage can reduce the spread of some weeds such as quackgrass, as tillage cuts up the rhizome triggering the development of more shoots. Monitoring uncultivated field edges and roadsides and mowing weeds prior to flowering can help minimize spread into fields. The management of field-scale infestations requires a combination of control measures over several years, along with good fertility to improve crop competition. Careful record keeping on herbicide treatments is essential for the selection of herbicide groups, to minimize potential weed resistance problems and to prevent crop injury from herbicide carryover. Cleaning equipment between fields to prevent the transport of weed seeds can reduce dispersal of weeds seeds. Additional management practices for weeds are listed in *Table 11. Adoption of weed management practices in sweet corn production in Canada*.

Resistant Cultivars: None available.

Control Products: Refer to *Table 12. Herbicides and bioherbicides registered for the control of weeds in sweet corn production in Canada*.

Issues for Weeds

Annual Weeds:

1. There is concern over the development of herbicide resistant annual weeds and the loss in efficacy of available herbicides. Triazine-resistant lamb's-quarters has become a problem across the country. Resistance to group 2 herbicides has been observed within eastern black nightshade and ragweed populations.

Perennial Weeds:

1. There is concern over the development of resistance of perennial weeds to some families of chemical herbicides.
2. Available herbicides provide only limited control of perennial weeds in sweet corn. There a need for the development of an improved control strategy for perennial weeds including cultural approaches and the registration of new herbicides.

Vertebrate Pests

Deer, birds and raccoons can affect sweet corn production. The severity of feeding damage depends on the location of the field and local wildlife populations.

Raccoons can cause substantial damage to corn crops throughout the cropping year. Electric fencing, constructed of two strands of electric fence at heights of five cm and twelve cm, if kept weed free, are usually effective against raccoons.

Electric fencing at a height of 75 cm can also deter deer.

Red winged black birds and crows are the bird pests which cause the most damage. Noisemakers will scare birds away. Avoiding planting corn near known bird nesting areas such as wetlands will reduce damage caused by birds.

Resources

Integrated Pest Management / Integrated Crop Management Resources for Production of Sweet Corn in Canada

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

British Columbia Ministry of Agriculture. *Vegetable Production Guide 2012: Beneficial Management Practices for Commercial growers in British Columbia* (updated) http://productionguide.agrifoodbc.ca/guides/17

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

Howard, R.J., J.A. Garland and W.L. Seaman. Ed. 1994. *Diseases and Pests of Vegetable Crops in Canada*. Canadian Phytopathological Society and Entomological Society of Canada. Ottawa, ON. 554pp. http://phytopath.ca/publication/books/

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

Ontario Ministry of Agriculture and Food and Rural Affairs. 2004. *Publication 12 Sweet Corn Production Manual*. http://www.omafra.gov.on.ca/english/crops/pub12/p12order.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. 2017. *Publication 75, Guide to Weed Control 2016-17*. http://www.omafra.gov.on.ca/english/crops/pub75/pub75toc.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *OMAFRA Vegetables: Sweet Corn* http://www.omafra.gov.on.ca/english/crops/hort/sweet_corn.html

Ontario Ministry of Agriculture, Food and Rural Affairs. *Vegetable Production Recommendations (2009-10) Publication 363); Publication 363SE, Supplement - Vegetable Production Recommendations 2010-2011* http://www.omafra.gov.on.ca/english/crops/vegpubs/vegpubs.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Ontario Vegetable Crop Production Guide (2014-15) Publication 838E*; 2016 Supplement http://www.omafra.gov.on.ca/english/crops/vegpubs/vegpubs.htm

Sage Pesticides http://www.sagepesticides.qc.ca/

Provincial Crop Specialists and Provincial Minor Use Coordinators

Province	Ministry	Crop Specialist	Minor Use Coordinator
British Columbia	British Columbia Ministry of Agriculture and Lands https://www2.gov.bc.ca/gov/content/governments/organizational-structure/ministries-organizations/ministries/agriculture -	Susan Smith susan.l.smith@gov.bc.ca -	Caroline Bédard caroline.bédard@gov.bc.ca -
Alberta	Alberta Agriculture and Forestry www.agric.gov.ab.ca/	Patricia McAllistair tricia.mcallister@gov.ab.ca	Gayah Sieusahai gayah.sieusahai@gov.ab.ca
	-	-	Ron Pidskalny Prairie Minor Use Consortium pidskaln@gmail.com
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca	Elaine Roddy elaine.roddy@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	Brigitte Duval brigitte.duval@mapaq.gouv.qc.ca	Luc Urbain luc.urbain@mapaq.gouv.qc.ca

National and Provincial Vegetable Grower Organizations

British Columbia Potato and Vegetable Growers Association
http://bcfresh.ca/associations/

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

National

Canadian Horticultural Council
https://www.hortcouncil.ca/en/

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.

<table>
<tr><th>Presence</th><th colspan="4">Occurrence information</th><th rowspan="2">Colour Code</th></tr>
<tr><td rowspan="15">Present</td><td rowspan="13">Data available</td><th>Frequency</th><th>Distribution</th><th>Pressure</th></tr>
<tr><td rowspan="6">Yearly - Pest is present 2 or more years out of 3 in a given region of the province.</td><td rowspan="3">Widespread - The pest population is generally distributed throughout crop growing regions of the province. In a given year, outbreaks may occur in any region.</td><td>High - If present, potential for spread and crop loss is high and controls must be implemented even for small populations.</td><td>Red</td></tr>
<tr><td>Moderate - If present, potential for spread and crop loss is moderate: pest situation must be monitored and controls may be implemented.</td><td>Orange</td></tr>
<tr><td>Low - If present, the pest causes low or negligible crop damage and controls need not be implemented.</td><td>Yellow</td></tr>
<tr><td rowspan="3">Localized - The pest is established as localized populations and is found only in scattered or limited areas of the province.</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="6">Sporadic - Pest is present 1 year out of 3 in a given region of the province.</td><td rowspan="3">Widespread - as above</td><td>High - see above</td><td>Orange</td></tr>
<tr><td>Moderate - see above</td><td>Yellow</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="3">Localized - as above</td><td>High - see above</td><td>Yellow</td></tr>
<tr><td>Moderate -see above</td><td>White</td></tr>
<tr><td>Low - see above</td><td>White</td></tr>
<tr><td rowspan="2">Data not available</td><td colspan="3">Not of concern: The pest is present in commercial crop growing areas of the province but is causing no significant damage. Little is known about its population distribution and frequency in this province; however, it is not of concern.</td><td>White</td></tr>
<tr><td colspan="3">Is of concern: The pest is present in commercial crop growing areas of the province. Little is known about its population distribution and frequency of outbreaks in this province and due to its potential to cause economic damage, is of concern.</td><td>Blue</td></tr>
<tr><td>Not present</td><td colspan="4">The pest is not present in commercial crop growing areas of the province, to the best of our knowledge.</td><td>black</td></tr>
<tr><td>Data not reported</td><td colspan="4">Information on the pest in this province is unknown. No data is being reported for this pest.</td><td>grey</td></tr>
</table>

References

Agriculture and Agri-Food Canada. Horticulture and Cross Sectoral Division, Market Analysis and Information Section. *Statistical Overview of the Canadian Vegetable Industry - 2015*. http://www.agr.gc.ca/resources/prod/doc/pdf/VegRep_2015-eng.pdf

Agriculture ande Agri-Food Canada. Research Branch. 2001. *Common Diseases of Corn in Canada*. 67pp. http://publications.gc.ca/site/eng/104123/publication.html

Bailey, K.L. *et al*, eds. 2003. *Diseases of Field Crops in Canada*. Canadian Phytopathological Society. Canada. 304 pp. http://phytopath.ca/publication/books/

British Columbia Ministry of Agriculture. *Vegetable Production Guide 2012:* Crop Recommendations http://productionguide.agrifoodbc.ca/guides/17

Howard, R.J., *et al*. eds. 1994. *Diseases and Pests of Vegetable Crops in Canada*. Canadian Phytopathological Society and Entomological Society of Canada. Canada. 554 pp. http://phytopath.ca/publication/books/

Ontario Ministry of Agriculture and Food and Rural Affairs. Agronomy guide for Field Crops – Publication 811. http://www.omafra.gov.on.ca/english/crops/pub811/p811toc.html (Accessed April 18, 2017)

Ontario Ministry of Agriculture, Food and Rural Affairs. *Brown Marmorated Stink Bug Update*. http://www.omafra.gov.on.ca/english/crops/insects/bmsb-update.htm (Accessed December 5, 2017)

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

Ontario Ministry of Agriculture, Food and Rural Affairs. 2004. *Publication 12 Sweet Corn Production*. http://www.omafra.gov.on.ca/english/crops/pub12/p12order.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *OMAFRA Vegetables: Sweet Corn* http://www.omafra.gov.on.ca/english/crops/hort/sweet_corn.html

Ontario Ministry of Agriculture, Food and Rural Affairs. 2004. *Publication 12 Sweet Corn Production*. http://www.omafra.gov.on.ca/english/crops/pub12/p12order.htm

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

Ontario Ministry of Agriculture, Food and Rural Affairs. 2014. *Publication 838 Vegetable Crop Protection Guide 2014-15*. http://www.omafra.gov.on.ca/english/crops/pub838/p838order.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Ontario Vegetable Crop Protection Guide 2014-2015, Publication 838*
http://www.omafra.gov.on.ca/english/crops/vegpubs/vegpubs.htm

Ontario Ministry of Agriculture, Food and Rural Affairs. *Vegetable Production Recommendations 2010-2011, Publication 363; Publication 363SE, Supplement - Vegetable Production Recommendations 2010-2011*
http://www.omafra.gov.on.ca/english/crops/vegpubs/vegpubs.htm

Pennsylvania State University. The Penn State Agronomy Guide 2017-2018. 478 pp.
http://agguide.agronomy.psu.edu/PDF03/CM/Sec4toc.html

Purdue University, Department of Agronomy. *King Corn, The Corn Growers' Guidebook*
http://www.agry.purdue.edu/ext/corn/

Statistics Canada. CANSIM http://www5.statcan.gc.ca/cansim/

U.S. Department of Agriculture. Northeastern IPM Center, Brown Marmorated Stink Bug SCRI CAP Vegetable Commodity Team. *Integrated Pest Management for Brown Marmorated Stink Bug in Vegetables*. http://www.stopbmsb.org/stopBMSB/assets/File/BMSB-in-Vegetables-English.pdf. (Site consulté le 25 avril 2017)