



Crop Profile for Industrial Hemp in Canada, 2020

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Preface

National crop profiles are developed by the Pest Management Program of Agriculture and Agri-Food Canada (AAFC). The crop profiles provide baseline information on production and pest management practices and document growers' needs to address pest management gaps and issues for specific crops grown in Canada. This information is developed through extensive consultation with stakeholders and data collected from reporting provinces. Reporting provinces are selected based on their acreage of the target crop (>3% of the national production) and provide qualitative data on pest occurrence and integrated pest management practices used by growers in those provinces. For industrial hemp production, the reporting provinces are Alberta, Saskatchewan, Manitoba, Ontario and Quebec.

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

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

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Crop Profile for Industrial Hemp in Canada

Hemp, *Cannabis sativa*, is a member of the Cannabaceae family. *Cannabis sativa* is dioecious, having male and female flowers on separate plants. It is native to central Asia and the East Indies where it was cultivated at least 5000 years ago. Today, industrial hemp is cultivated as an annual crop in all temperate and tropical areas of the world.

Hemp was introduced to Canada in 1606. It was banned from cultivation in 1938 under the Opium and Narcotics Control Act. Cultivation was again permitted in 1998 under licenses and authorizations issued by Health Canada. Restrictions were further loosened in 2018 under the Cannabis Act when cultivation for use in cannabidiol (CBD) production was permitted.

Canada defines industrial hemp as *Cannabis* plants, and parts of the plant, of any variety, that contain 0.3 percent or less tetrahydrocannabinol (THC) in the leaves and flowering heads. All aspects of industrial hemp production are regulated by Health Canada. This means producers may only plant hemp cultivars cited in the List of Approved Cultivars and purchase only certified seeds for planting.

Industrial hemp is an important source of nutritious seeds, durable fibres and medical extracts. Different cultivars of industrial hemp are grown for grain, fibre, and cannabinoid uses. Grain cultivars are bred to produce high yields of seeds that are food grade quality. Both male and female plants are needed to produce a grain crop. Fibre cultivars are bred to produce bast fiber. Cultivars used to produce both grain and fibres are bred to be monoecious. Cannabinoid cultivars (CBD hemp) are bred to produce high levels of CBD and 0.3 percent or less THC with only female hemp plants producing flowers with a high CBD content.

Crop Production

Industry Overview

Since 1998, when hemp cultivation was again permitted in Canada, the area under cultivation has varied greatly from year-to-year. In 2014, 40,467 ha were planted. The number fell to 3,355 ha in 2016, rising again to 56,657 ha in 2017. Growing area fell again and in 2020 stood at 22,243 ha (Table 1). Downturns in growing area were partly caused by changes in export markets. For example, the 2016 downturn occurred when the South Korean hemp market shifted from Canadian hemp products to Chinese hemp products.

Overall hemp exports have doubled since 2014. In 2020, there was \$111.5 million worth of total hemp product exports (Table 1), with \$103.1 million sold to the United States. Hemp seed and oils are the main components of these exports, representing \$111.2 million in sales (Table 1).

Markets and production continue to be fluid due to factors as other countries enter the hemp market. New market opportunities for Canadian producers are now available since changes in the industrial hemp regulations. Cannabidiol and other bioactives can be extracted from hemp for use as ingredients of cosmetics, natural health products and pharmaceuticals. Research is underway to find uses for hemp straw and seed hulls as inputs for construction materials, erosion

control, automotive parts, paper, sustainable packaging, textiles and bedding. The sector has developed grading standards so Canadian hemp products can be recognized globally for their quality and consistency. Another trend is production of certified organic hemp, which now represents about half of the total production.

Over 90 percent of seed used for hemp cultivation in Canada is produced in Canada and consists mostly of Canadian developed cultivars. In 2020, the five top cultivars grown in Canada were: Finola, an oilseed cultivar; Katani, a CBD cultivar; CanMa, a grain/fiber cultivar; CFX-2, a food/fiber/CBD cultivar; and Carmagnola, a CBD cultivar.

Table 1. General production information for industrial hemp, 2020

Canadian Production		22,243 ha ¹ 49,402 metric tonnes ²
Total Farm Gate Value²		\$45,132,626
Exports³:	Oil seeds	\$111,215,559
	Hemp fiber products	\$293,878
Imports³	Oil seeds	\$25,166,942
	Hemp fiber products	\$1,996,217

¹Health Canada. [Industrial hemp licensing statistics](#) (accessed: 2021-07-02)

²Canadian Hemp Trade Alliance data for 2020.

³Innovation, Science and Economic Development Canada. Search by [Industry \(NAICS codes\) - Trade Data Online](#) HS 120799 - oil seeds and oleaginous fruits, nes, whether or not broken; HS 530210 - True Hemp - Raw or Retted; HS 530290 - Tow and Waste of True Hemp (Including Yarn Waste and Garnetted Stock); HS 530820 - True Hemp Yarn (assessed 2021-07-10).

Production Regions

In 2020, the growing area for industrial hemp in Canada was 22,243 ha, production was 49,402 metric tonnes, and farm gate value was just over \$45 million (Table 2). Alberta had the largest growing area followed by Saskatchewan, Manitoba, Ontario and Quebec (Table 2). The exact same trend was seen for production and farm gate value, where Alberta led followed by Saskatchewan, Manitoba Ontario and Quebec (Table 2). Licensing followed a different pattern, with Ontario having the largest number of licenses, followed by Alberta, Saskatchewan, Quebec and Manitoba (Table 2).

Table 2. Distribution of industrial hemp production in Canada, 2020

Production Regions	Growing Area¹ (percentage)	Production² (metric tonnes)	Farm Gate² Value	Number of licenses for cultivation¹
Alberta	8,333 ha (37%)	18,507	\$16,907,133	230
Saskatchewan	6,165 ha (28%)	13,692	\$12,508,056	160
Manitoba	5,041 ha (23%)	11,197	\$10,228,858	92
Ontario	1,300 ha (6%)	2,888	\$2,638,453	278
Quebec	780 ha (4%)	1,733	\$1,583,853	93
Canada	22,243 ha	49,403	\$45,132,626	1,091

¹Source: Health Canada. [Industrial hemp licensing statistics](#) (accessed: 2021-07-02).

²Canadian Hemp Trade Alliance data for 2020.

Cultural Practices

Planting sites with good drainage and fertile soils are best suited for growing hemp. Most ideal are well drained, loamy soils with high levels of organic matter and a pH of 6 to 7. Least ideal are compacted soils, heavy clay soils and low-lying areas due to their poor drainage.

Hemp is a high nutrient user so good soil management is important. Soil nutrient levels are tested before the start of the cropping season. Soil sample cores (approximately 60 cm deep) are used for testing because hemp has a deep, fibrous taproot. Leaf tissue analysis is sometime used to supplement soil fertility information. The exact nutrient needs of hemp cultivars are unknown, so growers follow canola guidelines. It is important that conventional nitrogen fertilizers are placed at least 5 cm from hemp seeds or seedlings to avoid burning the crop.

Crop rotation is practiced to improve soil structure and fertility as well as to break disease, pest and weed cycles. Conventional hemp is preceded by cereal crops while organic hemp is preceded by alfalfa, green-manure crops, legumes and potatoes.

Grain and fiber hemp are grown from seed. Ideal sowing conditions require warm, moist soils so the hemp can germinate, emerge and establish quickly. Seeding rates vary depending on cultivar and productions goals. Typically, grain hemp is sown at a rate of 100 to 125 seeds/m² and fiber hemp is sown at a rate of 200 to 375 seeds/m². Often, fields are over-sown by 30 percent to compensate for non-viable hemp seeds and seedling death. Generally, air drills are used to sow the seed. Care must be taken to not use too high an air pressure otherwise seed cracking will occur.

Irrigation is used to supply water to the crop, but is not generally used in the Prairie Provinces (i.e. Alberta, Saskatchewan, and Manitoba). Instead, dryland farming techniques are used to produce hemp.

Grain hemp is harvested when the bracts around the seed heads have dried up and seeds begin to shatter. After harvest, the seeds are cleaned and dried. Care needs to be taken that the temperature for drying does not exceed 45 °C because otherwise the oils in the hemp seed go rancid. When dried to a 9 percent moisture level, the grain can be safely stored. Stems of the grain hemp can also be harvested for fiber.

Fiber hemp is cut when male plants have flowered and before female plants set seeds. After harvesting, fiber hemp undergoes a process called retting whereby the hemp fibers are separated from each other. This can be done in the field using dew retting or winter retting. Retting is also done in processing plants using water, chemicals and enzymes.

The growing requirements for cannabidiol (CBD) hemp are similar to that of grain and fiber hemp. However, there are some key differences in cultural practices. The CBD content is highest in unfertilized female flowers. For this reason, male plants are rogued at about six weeks of age. This needs to be done when using regular hemp seeds with a 50:50 male-to-female ratio. To avoid having to remove male plants, feminized seeds that produce only female plants or cuttings taken from female mother plants can be used.

Seeds can be sown directly outdoors. Alternatively, seeds or cuttings can be started in containers indoors and are later transplanted into the field. In still other instances, the crop remains indoors throughout the complete production cycle.

Outdoors CBD hemp plants are widely spaced to ensure thorough light penetration into the crop. Plants are spaced 1.2 to 1.5 meters apart on centre with 0.3 to 0.6 meters between rows.

The CBD hemp is harvested when flowers are ripe and full. The plants or flowers are first dried and cured before the CBDs are extracted through industrial processes.

Table 3. Industrial hemp production and pest management schedule in Canada

Time of Year	Activity	Action
May	Plant care	Seed crop when the soil moisture is adequate using minimal tillage For CBD hemp production: start transplants in the greenhouse for planting a female-only population in the field.
	Soil care	Conventional hemp: pre-plant banding of fertilizers. Organic hemp: apply manure and utilize green manure crops.
	Disease management	Organic hemp: applications of biopesticides as needed.
	Insect and mite management	Generally, no management is required at this point in the cropping cycle.
	Weed management	Conventional hemp: pre-plant herbicide applications. Organic hemp: use inter-row cultivators to manage weeds.
June	Plant care	Monitoring the crop.
	Soil care	Organic hemp: hilling and rotary hoe are used to prevent soil erosion. For CBD hemp production: prepare field for transplanting, possibly include herbicide treatment to give a stale seedbed. Transplant female seedlings.
	Disease management	There is limited activity at this point in the cropping cycle.
	Insect and mite management	Monitoring for cutworm, wireworm, European corn borer and other pests: biopesticide applications when necessary, if products are available.
	Weed management	Conventional hemp: if needed, apply an herbicide. Organic hemp: use inter-row cultivation to manage weeds.
July	Plant care	Monitoring the crop.
	Soil care	Organic hemp: cultivation to prevent soil erosion.
	Disease management	Monitoring for diseases. Application of biopesticides as needed.
	Insect and mite management	Monitoring for pests. Application of biopesticides as needed.
	Weed management	Monitoring weed populations. Organic hemp: use inter-row cultivation to manage weeds.
August	Plant care	Monitor the crop.
	Disease management	Monitoring for diseases. Application of biopesticides as needed. There is limited activity at this point in the cropping cycle. For CBD hemp production: manage diseases like powdery mildew and <i>Septoria</i> leaf spot
	Insect and mite management	Monitoring of pests. Application of biopesticides as needed. There is limited activity at this point in the cropping cycle.
	Weed management	There is limited activity at this point in the cropping cycle. For CBD hemp production: manage weeds to minimize weed growth in the field.

...continued

Table 3. Industrial hemp production and pest management schedule in Canada (continued)

September	Plant care	<p>Harvest begins: care is taken to make sure harvest timing is right so as not to lose seeds.</p> <p>For CBD hemp production: Flower harvest may begin in late August depending on planting date, variety, and plant maturity. Once harvested, flowers will need to be rapidly dried to prevent spoilage from mould and fungus.</p>
	Disease management	<p>Monitoring for late season diseases. There is limited activity at this point in the cropping cycle.</p> <p>For CBD hemp production: there may be a need to manage diseases.</p>
	Insect and mite management	Monitoring for late season pests. There is limited activity at this point in the cropping cycle.
	Weed management	There is limited activity at this point in the cropping cycle.
October	Soil care	Soil samples are collected and sent to the lab for fertility analysis.

Abiotic Factors Limiting Production

Soil Quality

Industrial hemp is a heavy nutrient feeder. For this reason, low nutrient and organic matter content negatively impacts crop health. Nutrient deficiencies reduce both the quality and the quantity of crop yields either with or without visible plant symptoms. Industrial hemp may also be negatively impacted by herbicide residues present in the soil.

Moisture Stress

Industrial hemp does not like either drought or saturated, wet soils. Therefore, soils with poor drainage have a negative impact crop health. Under conditions of moisture stress industrial hemp wilts. Wilting might be temporary if the factor causing moisture stress can be quickly corrected.

Other Climatic Factors

Industrial hemp is sensitive to frost. Mature plants are damaged when temperatures reach -2 °C. Flowers with frost damage turn black and develop a harsh taste. Seedlings are more tolerant and are able to withstand temperatures of -7 °C. Damaged seedlings often have chlorotic leaves.

High winds can cause plant lodging. This generally occurs when the plants are experiencing rapid stem elongation, before stem strength has fully developed. If plants are lodged at their bases, it is possible for them to right themselves. If kinked further up the stem, the stems often curve upright again so that the plant stem forms a “gooseneck”.

Hail can severely damage young seedlings and split branches and break stalks of mature plants.

Too much sun can burn crop leaves especially when indoor seedlings are first transplanted outdoors.

Diseases

Key issues

- For all diseases, there is a need to determine economic thresholds and IPM control strategies for the various hemp cultivars.
- Conventional and non-conventional fungicides, including biopesticides are needed for the management of industrial hemp diseases.
- Further research is needed to determine which cultivars are resistant or tolerant to the various hemp diseases.
- There is a need to develop in-crop biological control products for the management of white mold (*Sclerotinia sclerotiorum*).
- There is a need to identify the causal pathogens of complexes such as soil and seed borne diseases.
- There is a need to monitor new and emerging diseases.

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

Disease	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
Botrytis head blight, gray mold					
Soil and seed borne disease					
Damping Off (<i>Pythium</i> spp.)					
Damping Off (<i>Fusarium</i> spp.)					
White mold, stem rot					
Downy Mildew ³					
Powdery Mildew ³					
Blight of grapevine ⁴					
Alternaria / Brown blight ⁴					
<i>Nigrospora sphaerica</i> ⁴					
<i>Nigrospora oryae</i> ⁴					
Widespread yearly occurrence with high pest pressure.					
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.					
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.					
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.					
Pest is present and of concern, however little is known of its distribution, frequency and pressure.					
Pest not present.					
Data not reported.					

¹Source: Hemp stakeholders in reporting provinces (Alberta, Saskatchewan, Manitoba, Ontario and Quebec); the data reflect the 2018, 2019 and 2020 production years.

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

³These are primarily diseases of cannabis production and are included here for information purposes only.

⁴As of August 2021, little is known about the impact of these diseases on hemp in Canada; they are included here for information purposes only.

Table 5. Adoption of disease pest management practices in hemp production in Canada¹

Practice / Pest		Soil and seedborne diseases (<i>Pythium</i> sp., <i>Fusarium</i> sp.)	Botrytis head blight	White mold, Stem rot
Avoidance	Varietal selection / use of resistant or tolerant varieties			
	Planting / harvest data adjustment			
	Rotation with non-host crops			
	Choice of planting site			
	Optimizing fertilization for balanced growth and to minimize stress			
	Minimizing wounding and insect damage to limit infection sites			
	Use of disease-free propagative materials (seed, cuttings or transplants)			
Prevention	Equipment sanitation			
	Canopy management (thinning, pruning, row or plant spacing)			
	Manipulating seeding / planting depth			
	End of season or pre-planting crop residue removal/management			
	Removal of other hosts (weeds / volunteers / wild plants) in field and vicinity			
Monitoring	Scouting / spore trapping			
	Maintaining records to track diseases			
	Soil analysis for the presence of pathogens			
	Weather monitoring for disease forecasting			
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of diseases			

...continued

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

Practice / Pest		Soil and seedborne diseases (<i>Pythium</i> sp., <i>Fusarium</i> sp.)	Botrytis head blight	White mold, Stem rot
Decision making tools	Economic threshold			
	Use of predictive model for management decisions			
	Crop specialist recommendation or advisory bulletin			
	Decision to treat based on observed disease symptoms			
	Use of portable electronic devices in the field to access pathogen / disease identification / management information			
Suppression	Use of diverse product modes of action for resistance management			
	Use of non-conventional pesticides (e.g., biopesticides)			
	Controlled atmosphere storage			
Crop specific practices	Avoid contaminating grain through good farm hygiene practices			
This practice is used to manage this pest by at least some growers in the province.				
This practice is not used by growers in the province to manage this pest.				
This practice is not applicable for the management of this pest.				
Information regarding the practice for this pest is unknown.				

¹Source: Hemp stakeholders in reporting provinces (Alberta, Saskatchewan, Manitoba, Ontario and Quebec); the data reflect the 2018, 2019 and 2020 production years.

Botrytis head blight, grey mold (*Botrytis cinerea*)

Pest Information

Damage: Botrytis head blight predominately attacks the moisture-retaining flower heads of grain hemp varieties and the stems of fiber hemp varieties. Initially with a flower infection, the fan leaflets turn yellow and wilt. Later the pistils turn brown. Eventually the whole flower turns brown, withers and dies. When conditions are humid, the flowers also become covered in a grey fuzz that turns into a grey-brown slime. With the stem, infected tissue first becomes chlorotic, which then turn into soft, shredded cankers. Cankers may enlarge to circle and girdle the stem, resulting in plant wilting above the canker line. Stalks may snap at the cankers. When conditions are humid, the cankers also become covered in spores. When environmental conditions conducive to the disease persist, yield losses of up to 100 percent can occur.

Life Cycle: *Botrytis cinerea* overwinters as sclerotia or dormant hyphae. Spring rains trigger sclerotia to germinate and produce spores. Spores are blown or splashed onto host plants. Spores germinate under moist conditions to directly penetrate young plant tissue or enter older plants through plant wounds. *B. cinerea* also colonizes dead leaves and flowers, and from there invades the plant. Under humid conditions, the fungus produces new spores that spread and cause secondary infections. As plant tissue resources are depleted, small, black sclerotia form within the plant stem. High humidity and cool to moderate temperatures favour disease development. Such conditions often occur with persistent cool-to-warm, wet weather or after crop canopy closure.

Pest Management

Cultural Controls: Weeds that act as alternate hosts for the disease are controlled. Sclerotia viability is reduced with burial or deep plowing. Removal and/or disposal of plant debris containing sclerotia reduces inoculum loads. Late planting avoids cool temperatures that favour Botrytis head blight establishment. Avoiding field areas with poor drainage and high soil moisture prevents disease establishment. In areas with acidic soils, calcium fertilizers are applied to neutralize the soil pH and increase calcium uptake and excess nitrogen and phosphorus are avoided. Using clean, certified hemp seeds for planting is important. Reducing seeding rates lowers stand density and humidity within the crop minimizing disease development.

Resistant Cultivars: Tolerant cultivars are available. Cultivar physical traits may provide a clue about its tolerance to *Botrytis cinerea*. For example, slimmer grain heads hold less moisture which reduces susceptibility to the disease.

Issues for Botrytis head blight, grey mold

1. Research is needed to evaluate industrial hemp cultivars for differences in susceptibility to *Botrytis cinerea* and severity of disease incidence.
2. Techniques for predicting *Botrytis* infection need to be improved. Current models depend on weather and provide only a crude indication of the potential for disease.
3. Conventional and non-conventional fungicide seed treatments, including biopesticides are needed to manage pre- and post-emergent diseases caused by *Botrytis*.

Soil and seed borne diseases, damping off (*Pythium* sp. and *Fusarium* sp.)

Pest Information

Damage: With pre-emergent damping off, infected seeds or seedlings rot and die before they emerge from the soil. With post-emergent damping off, seedlings are infected after they emerge from the soil. Symptoms include brown-rot or lesions on the stem near the soil line, followed by wilting and toppling. In older seedlings, growth stops and leaves turn yellow. Eventually the seedlings wilt and fall over. In young plants, *Pythium* root-rot starts at the root tips and feeder roots and over time only brown stubby roots are left. For large roots, the outer root tissue peels off leaving only string-like vascular bundles beneath. With *Fusarium*, mature plants exhibit root rot, stem cankers and plant wilt. Seed borne and soil diseases can reduce crop establishment by up to 50 percent.

Life Cycle: *Pythium* overwinters in the soil and plant root residues as oospores and chlamydospores. When conditions are right, oospores and chlamydospores germinate to produce hyphae. The hyphae can live in the soil on dead organic matter as well as infecting seeds and seedling roots. The disease is spread further when the fungus produces sporangia which release zoospores. The zoospores swim through water until they reach plant roots. The zoospores then encyst and produce hyphae that feed on root tissues. *Fusarium* overwinters as tough dormant spores. The spores are spread by rain and water run-off. The spores germinate in the spring and survive in the soil as saprophytes until they come into contact with seeds and plant roots. The spores invade the plant roots and develop in the xylem, impairing water transport. Plant pathogens that cause damping off prefer many different types of environmental conditions, but all need excess moisture in order to thrive.

Pest Management

Cultural Controls: Seeds are sown shallowly and only when the soil is warm in order to promote quick crop establishment. Where seed viability is an issue, growers over-sow to ensure proper stand establishment. Avoiding field areas with heavy soils, poor drainage and high moisture levels prevents disease establishment. Excess plant nutrients are avoided. Clean, certified hemp seeds are used for planting.

Resistant Cultivars: Some vigorous varieties may have some tolerance to damping off.

Issues for soil and seed borne diseases, damping off

1. Research is needed to identify cultivars with both early season vigour and resistance to damping off.
2. Research is needed to identify effective seed treatments to manage seed borne diseases and damping off.
3. Conventional and non-conventional fungicide seed treatments, including biopesticide seed treatments are needed to manage seed borne disease and damping off.
4. As growers seed earlier to maximize yields, there have been more reports of crop establishment issues caused by seedling diseases. More research is needed to evaluate the balance between early seeding and avoiding seedling diseases.
5. A seedling diagnostic tool is under development to assist agronomists and growers in diagnosing seedling problems. There is a need for the continued support of the development of this important tool.
6. A greater understanding is required of the impact of residual herbicides on the incidence of seedling diseases.

White mold, stem rot, hemp canker (*Sclerotinia sclerotiorum*)

Pest Information

Damage: White mold symptoms begin in the early spring with water-soaked lesions appearing at the soil surface or up the length of the plant. As the disease progresses, the cortical tissue under the lesions collapses, resulting in pale tan or grey cankers. Under humid conditions, the stalk also becomes covered in white mycelium. Later in the growing season, hard, black sclerotia form on the canker surfaces and inside the hollow plant stems. The shape of the sclerotia can be round, oblong or irregular. If the plants are flowering, flowering ceases. Stems sometimes shred and break at the lesion sites, resulting in wilting or toppling of the plant. The disease can also infect the grain head. Plant tissue located above the site of the head infection dies. Sclerotia eventually form at the head infection site and contaminate the grain harvested. White mold can cause yield losses of up to 40 percent.

Life Cycle: The disease overwinters in the soil or crop debris as sclerotia. In the spring, warm temperatures and moisture cause the sclerotia to produce apothecia. The apothecia release spores that are spread by wind or insects (e.g., honey bees) to host plants where new infections occur. Infection can be direct or through plant wounds. By late-summer or early-fall, the overwintering sclerotia develop on or inside the plant. Once in the soil, sclerotia can remain viable for many years. Disease development and spread are favoured by warm, moist, humid environmental conditions. Such conditions often occur with persistent warm, wet weather or after crop canopy closure. Moist microclimates also occur more often in hemp varieties characterized by dense plant heads.

Pest Management

Cultural Controls: Industrial hemp is rotated with non-host plants such as grains and grasses in a 3-to-4-year cycle to reduce the number of viable sclerotia in the soil. Such an approach is done in combination with the control of dicot weeds that act as alternate hosts for the disease. Sclerotia viability is reduced with burial (deeper than 6 cm) or deep plowing. Removal and/or

disposal of plant debris containing sclerotia reduces inoculum loads. Avoiding field areas with poor drainage and high soil moisture prevents disease establishment. In areas with acidic soils, calcium fertilizers are applied to neutralize the soil pH and increase calcium uptake. Clean, certified hemp seeds are used for planting. Reducing seeding rates lowers stand density and humidity within the crop minimizing disease development. Commercially available wind-blown spore traps or walking the field to identify apothecia are tools or practices used to monitor pathogen presence. Commercial weather modelling services are used to forecast disease development.

Resistant Cultivars: Tolerant cultivars are available. Cultivar physical traits may provide a clue about its tolerance to *S. sclerotiorum*. For example, slimmer grain heads hold less moisture, which reduces susceptibility to the disease.

<i>Issues for white mold, stem rot, hemp canker</i>
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1. Research is needed to evaluate industrial hemp cultivars for differences in susceptibility to *S. sclerotiorum* and severity of disease incidence.
2. Techniques for predicting *S. sclerotiorum* infection need to be improved. Current models depend on weather and provide only a crude indication of the potential for disease.
3. Educational tools are needed so that growers can better recognize and deal with the disease. In some areas, growers are less familiar with the disease.

Insects and Mites

Key issues

- Research is needed to determine which insect species are present on hemp, and which of these species are damaging the crop.
- Research is needed to determine the life histories of several insects including aphids and cutworms on hemp.
- Research is needed to determine the potential crop damage by insects for different hemp cultivars, and which cultivars are resistant or tolerant to these pests.
- There is a need to identify or develop monitoring methods for the various insect pests.
- For all pests, there is a need to determine economic thresholds and IPM control strategies for the various hemp cultivars.
- There is a need to evaluate various types of pest controls methods including biological, cultural and chemical controls.
- Conventional and non-conventional pest control products, including biopesticides are needed for the management of hemp pests.
- Effective biological control options are needed for key pests such as aphids, European corn borer, hemp borer, cutworms, Bertha armyworm and grasshoppers.
- Research is needed to determine the pest complexes found on CBD hemp cultivars.

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

Insect and mite	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
Cannabis aphid					
Green peach aphid					
Rice root aphid					
European corn borer					
Eurasian hemp borer					
Cutworms					
Bertha armyworm					
Grasshopper					
Leafhoppers					
Flea beetles ³					
Spider mites ³					
Thrips ³					
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.					
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.					
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.					
Pest is present and of concern, however little is known of its distribution, frequency and pressure.					
Pest not present.					
Data not reported.					

¹Source: Hemp stakeholders in reporting provinces (Alberta, Saskatchewan, Manitoba, Ontario and Quebec); the data reflect the 2018, 2019 and 2020 production years.

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

³These are primarily pests of cannabis production and are included here for information purposes only.

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

Practice / Pest		Cutworms (Various species)	European corn borer	Eurasian hemp borer	Aphids	Grasshoppers
Avoidance	Varietal selection / use of resistant or tolerant varieties					
	Planting / harvest date adjustment					
	Rotation with non-host crops					
	Choice of planting site					
	Optimizing fertilization for balanced growth					
	Reducing pest populations at field perimeters					
	Use of pest-free propagative materials (seeds, cuttings or transplants)					
Prevention	Equipment sanitation					
	Manipulating seeding / planting depth					
	End of season or pre-planting crop residue removal / management					
	Tillage / cultivation to expose soil insect pests					
	Removal of other hosts (weeds / wild plants / volunteer crops) in field and vicinity					
Monitoring	Scouting / trapping					
	Maintaining records to track pests					
	Weather monitoring for degree day modelling					
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of pests					

...continued

Table7. Adoption of insect pest management practices in hemp production in Canada¹ (continued)

Practice / Pest		Cutworms (Various species)	European corn borer	Eurasian hemp borer	Aphids	Grasshoppers
Decision making tools	Economic threshold					
	Use of predictive model for management decisions					
	Crop specialist recommendation or advisory bulletin					
	Use of portable electronic devices in the field to access pest identification / management information					
Suppression	Use of diverse pesticide modes of action for resistance management					
	Use of non-conventional pest control products (e.g., biopesticides)					
	Release of arthropod biological control agents					
	Trapping					
	Targeted pesticide applications (e.g., banding, spot treatments, use of variable rate sprayers)					
This practice is used to manage this pest by at least some growers in the province.						
This practice is not used by growers in the province to manage this pest.						
This practice is not applicable for the management of this pest.						
Information regarding the practice for this pest is unknown.						

¹Source: Hemp stakeholders in reporting provinces (Alberta, Saskatchewan, Manitoba, Ontario and Quebec); the data reflect the 2018, 2019 and 2020 production years.

Green peach aphid (*Myzus persicae*) and cannabis aphid (*Phorodon cannabis*)

Pest Information

Damage: Nymphs and adults feed on plant sap by using stylet mouthparts to pierce plant tissues. Initial symptoms from aphid feeding are light coloured spots near leaf veins. Later leaves and flowers become yellow, puckered and distorted. Growth of heavily infested plants slows and the plant eventually wilts and dies. Honeydew excreted by feeding aphids leads to sooty mold and ants. The sooty mold grows on the honeydew, reducing plant photosynthesis and transpiration. Ants eat the honeydew and attack arthropods that feed on aphids. It is also important to note that winged aphids transmit serious plant diseases caused by fungi, bacteria and viruses.

Life cycle: Aphids overwinter as eggs. Eggs hatch in the spring into wing-less females who give live birth to immature females through asexual reproduction. During asexual reproduction aphid colonies grow quickly. When conditions become crowded or food becomes scarce, winged females are produced. The winged females fly to a new plant, establish a new colony and the cycle is repeated. Asexual reproduction continues throughout the growing season until fall. In the fall, male and female aphids are produced and they mate. The mated females lay the overwintering eggs. Warm, moist weather with gentle rains and little wind favours the build-up of aphid populations. Under ideal conditions, up to 12 generations are produced in a year. Hemp is the only host plant of the cannabis aphid. By contrast, green peach aphid is found on *Prunus* species from fall to early spring and on hemp from late spring to late summer.

Pest management

Cultural controls: Vigorous, healthy plants are more resistant to aphid attack and are grown by using proper nutrient and water management. Yellow sticky traps are placed at field edges to detect winged aphids migrating into the crop. Ants that might protect aphids are managed. Numerous natural enemies of aphids such as ladybugs, flower flies, lacewings and parasitoid wasps are usually present in hemp fields. Specific to cannabis aphid, control relies on destroying all hemp material after harvest and roguing out volunteer hemp seedlings in the spring.

Resistant cultivars: There are no aphid resistant or tolerant hemp cultivars available.

Issues for Aphids

1. Research is needed to determine which aphid species are present on hemp and which species are damaging to the crop.
2. There is a need to determine the economic thresholds and IPM control strategies for the management of aphids on hemp.
3. There is a need for pest control products, including systemic products, to manage aphids in hemp production.
4. Biological control agents need to be evaluated for their effectiveness in controlling aphids.

Rice root aphid (*Rhopalosiphum rufiabdominalis*)

Pest Information

Damage: Nymphs and wingless adults feed on sap by using stylet mouthparts to pierce root tissues. When populations are large, heavy feeding damages the roots, inhibiting nutrient and water uptake. The crop shows signs of nutrient deficiencies such as off-coloured lower leaves. Plant vigour and growth are reduced. The root wounds caused by rice root aphids serve as entry points for root rot pathogens. Eventually the plant wilts and dies. Winged aphids are eventually produced and move from the soil onto stems, leaves and flower heads. These aphids excrete honeydew, encouraging sooty mold and ants. The winged aphid forms also transmit serious plant diseases from one plant to another. Flower heads contaminated with aphids and honeydew reduce crop quality and yields.

Life cycle: For hemp, rice root aphid is only known to impact indoor and greenhouse-grown transplants and crops. Under protected culture the aphid remains in its asexual reproductive phase year-round. Wingless females and nymphs feed on roots. Eventually winged forms are produced that crawl out of the soil, fly and colonize above ground plant parts. Wingless daughters are produced and crawl down the plant to feed on the plant roots. Rice root aphids are introduced to clean facilities when winged forms from outside enter through vents and doors. The movement of infested growing media and plants into pest free facilities also brings the aphid into contact with the crop. Under ideal environmental conditions, up to 55 generations per year are produced. Plants of the grass and sedge families are the primary alternate hosts for the rice root aphid. The rice root aphid proliferates under the warm, mild conditions of protected culture.

Pest management

Cultural controls: New plants are quarantined from all other plants until it is certain that the growing media and plants are free of rice root aphids. New plantings are isolated from older plantings. When the rice root aphid is detected, the facility is cleaned out, sanitized and left empty for at least a week. Growing media between crops is disposed of or is sterilized. This prevents pest carry over from the old crop to the new crop. If crop is grown in soil, the use of mulches is avoided. There are a number of monitoring techniques. First, plants are inspected for aphids after irrigation. Second, with new plants, the plant is placed on a tray and watered to see if any aphids are flushed out. Third, plants are inspected for signs of water stress. Fourth, yellow sticky traps are placed close to the growing media. The beetle, *Dalotia coriaria*, is a predator of the rice root aphid. Green lacewing larvae feed on aphids found on the above ground plant parts.

Resistant cultivars: There are no aphid resistant or tolerant hemp cultivars available.

Issues for Rice Root Aphids

1. An improved understanding of the biology of rice root aphid is required to aid in the development of management strategies.
2. Systemic, conventional insecticides are needed to augment the currently registered biopesticides.
3. Biological control agents need to be evaluated for the optimal environmental requirements for their application to optimize effectiveness in controlling rice root aphids.

4. There is a need to determine the economic thresholds for the management of rice root aphids on hemp.

European corn borer (*Ostrinia nubilalis*)

Pest Information

Damage: Initially, young European corn borer (ECB) larvae eat plant leaves and subsequently bore into branches and stems. Feeding within the stems may cause plant wilting and the formation of galls. The galls are usually found on the bottom three-quarters of the plant stem. Stems may snap at the gall sites. Larvae hatching in late summer or fall bore into the flowering heads, spin webs and feed on the flowers and seeds. With severe infestations, yield losses of up to 50 to 100 percent are possible.

Life cycle: European corn borers over-winter as mature larvae in plant stubble. Larvae begin feeding again in the spring, pupate and emerge as adult moths. Females fly until they find a host plant. Eggs are laid on the leaves of the plant. Larvae hatch from the eggs, feed and pupate. Moths emerge and the cycle is repeated. Canada is at the northern range of the European corn borer distribution, so there is generally only one generation per year. High humidity and little wind in the summer favour egg-laying as well as egg and larval survival. European corn borer has a wide host range, invading any herbaceous plant with a stem large enough to bore into.

Pest management

Cultural controls: Crop residues that might contain ECB are destroyed after harvest. Deep plowing also reduces overwintering populations. Care is taken not to move stems infested with ECB to pest free fields. Volunteer hemp and weeds that act as pest reservoirs are controlled. Clean, certified seed is used. Hemp is not planted next to corn fields and corn is not used in crop rotation with hemp. Black light and pheromone traps are used to monitor for adult ECB. Fields are scouted to determine when egg laying and damage is occurring. A wide sample area is scouted because ECB clusters its egg laying, causing an uneven distribution of the pest in the field. Many arthropods are enemies of ECB. *Trichogramma* wasps, lacewings, predatory stink bugs and pirate bugs target eggs. A tachinid fly, *Lydella thompsonii*, and braconid wasps attack larvae.

Resistant cultivars: *Carmagrola* is highly resistant to ECB while *Uniko-B* and *USO-14* are moderately resistant cultivars.

Issues for European corn borer

1. There is a need for continued monitoring of ECB to determine its distribution and the level of damage it causes in hemp growing regions across Canada.
2. There is a need to determine the economic thresholds for the management of ECB on hemp.
3. There is a need for conventional and non-conventional pest control products, which are compatible with the use of *Trichogramma* sp. for the management of ECB.
4. *Trichogramma* application techniques need to be improved, especially for large acreage production.

Eurasian Hemp borer (*Grapholita deliueana*)

Pest Information

Damage: Initially, young larvae eat plant leaves and subsequently bore into petioles, branches and stems. Damage is often found on the top one-third of the plant. Feeding within the stems may cause plant wilting and the formation of galls. Stems may snap at the gall sites. Larvae hatching in late summer or fall, spin a loose web around the flower heads, and feed on the flowers and seeds. With severe infestations, seed losses of up to 40 percent are possible.

Life cycle: Eurasian hemp borers over-winter as mature larvae in plant stubble, weeds and sometimes stored seed. Larvae begin feeding in the spring, pupate and emerge as adult moths. Females fly until they find a host plant. Eggs are laid on the leaves of the plant. Larvae hatch from the eggs, feed and pupate. Moths emerge and the cycle is repeated. Canada is at the northern range of the hemp borer distribution, so there is generally only one generation per year. The host plants of hemp borer are limited to *Cannabis sativa*, hops and knotweed. The build-up of hemp borer populations is favoured by large amounts of hemp debris between cropping seasons; volunteer hemp or very early planted hemp; and year-after-year continuous hemp cropping on the same site.

Pest management

Cultural controls: Crop residues that might contain hemp borers are destroyed after harvest.

Deep plowing also reduces overwintering populations. Care is taken not to move stems infested with hemp borers to pest free fields. Volunteer hemp and hops that act as pest reservoirs are controlled. Clean, certified seed is used. Grain crops are harvested early. Field edges are regularly scouted and sweep nets are used to determine hemp borer populations. Many native arthropods attack hemp borer. *Trichogramma* wasps, lacewings and pirate bugs target eggs. A tachinid fly, *Lixophaga variabilis*, and a braconid wasp, *Macrocentrus delicatus*, attack larvae.

Resistant cultivars: Dwarf hemp cultivars (< 30 cm tall) are rarely attacked by hemp borer.

Issues for Eurasian hemp borer

1. Research is needed to develop monitoring techniques to detect early hemp borer outbreaks.
2. An improved understanding of the biology of hemp borer, including use of alternative hosts, is required to aid in the development of management strategies.
3. Conventional and non-conventional pest control products, which are compatible with the use of *Trichogramma* sp. for the management of hemp borer are needed.
4. *Trichogramma* application techniques need to be improved, especially for large acreage production.
5. There is a need to determine the economic thresholds for the management of hemp borer.

Cutworms: Noctuidae (*Euxoa* species)

Pest Information

Damage: Cutworm larvae feed on plants at night and burrow in the soil during the day. Young, small larvae leave holes and small notches in leaves. Older, larger larvae eat the stems of seedlings and young plants. The stems are chewed at the soil line so that plants are found notched, tilted, wilted, dead or cut-off. Larvae can drag toppled seedlings into their burrows, resulting in missing seedlings and bare patches in the field. If too many seedlings are damaged, the hemp crop will need to be reseeded.

Life cycle: Depending on the species, cutworms overwinter in the soil as eggs or immature larvae. Still others overwinter outside the region and re-invade Canadian hemp growing areas annually. Adult moths emerge from spring to fall to mate and lay eggs in or on the soil. Larvae hatch to feed on host plants, and molt five to six times before pupating. Adults emerge and the cycle is repeated. In Canada, there are usually just one generation per year. Cutworms are polyphagous, feeding on many different plant species. Environmental conditions that favour cutworms vary depending on the cutworm species.

Pest management

Cultural controls: Cutworm larvae are starved when fields are cultivated and left fallow for two weeks before the crop is sown. Alternative food sources such as weeds are controlled. Cutworm populations are often high in pastures, so planting hemp on plowed pastureland is delayed for at least a year. Fall plowing kills the overwintering cutworm stages by mechanical damage. By contrast, minimum tillage conserves the parasites and predators of cutworms. Pheromone traps are used to monitor for adult moths. Hemp seedlings are scouted on a regular basis for signs of cutworm damage. Larvae numbers are monitored by either inspecting the crop at night when the larvae are active, or by digging and sifting the soil around recently damaged plants to find larvae that are hiding in the soil. Native arthropods that feed on cutworms include pirate bugs, bee flies, tachinid flies, parasitic wasps, ground beetles and the spined soldier bug. Wet soil conditions promote fungal diseases of cutworms and cause the larvae to remain on the soil surface where they are more vulnerable to parasites and predators.

Resistant cultivars: There are no cutworm resistant or tolerant hemp cultivars available.

Issues for Cutworms

1. Research is needed to determine which cutworm species feed on hemp and their life histories.
2. There is a need to determine the economic thresholds for the management of cutworms on hemp.
3. Research is needed to determine the effects of cutworm damage on seed, fiber and CBD production.
4. Cutworm pressure in hemp seems to be on the increase. It is not clear at this time if this is due to normal population fluctuations and management practices. The situation needs to be monitored and addressed.

Bertha Armyworm (*Mamestra configurate*)

Pest Information

Damage: Newly hatched larvae feed on the underside of leaves, making irregularly shaped holes. When larvae have grown larger, they eat all the leaf blade tissues so that only skeletonized leaves remain on the plant. In Manitoba, Bertha armyworm is reported to have caused the complete defoliation of hemp crops.

Life cycle: Bertha armyworm overwinters as pupae in the soil. Adult moths emerge from May to August. They mate and the females lay eggs on the undersides of plant leaves. Larvae hatch, feed and go through five molts. When mature in late summer or early fall, larvae borrow into the soil and pupate. Bertha armyworm is polyphagous and is known to feed on hemp, canola, alfalfa, flax, peas, potatoes, lamb's quarters and wild mustard. Mild winters or winters with heavy snowfall increase the survival rate of the pupae and subsequent adult emergence.

Pest management

Cultural controls: Fall cultivation kills Bertha armyworm pupae by mechanical damage. Hemp stubble that holds snow, thereby protecting pupae, are flattened or removed. Alternative food sources such as weeds are controlled. Accumulated degree-days are used to forecast adult emergence in the spring. After adult emergence, pheromone traps are used to monitor adult population levels. Field scouting is used to monitor larvae numbers. Economic thresholds exist for various crops, but none are established for hemp. There are two native parasites that feed on Bertha armyworm larvae: an ichneumonid wasp, *Banchus flavescens*, and a tachinid fly, *Athrycia cinerea*.

Resistant cultivars: There are no Bertha armyworm resistant or tolerant hemp cultivars available.

Issues for Bertha Armyworm

1. There is a need to determine the economic thresholds for the management of Bertha armyworm on hemp.
2. There is a need to better understand the impact of Bertha armyworm defoliation on hemp growth and yield.
3. Research is needed to determine the effects of Bertha armyworm damage on seed, fiber and CBD production.
4. Research is needed to determine if Bertha armyworm damage may change the plant production of THC.

Grasshoppers (*Melanoplus* species)

Pest Information

Damage: Grasshopper nymphs and adults make round, smooth edged holes when they feed on hemp leaves. Grasshoppers bite through twigs, causing them to flag and the stems of young plants, causing them to fall over. Grasshoppers also destroy plant growing tips, stunting plants and reducing seed production. When infestations are extremely high, some grasshopper species form into migratory swarms that defoliate crops. These swarms can severely impact hemp seed and fiber yield.

Life cycle: Grasshoppers overwinter in the ground as egg clusters or egg pods. Nymphs hatch from the eggs in spring following rain and warm temperatures. The nymphs feed on young, green vegetation and go through a number of molts. By summer the nymphs have molted into adults. After mating and a period for egg development, females seek suitable sites to lay their eggs, often in compact soil found at field edges. There is generally one generation per year. Grasshoppers are polyphagous, eating many kinds of plants. Adults can also feed on plant litter. Grasshopper populations build under certain environmental conditions such as warm, moist springs followed by warm, dry summers.

Pest management

Cultural controls: Deep plowing disturbs and kills grasshopper eggs. Controlling weeds reduces the amount of vegetation available for the pest to feed on. Growing hemp next to pastures or on land that was previously in pasture is avoided. Counting adults along roadsides and in the field determines grasshopper densities. Adult density provides an estimate of the overwintering eggs and a forecast of whether-or-not grasshoppers will be a problem in the next growing season. Sweep nets are used to capture grasshoppers for identification to the species level. General action thresholds for a wide range of crops exist, but none are specific to hemp. Naturally occurring arthropods such as spiders and flesh flies provide some control of grasshoppers.

Resistant cultivars: There are no known cultivars resistant or tolerant to grasshopper feeding.

Issues for Grasshoppers

1. There is a need to distinguish between grasshopper species that feed on hemp and those that feed on weeds associated with the crop.
2. Research is needed to determine which, if any hemp cultivars are resistant to grasshopper feeding.
3. There is a need to determine the economic thresholds for the management of grasshoppers on hemp.
4. Research is needed to determine the impact of grasshopper defoliation on hemp growth and yield.
5. Research is needed to determine the effects of grasshopper damage on seed, fiber and CBD production.
6. Research is needed to determine if grasshopper damage may change the plant production of THC.

Leafhoppers

Pest Information

Damage: Nymphs and adults feed on plant sap by using piercing, sucking mouthparts. Most leafhopper species observed on hemp are transient and only feed briefly or not at all. Those that do feed and reproduce on hemp have an insignificant effect and leave no visible symptoms. A few leafhoppers such as *Empoasca* species produce leaf stippling at the feeding site. One species, the potato leafhopper (*Empoasca fabae*), can cause hopper burn. Hopper burn symptoms initially show as yellowing at the leaf tips. Symptoms may progress to include the whole leaf, followed by areas of leaf death. Leaf curling may also occur. Another species, the beet leafhopper (*Neolotus tenellus*), is rarely found on hemp. However, beet leafhopper is known to cause serious injury to the crop because of its ability to transmit the Beet Curly Top Virus. When present on hemp, both potato and beet leafhopper have the potential to cause significant yield losses.

Life cycle: Leafhoppers overwinter as eggs or adults. Eggs are laid into leaf veins or plant stems. Eggs hatch in the spring and nymphs feed on tender, new growth of the host plant. Most leafhopper species produce one generation per year, but some species have up to six generations per year. The potato leafhopper can have up to four generations per year and it attacks over 200 different plant species. It is found in eastern North America and overwinters as an adult in the US Gulf states, carried north on weather fronts each spring. The beet leafhopper overwinters in the southern parts of North America as an adult on winter annual mustards. It is capable of flying hundreds of kilometers and migrates northward in the spring. The beet leafhopper can have up to three generations per year and its. The main host plants for the beet leafhopper are beets, tomatoes, and various weedy plant species.

Pest management

Cultural controls: Vigorous, healthy plants are more resistant to leafhopper attack and are grown by using proper nutrient and water management. Sweep nets and visual inspection of hemp plants are used to monitor for the presence of leafhoppers. Various generalist predators, such as minute pirate bug, damsel bug, lacewings and lady beetles, are known to feed on leafhoppers. In addition, leafhopper eggs are parasitized by wasps of the genus *Anagrus* and *Aphelopus*. For potato leafhopper, growing hemp close to alfalfa, soybean, potato, snap bean and other susceptible crops is avoided.

Resistant cultivars: There are no leafhopper resistant or tolerant hemp cultivars available.

Issues for Leafhoppers

1. Research is needed to determine which leafhopper species are present on hemp and which species are damaging to the crop.
2. There is a need to determine the economic thresholds and IPM control strategies for the management of leafhoppers on hemp.
3. Conventional and non-conventional pest control products, including systemic products, are needed to manage leafhoppers.
4. Biological control agents need to be evaluated for their effectiveness in controlling leafhoppers.

Plant Bugs (*Lygus* sp. and Stink Bugs)

Pest Information

Damage: Nymphs and adults consume plant sap by using piercing, sucking mouthparts. The tender parts of the plant are preferentially fed on including young leaves, stems and branches as well as flowering tops and unripe seeds. Feeding injury includes small discolored areas, distortion of new growth, bud and flower abortion, deformed seeds and delayed seed maturity. Some plant bugs inject a toxic saliva into the plant as they feed, turning plant tissues brown and lumpy. In addition, plant bugs can transmit serious plant diseases such as Asters Yellow. In hemp, large numbers of plant bugs feeding on seed bracts can cause significant yield losses.

Life cycle: Plant bugs overwinter as adults in sheltered spots in the soil, on weeds and in crop stubble. In the spring, females emerge and lay eggs. *Lygus* species lay eggs into plant stems while stink bugs lay eggs in masses on the surface of plant leaves. Eggs hatch and nymphs emerge to feed on the tender, new growth of the host plant. Plant bugs species produce one to five generations per year, with fewer generations produced in the northern parts of the insect's range. Plant bugs infest more than 100 plant species but prefer alfalfa, canola, and other types of legume and mustard plants. Plant bugs are very mobile and often move onto hemp after other nearby crops mature and dry down or are harvested. Adults continue to feed until early fall before moving to sheltered sites to overwinter.

Pest management

Cultural controls: Crop residues that might shelter overwintering adults are destroyed after harvest. Deep plowing kills overwintering adults in the soil. Alternative food sources such as weeds are controlled. Yellow or white sticky traps and visual inspection of hemp plants are used to monitor for the presence of plant bugs. Growing hemp close to alfalfa, canola and other susceptible crops is avoided. Various generalist predators such as damsel bug, lacewings and crab spiders, are known to feed on plant bugs. In addition, plant bug eggs are parasitized by wasps including those of the genus *Anaphes*, *Telenonus* and *Polynema*. Other wasps such as the genus *Peristenus* attack nymphs. Lastly, tachinid flies target adult plant bugs.

Resistant cultivars: There are no plant bug resistant or tolerant hemp cultivars available.

Issues for Plant Bugs

1. Research is needed to determine which plant bug species are present on hemp and which species are damaging to the crop.
2. There is a need to determine the economic thresholds and IPM control strategies for the management of plant bugs on hemp.
3. Conventional and non-conventional pest control products, including systemic products, are needed to manage plant bugs.
4. Biological control agents need to be evaluated for their effectiveness in controlling plant bugs.

Weeds

Key Issues

- There is a need to support continued weed surveys because changes in tillage and production practices are resulting in changes to weed species present in hemp fields.
- There is a need for post-planting herbicides as there are none available for broadleaf weed control and, as of 2021, only one herbicide is available for grassy weed control.
- There is a need to develop economic thresholds for single weed species, multiple weed species complexes as well as volunteer crops.
- Short grain cultivars are especially vulnerable to contamination by volunteer cereals. For this reason, research is needed to determine the best ways to control volunteer cereals.
- The greater adoption of improved sanitation practices such as cleaning of equipment between fields, cleanliness of fields in proximity to hemp crops is needed.

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

Weeds	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
Annual broadleaf weeds					
Annual grass weeds					
Perennial broadleaf weeds					
Perennial grass weeds					
Widespread yearly occurrence with high pest pressure.					
Widespread yearly occurrence with moderate pest pressure OR localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure.					
Widespread yearly occurrence with low pest pressure OR widespread sporadic occurrence with moderate pressure OR sporadic localized occurrence with high pest pressure.					
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low pressure OR localized sporadic occurrence with low to moderate pest pressure OR pest not of concern.					
Pest is present and of concern, however little is known of its distribution, frequency and pressure.					
Pest not present.					
Data not reported.					

¹Source: Hemp stakeholders in reporting provinces (Alberta, Saskatchewan, Manitoba, Ontario and Quebec); the data reflect the 2018, 2019 and 2020 production years.

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

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

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Avoidance	Varietal selection / use of competitive varieties				
	Planting / harvest date adjustment				
	Rotation with non-host crops				
	Choice of planting site				
	Optimizing fertilization for balanced crop growth				
	Use of weed-free propagative materials (seed, cuttings or transplants)				
	No till or low disturbance seeding to minimize weed seed germination				
	Use of physical barriers (e.g., mulches)				
Prevention	Equipment sanitation				
	Manipulating seeding / planting depth				
	Irrigation management (timing, duration, amount) to maximize crop growth				
	Management of soil moisture (improvements in drainage, use of raised beds, hilling, mounds)				
	Weed management in non-crop lands				
Monitoring	Scouting / field inspection				
	Maintaining records of weed incidence including herbicide resistant weeds				
	Use of precision agriculture technology (GPS, GIS) for data collection and mapping of weeds				

...continued

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

Practice / Pest		Annual broadleaf weeds	Annual grasses	Perennial broadleaf weeds	Perennial grasses
Decision making tools	Economic threshold				
	Crop specialist recommendation or advisory bulletin				
	Decision to treat based on observed presence of weed at susceptible stage of development				
Suppression	Use of diverse herbicide modes of action for resistance management				
	Mechanical weed control (cultivation / tillage) populations				
This practice is used to manage this pest by at least some growers in the province.					
This practice is not used by growers in the province to manage this pest.					
This practice is not applicable for the management of this pest.					
Information regarding the practice for this pest is unknown.					

¹Source: Hemp stakeholders in reporting provinces (Alberta, Saskatchewan, Manitoba, Ontario and Quebec); the data reflect the 2018, 2019 and 2020 production years.

Annual Broadleaf and Grassy Weeds

Pest Information

Damage: Weeds compete with hemp for light, water and nutrients, reducing crop yield and vigour. Tall, fast growing hemp cultivars are most vulnerable to annual weed competition as seedlings. However, once the crop canopy is established, weed competition is minimized. For short, slower growing hemp cultivars, potential weed impact on yield and crop vigour occurs throughout the cropping cycle. Buckwheat (*Polygonum convolvulus*) is a concern with seed cultivars because the buckwheat seeds contaminate the harvested hemp seeds. Seeds of volunteer cereal crops also contaminate the hemp seeds, negating the claim that the hemp seeds are gluten-free. Another volunteer crop, canola, is a concern because canola harbours many diseases and pests that also attack hemp.

Life Cycle: Annual weeds complete their life cycles in one year starting with seed germination in the spring, followed by vegetative growth, flowering and seed production. By contrast, winter annuals germinate in the fall and overwinter as plants. In the spring they start to grow again, eventually flowering and setting seed. The main source of annual weeds in any cropping system is the dormant seeds found in the soil. The seeds remain viable for many years, germinating when environmental conditions favour weed growth. Annual weeds are spread when farm equipment, farmers' boots, etc. move soil containing weed seeds from one field to another.

Pest Management

Cultural Controls: Fields with a history of problematic weeds are avoided and seeding is delayed in fields previously planted in cereals and canola. Hemp is rotated with crops whose planting dates, emergence, height, and nutrient requirements differ from that of hemp, disrupting weed life cycles. Certified seed, free of weed seeds is used. Equipment and footwear are cleaned when moving between fields to reduce the spread of weed seeds. Three main cultural practices focus on quick closing of the crop canopy to prevent and suppress weed growth. First, seeds are shallowly sown when the soil is warm and moist, permitting fast germination and seedling establishment. Second, adequate nutrients are provided to permit healthy, fast plant growth. Third, a sowing rate of 100 seeds/m² or more is used, resulting in a crop canopy dense enough to prevent or suppress weed growth. Short, slower growing hemp cultivars do not achieve canopy closure so require additional cultural practices. Hemp is planted in rows into a plastic or cover-crop mulch. Repeated cultivation, before and after planting, reduces the number of annual weeds that survive.

Issues for Annual Weeds

1. Herbicides for annual weed control on hemp are needed.
2. There is a need for herbicides for the control of wild buckwheat; its seeds are the same size and colour as hemp seed making them difficult to remove during cleaning, causing dockage, which is an economic cost to farmers.
3. There is a need to develop IPM control strategies for volunteer cereal crops and canola.
4. Research is needed to develop annual weed control strategies specific to grain, fiber and CBD hemp cultivars.

Perennial Broadleaf and Grassy Weeds

Pest Information

Damage: Perennial weeds, especially those that are well established, compete with hemp for light, water and nutrients, reducing crop yield and vigour. Tall, fast growing hemp cultivars are most vulnerable to perennial weed competition as seedlings. However, once the crop canopy is established, weed competition is minimized. For short, slower growing hemp cultivars, potential weed impact on yield and crop vigour occurs throughout the cropping cycle.

Life Cycle: Perennial weeds are long lived, completing their life cycles over many years. Perennial weeds propagate through seeds and vegetative parts such as roots, rhizomes, and corms. Cultivation, tillage and plowing cut roots, rhizomes and corms into pieces and spread them around the field. Each piece has the potential to grow into a new perennial weed. Farm equipment and farmers' boots that are not cleaned can move soil containing vegetative parts and seeds from one field to another.

Pest Management

Cultural Controls: Most of the cultural control practices used to control annual weeds can also be used to control perennial weeds. Exceptions are cultivation, tillage and plowing, which can spread vegetative weed parts around the field. Instead, minimum tillage is used to prevent the multiplication of perennial weeds.

Issues for Perennial Weeds

1. Herbicides for perennial weed control are needed.
2. Perennial weed control strategies specific to grain, fiber and CBD varieties need to be developed.
3. There is a need to develop IPM control strategies for Canada thistle and quackgrass.

Resources

Integrated Pest Management & Integrated Crop Management (IPM/ICM) Resources for Industrial Hemp Production in Canada

Alberta Agriculture and Forestry (2015). *Industrial Hemp Enterprise*.

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[%20Hemp%20Diseases%20and%20Pests%20Management%20and%20Biological%20Control.pdf](https://avalonlibrary.net/ebooks/Robert%20Clarke%20-%20Hemp%20Diseases%20and%20Pests%20Management%20and%20Biological%20Control.pdf)

Ontario Ministry of Agriculture, Food and Rural Affairs. *Growing Industrial Hemp in Ontario*.

<http://www.omafra.gov.on.ca/english/crops/facts/00-067.htm>

Provincial Contacts

Province	Ministry	Crop Specialist	Minor Use Coordinator
Alberta	Alberta Agriculture and Forestry www.agric.gov.ab.ca/	N.A	Gayah Sieusahai Gayah.Sieusahai@gov.ab.ca
Saskatchewan	Ministry of Agriculture www.saskatchewan.ca/government/government-structure/ministries/agriculture	Dale Risula Dale.Risula@gov.sk.ca	Carter Peru carter.peru@gov.sk.ca
Manitoba	Manitoba Agriculture, Food and Rural Development www.gov.mb.ca/agriculture/	N.A	Pratisara Bajracharya Pratisara.Bajracharya@gov.mb.ca
Ontario	Ontario Ministry of Agriculture, Food and Rural Affairs www.omafra.gov.on.ca/english	Jim Todd jim.todd@ontario.ca	Joshua Mosiondz Joshua.Mosiondz@ontario.ca
Quebec	Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec www.mapaq.gouv.qc.ca	N.A	Mathieu Coté mathieu.cote@mapaq.gouv.qc.ca

National and Provincial Industrial Hemp Grower Organizations

Alberta Hemp Alliance: albertahempalliance.com/

Canadian Hemp Trade Alliance: www.hemptrade.ca/

Canadian Seed Growers Association: <https://seedgrowers.ca/tag/hemp-industrial/>

Appendix 1

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

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

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

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