Crop Profile for Dry Bean in Canada

Prepared by:

Pesticide Risk Reduction Program

Pest Management Centre

Agriculture and Agri-Food Canada

February 2005

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada | Canada

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The authors recognize the efforts of the Pest Management Regulatory Agency, provincial pest management representatives, industry specialists and growers in the gathering of information that was required, and the review and validation of the content of this publication.

Table of Contents

List of Tables

Crop Profile for Dry Bean in Canada

Dry bean (*Phaseolus vulgaris*) is a member of the *Leguminosae* family. There are two main types of dry beans, white and coloured. Cultivars may be classified according to growth habit, determinate (bush) or indeterminate (vining or trailing). The major classes of beans grown are: navy (also referred to as white or white pea beans), pinto, kidney (light red, dark red and white) and cranberry; black (sometimes referred to as black turtle), small red (also referred to as small Mexican red), brown, pink, yellow-eye and great northern.

Dry beans have been grown in southern Ontario since the 1940's. In the 1980's, the crop began an acreage expansion in western Canada, primarily in Manitoba and the irrigated areas of Alberta. Dry beans are grown primarily for human consumption. Recognized as a superb source of vegetable protein, dry beans are an excellent low fat source of complex carbohydrates, fibre, folate, potassium and B vitamins. World demand for dry beans is increasing. Approximately 20 million tons of dry beans are produced yearly with a market value of 10 billion US dollars. Small farms in Mexico, Brazil, Central America and Africa account for about 80% of the world's annual production.

General Production Information

Canadian Production	357,000 metric tonnes 167,000 hectares
Farm gate value	$177 million
Domestic consumption	86,000 metric tonnes
Export (excludes products)	347,000 metric tonnes
Import (excludes products)	31,000 metric tonnes
Source (2003): Market Analysis Division, Agriculture and Agri-Food Canada: http://www.agr.gc.ca/mad-dam/e/sd2e/hsd2ez.htm	

Production Regions

Most of the Canadian production is found in Manitoba (57%), with Ontario (27%) and Alberta (12%) contributing significant amounts. (Source: Statistics Canada, based on 3 year average (2000-2002) of area cropped).

Cultural Practices

Certified seed is used for most dry bean crops in Canada. Most certified seed is produced in the US and imported into Canada, although this is changing as the cropped area increases in the prairies.

Beans are adaptable to various growing situations. Their symbiotic relationship with nitrogen-fixing bacteria can help improve marginal soils. The best soils for growing beans are well drained, light, dark brown and black soils that have a high percentage of organic matter. On the prairies, irrigation is not required but will normally result in higher yields. Crop rotations, in which dry beans are grown only once every 3-4 years, preferably following a cereal crop, are recommended to minimize problems due to disease and volunteer bean crops.

In Ontario, conventional and no-till tillage practices are common depending on the market class of bean being grown. Dry bean crops may be row-cropped or solid-seeded, depending primarily on whether there are other row crops such as corn or potatoes in rotation. Row width is dependent on the type of bean as some types require the use of specialized harvest equipment.

Production Issues

Diseases and weeds pose the greatest production problems for dry bean growers. Preventative practices are ineffective for some diseases under certain weather conditions. Reduced risk products are required for white mould and bacterial bean blight control. There is a lack of efficient controls for broadleaf weeds as well as weed resistance problems including ACCase resistant wild oats and *Setaria* spp. and ALS inhibitor resistant broadleaf weeds. The diversity of classes and varieties within the crop results in a wide range of management practices and increases the need for coordinated research among universities, the federal government and grower associations on production and pest management issues.

Table 1. Canadian dry bean production and pest management schedule

Time of year	Activity	Action
October	Fertilization	Some producers may apply fertilizer, for the following year
November-March	Nothing done	
April	Soil Care	Soil test for fertilizer needs Pre-seeding herbicide application on most acres (glyphosate type burn-down to most other acres) Incorporation of the herbicide
	Fertilization	Spring fertilizer application for recommended needs, may be combined with herbicide application
May	Plant care	Seeding (may have seed treatment applied)
	Soil care	Seeding may be followed by rolling if required
	Disease management	Field scouting (done manually) for root rot and white mould mushrooms
	Insect & mite management	Field scouting (done manually) for cutworms, root maggots and wireworm damage
	Weed management	Field scouting (done manually) for weed problems
June	Soil care	Row-crops will have a tillage done between the rows
	Disease management	Field scouting (done manually) for all diseases
	Insect & mite management	Field scouting (done manually) for potato leaf hopper Spraying may occur
	Weed management	Field scouting (done manually) for all weeds Spraying may occur
July	Soil care	Row-crops will usually have a second tillage done between rows
	Disease management	Field scouting (done manually) continues for all diseases Spraying may occur
	Insect & mite management	Field scouting (done manually) for all insects Second spraying may occur
August	Soil care	Row-crops may have a third tillage done between rows (not very often)
	Disease management	Field scouting (done manually) continues for all diseases Second spraying may occur
	Insect & mite management	Field scouting (done manually) continues for all insects Usually won't require spraying this late in the year, but may
September	Plant care	Most row-crop beans undercut or pulled, then windrowed and combined Solid-seeded beans chemically desiccated (on around 50% of acres), swathed and combined Small amount of acres (either row-crop or solid-seeded) straight cut with a flex-header combine
	Disease management	Soil may be tilled directly after harvest if diseases present

Abiotic Factors Limiting Production

Key Issues

- Short-season varieties suited to each production area, in all bean classes are needed to reduce the risk of frost injury.

Frost

Beans are intolerant to frost. If the crop is set back by spring frost, there is an increased risk of disease, as well a likelihood of delayed maturity. Producers can minimize spring frost risk by planting into a warm seed bed, choosing short season varieties and delaying seeding as long as possible. In Ontario, the crop is rarely seeded early enough to be damaged by a spring frost and the growing season is long enough, that a frost damaged crop can be reseeded. Fall frosts rarely affect dry bean production in Ontario, unless spring seeding is severely delayed. However, in Manitoba and Southern Alberta, which have shorter growing seasons, fall frosts can be a problem. A fall frost will greatly affect the quality of the seed (discoloration of seed coat and seed hull degradation). Frost on a crop within the first week of swathing/undercutting/desiccating will have some effect on the quality of beans, depending on the bean moisture content and the severity of frost. Significant frost damage will result in a downgrade of the crop.

Quality of the Seed

The use of good quality seed is important to maximize production. Ideally, the seed must have 16-18% moisture, be free of disease, with only low amounts of cracked seed and be treated with a fungicide seed treatment (and potentially an insecticide). Seed must be handled with care, to prevent injury to the growing point and seed hull. Damaged seed can result in a "baldhead" that will not produce a strong, healthy plant.

Excessive moisture

Dry beans do not tolerate excessive moisture well, especially if it results in standing water. High moisture in the crop canopy favours disease development, especially in solid seeded stands and indeterminate varieties which have dense canopies.

Alkalinity/Salinity

Beans do not tolerate alkaline or saline fields very well. This is not a problem in Ontario.

Bronzing

Bronzing is an issue for Ontario producers in some areas. It is caused by airborne pollution (ozone) which causes a reddish-brown flecking of the leaves and eventual death of leaf tissue. Bronzing can result in premature ripening. Although foliar injury can be quite striking, most dry bean crops can handle up to 30 – 40% defoliation before yield is affected. Bronzing can be reduced by choosing the appropriate variety which is less susceptible to injury.

Re-growth

In Ontario, rainfall that follows a dry spell as plants approach maturity, can sometimes initiate new growth and flowering on plants. This causes problems at harvest because mature seed is contaminated with immature seed and green plant material can cause staining of seed during harvest. Desiccants can be used as a harvest aid, to dry down green, vegetative growth from bean plants and weeds.

Diseases

Key Issues

- Growers require more information and education on economic thresholds, scouting and how to use effective spray / no spray models. This is particularly so for white mould and anthracnose.
- There is a need for greater understanding of the biology of root rot organisms. Grower education on integrated approaches to minimize the impact of root rot diseases is required.
- There is a need for new varieties with improved disease resistance on which to build an IPM strategy.
- Seed treatments with greater efficacy are required for anthracnose.
- Effective seed treatments and alternative controls are required for bacterial blight.
- Effective controls, including an alternative to vinclozolin, the use of which creates a trade issue with the US, are required for white mould.

Table 2. Degree of occurrence of disease pests in Canadian dry bean production

	Degree of occurrence		
Major diseases	**AB**	**MB**	**ON**
Anthracnose		E	E
Bacterial Blight	E	E	E
White Mould	E	E	E
Root Rot	D	D	E
Lesser Diseases	**AB**	**MB**	**ON**
Rust		E	
Bean Common Mosaic Virus		E	
Widespread yearly occurrence with high pest pressure			
Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure			
Widespread yearly occurrence with low to moderate pest pressure			
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure			
Pest not present			
E – established			
D – invasion expected or dispersing			
DNR - Data not reported			

Source: Dry bean industry meeting – Prioritization of pest management issues

Major Diseases

Anthracnose (*Colletotrichum lindemuthianum*)

Pest Information

Damage: Anthracnose has become more widespread in recent years in the main seed producing areas of North America. Brown lesions develop on stems, petioles, pods and seeds. In Manitoba, anthracnose is present in 40-60% of the seeded area and impacts yield and quality in 20-30% of the production area.

Life Cycle: The pathogen is seed and stubble-borne. Spores produced within infected tissues are spread by splashing water and by the movement of equipment and people through the crop. Disease development is favoured by high relative humidity and free moisture on the foliage. Frequent showers, especially when accompanied by driving winds, can bring on epidemics.

Pest Management

Chemical Controls: Pyraclostrobin and azoxystrobin have been recently registered for anthracnose control. Seed treatments containing thiophanate methyl are also effective if seed is not severely infected.

Cultural Controls: Growing beans only one year in four and using seed free of disease or with a low disease rating (anthracnose DOME rating of 3 or less), will help to reduce disease severity.

Alternative Controls: None

Resistant Cultivars: Some varieties with resistance to the common races of anthracnose are available.

Issues for Anthracnose

1. Additional seed treatments are required (eg. Apron Maxx T) that have activity against soil borne inoculum and which would harmonize seed treatments with the United States.

Bacterial Blight, Common Blight (*Xanthomonas campestris* pv. *phaseoli*), Fuscous Blight (*X. campestris* pv. *phaseoli*) Halo Blight (*Pseudomonas syringae* pv. *phaseolicola*)

Pest Information

Damage: Bacterial blights cause irregular, large lesions on leaves and pods, resulting in early defoliation. Depending on the year, 50-70% of the seeded area has some disease present. Halo blight typically causes small brown spots that are surrounded by a toxin-induced, yellow halo up to the size of a quarter.

Life Cycle: Bacterial blights are carried on the seed and in some regions, crop debris. The disease is spread from plant to plant by rain, hail, irrigation or wind. Hail, blowing sand or wind whipping, followed by rain, often trigger bacterial blights. Blights are also spread if beans are cultivated while leaves are wet.

Pest Management

Chemical Controls: For coloured bean varieties, imported seed, treated with streptomycin is available. In-season, blue stone (copper sulphate) and other copper-based fungicides, can be

used preventively. As these treatments must be applied every 5-7 days if moisture conditions persist, they are not commonly used.

Cultural Controls: Following a four year crop rotation is important in minimizing disease. The use of certified seed or seed with a low disease rating (bacterial blight DOME rating of 3 or less) will also reduce bacterial blights. Decreasing the seeding rate and avoiding over-irrigation will encourage drying of the crop canopy and avoiding working the crop while the canopy is wet will minimize disease spread. Tillage in the fall, to bury crop debris and crop rotations will minimize disease carry over from one season to the next. Growing cultivars with a determinate or more upright growth habit will also help to reduce disease development as these growth habits facilitate drying of the crop canopy.

Alternative Controls: None

Resistant Cultivars: Varieties with true resistance to common bacterial blight (eg. OAC Rex) and halo blight, are available.

Issues for Bacterial Blights

1. The lack of effective controls for bacterial blights is a major concern. Permission for the importation of coloured bean seed treated with streptomycin is being withdrawn by PMRA leaving no effective, alternative seed treatment. Resistant varieties in all of the dry bean market classes are being developed, but widespread availability of these varieties is still several years away**.**

White Mould (*Sclerotinia sclerotiorum*)

Pest Information

Damage: The disease attacks all above ground tissues causing stem cankers, foliar blight, fruit rot and dieback of plants. This is the most common disease in Manitoba and Alberta with 60-80% of the acres affected, depending on the year. In Ontario, the affected area has been sporadic in recent years, but the potential for disease is high under favourable conditions.

Disease Cycle: The fungus overwinters as hard, black bodies called sclerotia in crop debris and in soil. The sclerotia germinate to produce small mushroom-like structures which produce spores which infect bean plants. The fungus initially infects dead blossoms from which it can spread to adjacent flowers, stems, leaves and pods. Fluffy white mycelium is often produced under high moisture conditions and dense canopies. Sclerotia are formed in diseased tissues and may persist in crop residue or drop to the soil and can remain viable for several years.

Pest Management

Chemical Control: The application of vinclozolin at early to mid bloom, with a second spray 7 - 14 days later if weather conditions are favourable disease, will help control white mould. Boscalid is also registered.

Cultural controls: Measures that enhance drying of the canopy such as seeding at lower densities and judicious irrigation are beneficial in reducing disease. Crop rotations are not entirely effective due to the longevity of sclerotia and broad host range.

Alternative Controls: None.

Resistant Cultivars: Some varieties and classes of beans have increased tolerance to white mould.

Issues for White Mould

1. As the use of vinclozolin is a trade issue for crop exported to the US and boscalid is the only other fungicide available, the lack of foliar fungicides is of great concern.

2. There is a need for reduced risk control strategies that include economic thresholds, prediction models and resistant varieties for white mould.

Root Rot (*Fusarium solani, Rhizoctonia solani* and *Pythium* spp.)

Pest Information

Damage: Root rotting fungi attack the root system and the lower portion of the stem at the soil line. Infected plants may be yellowed and stunted. Root rotting pathogens cause seed decay and seedling blight and infected seedlings often die.

Life Cycle: Root rotting fungi persist in the soil and crop debris. The fungi respond to plant root exudates and invade plant roots. Cool, wet weather in the spring favours root rot development.

Pest Management

Chemical Controls: Maxim-Apron seed treatment helps to reduce problems due to root rot**.**

Cultural Controls: Root rot can be minimized through proper rotations with non-susceptible crops. Cultural practices which favour rapid, even seed germination and emergence, such as planting into a warm seedbed, are also important in minimizing root rot. Over-irrigation should be avoided as prolonged and excessive soil moisture favour disease. Nitrogen applications help beans outgrow root rot.

Alternative Controls: None.

Resistant Cultivars: Bean varieties with some resistance are available.

Issues for Root Rot

1. There is a need for an integrated management approach to the root rot complex. Key factors required include alternative seed treatments and resistant varieties. There is also the need for improved understanding of the biology of the disease.

Minor Diseases

Rust (*Uromyces phaseoli*)

Pest Information

Damage: Dry beans are the only host crop in Canada. The disease affects primarily Pinto beans. Rust pustules develop on leaves and pods and rarely on stems. The lower leaves are the most severely infected. Affected leaves turn yellow and heavy leaf loss is common. The earlier the rust is present the greater the impact on yield. In Manitoba, depending on the year, 20-30% of the seeded acres are affected, due to the high percentage of pinto beans grown. Rust is not a problem in Ontario and Alberta, as most varieties grown in these regions have genetic resistance.

Life Cycle: Rust overwinters in infected crop debris. In the spring, spores released from bean crop residues are wind blown to new bean plants where infection occurs. Under favourable weather conditions, the rust fungus develops through a number of spore types eventually producing pustules of rusty brown urediniospores which are wind dispersed and cause new infections.

Pest Management

Chemical controls: Pyraclostrobin and azoxystrobin have been recently registered for rust control in dry beans

Cultural Controls: A four year crop rotation and prompt crop destruction after harvest is important to reduce the carry-over of rust. Measures that enhance drying of the foliage, such as increased plant spacing and avoiding over-irrigation, help reduce rust development.

Resistant Cultivars: Although most commonly grown bean cultivars are susceptible to one or more races of the rust fungus, some classes and varieties are somewhat more resistant.

Alternative Controls: None.

Issues for Rust

None identified

Table 3. Disease control products, classification and performance for Canadian dry bean production

Control product (active ingredient / organism)[1]	Classification[2]	Mode of action – resistance group[3]	PMRA status of active ingredient[4]	Pests or group of pests targeted	Performance of product according to recommended use[5]	Notes
Azoxystrobin	strobilurin fungicides	11	R	Mycophaerella blight	A[P]	
				Ascochyta blight	A[P]	
				Anthracnose	A[P]	
Boscalid	analide (oxythiin)	7	R	White Mould		
Captan	phthalimide fungicides	M4	R	Root Rot	A[P]	
Copper sulphate	copper fungicides	M1	R	Blight	I	Is only preventative, and requires multiple applications
				Anthracnose		
				downy mildew		
DCT (diazinon, captan, thiophanate-methyl)	phthalimide fungicides, dithiocarbamate fungicides	M4, 1	R	Anthracnose	A[P]	Only effective if seed is not severely infected
				Root Rot	A[P]	
Fludioxonil	phenylpyrroles	12	R	seed decay	A[P]	
				damping off	A[P]	
				seedling blights	A[P]	
Iprodione	oxazole fungicides	2	R	White Mould		
Metalaxyl	acylamino acid fungicides	4	R	seed rots and seedling blights	A[P]	
Metalaxyl-M and S-isomer	acylamino acid fungicides	4	R	Root Rot	A[P]	

Control product (active ingredient / organism)[1]	Classification[2]	Mode of action – resistance group[3]	PMRA status of active ingredient[4]	Pests or group of pests targeted	Performance of product according to recommended use[5]	Notes
Pyraclostrobin	strobilurin fungicides	11	R	Anthracnose	A^P	First year of use, unsure of effectiveness under different circumstances
				Rust	A^P	
Thiram/Carbarthiin and Thiram	dithiocarbamate/ analide (oxythiin) fungicides	M3/ 7 M3	R	seedling bight, damping-off/ , seed rots, root rot and seedling blights	A^P	
Vinclozolin	oxazole fungicides	2	R	White Mould	A^P	Concern regarding exports to the US when used

[1] Common trade name(s), if provided brackets, are for the purpose of product identification only. No endorsement of any product in particular is implied.

[2] Chemical classification according to "The Compendium of Pesticide Common Names", see http://www.hclrss.demon.co.uk/class_pesticides.html

[3] The mode of action group is based on the classification presented in the Pest Management Regulatory Agency Regulatory Directive DIR99-06, *Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action*

[4] R-full registration (non-reduced risk), RE-under re-evaluation, DI-discontinued, BI-biological, RR-reduced risk, OP-organophosphate replacement, NR-not registered. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Individual product labels should be consulted for up to date accurate information concerning specific registration details. The information in these tables should not be relied upon for pesticide application decisions. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Consult individual product labels for specific registration details. The following website can be consulted for more information on pesticide registrations: http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp

[5] A – Adequate (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control), A^P – Provisionally adequate (the PCP, while having the ability to provide acceptable control, possesses qualities which may make it unsustainable for some or all uses), I – Inadequate (the PCP, according to recommended use, does not maintain disease below economic threshold OR provides unacceptable control)

Sources: Provincial Crop Production Guides; Pulse Canada

Table 4. Availability and use of disease pest management approaches for Canadian dry bean production

	Practice \ Pest	Anthracnose	Bacterial blight	White mould	Root rot
Prevention	tillage				
	residue removal / management				
	water management				
	equipment sanitation				
	row spacing / seeding depth / seeding density				
	removal of alternative hosts (weeds/volunteers)				
	mowing / mulching / flaming				
Avoidance	resistant varieties				
	planting / harvest date adjustment				
	crop rotation				
	trap crops - perimeter spraying				
	use of disease-free seed				
	optimizing fertilization				
	reducing mechanical damage / insect damage				
	thinning / pruning				
Monitoring	scouting - trapping				
	records to track pests				
	field mapping of weeds				
	soil analysis				
	weather monitoring for disease forecasting				
	grading out infected produce				
Suppression	use of thresholds for application decisions				
	biological pesticides				
	pheromones				
	sterile mating technique				
	beneficial organisms & habitat management				
	pesticide rotation for resistance management				
	ground cover / physical barriers				
	controlled atmosphere storage				
	forecasting for applications				

no information regarding the practice is available
available/used
available/not used
not available
Source(s): Information in the crop profile for individual pests

Insects and Mites

Insects do not pose as serious a problem in dry beans as diseases and weeds. The greatest insect pressure occurs at seed germination from pests such as cutworms, seed corn maggots and wireworms. Infestations of these insects are usually found in pockets and generally do not pose a major problem. While potato leafhoppers are an in-season pest in Ontario, Alberta and Manitoba have little to no insect pressure in-season and very rarely apply an in-crop insecticide.

Key Issues

- There is a need for improved economic thresholds for common insects so growers can make spray/no spray decisions with greater precision.
- Reduced risk pesticides are required for leafhopper, seed corn maggot and wireworm control.

Table 5. Degree of occurrence of insect pests in Canadian dry bean production

	Degree of occurrence		
Major pests	**AB**	**MB**	**ON**
Potato leafhopper		D	E
Lesser pests	**AB**	**SK**	**ON**
Cutworm	E	E	
Grasshopper	E	E	E
Lygus bug		D	
Seed corn maggot/root maggots	E	E	E
Wireworm	E	E	E

Widespread yearly occurrence with high pest pressure

Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure

Widespread yearly occurrence with low to moderate pest pressure

Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure

Pest not present

E – established

D – invasion expected or dispersing

Source(s): Pulse Canada

Major Insects and Mites

Potato Leaf Hopper (*Empoasca fabae* (Harris))

Pest Information

Damage: Both adults and nymphs suck sap from the veins of the plant. Host crops include alfalfa, dry beans, potatoes and soybeans.

Life Cycle: The potato leafhopper does not overwinter in Canada. Large numbers migrate northward from the Gulf States each spring. The female lays eggs in the stems and large leaf veins of the plant. Tiny nymphs emerge from these eggs in a 7-10 day period and reach adult stage about two weeks later. The entire life cycle takes about a month. There are two to three generations a year.

Pest Management

Chemical Controls: Dimethoate is available as an in-crop chemical control product.

Cultural Controls: There are no effective preventative measures, since potato leafhoppers have many host crops.

Resistant Cultivars: None

Alternative Controls: None identified.

Issues for Potato Leaf Hopper

1. There is a need for a reduced risk insecticide for this insect.

Minor Insects and Mites

Cutworms or red-backed cutworm (*Euxoa ochrogaster*) and the Army Cutworm *(Euxoa auxiliaris*)

Pest Information

Damage: Cutworms feed on most field crops, vegetables and home garden plants. Cutworm damage is common on cereals, flax, sugar beets, canola and mustard. They can be found sporadically in some pockets of Alberta at seeding, especially when the field is coming out of perennial production.

Life cycle: Depending on species, cutworms overwinter as eggs (the red-backed cutworm) larvae or pupae, or re-invade annually from the USA, aided by southerly winds. Cutworm moths lay several hundred eggs on their host plants. After the eggs hatch, the larvae feed on the host plants eventually reaching about 5 cm (2 in.) in length. Pupation occurs in the soil. Most pest species have 1 or 2 generations per year.

Pest Management

Chemical Controls: There are no registered seed treatments or in-crop control measures available for cutworms.

Cultural Controls: There are no effective preventative measures, since cutworms have so many host crops.

Alternative Controls: None identified.

Resistant Cultivars: None.

Issues for Cutworms

None identified

Grasshopper (*Acrididae*)

Pest Information

Damage: Grasshoppers usually do not pose a problem unless there is an extremely high population in the area and all other host crops have been destroyed. Grasshopper adults and nymphs feed on foliage of all grain and forage crops.

Life cycle: Overwintering eggs are laid in August and September in packet-like bunches 1–5 cm below the surface of the soil. They are mainly deposited in uncultivated ground such as field margins, pasture and roadsides, although they may also be laid in considerable numbers in clover, alfalfa, and stubble fields. Egg hatch occurs May through June and nymphal development to adult stage generally requires about 1-2 months. A late spring or cool summer may delay development so that nymphs are present through the autumn. Adult feeding can continue until the first heavy frost.

Pest Management

Chemical controls: An in-crop chemical control product such as dimethoate can be used.

Cultural controls: There are no effective preventative measures, since grasshoppers have so many host crops.

Resistant cultivars: None available.

Alternative Controls: None identified.

Issues for Grasshopper

None identified

Lygus Bug/Tarnished Plant Bug (*Lygus lineolaris*)

Pest Information

Damage: Lygus bugs feed on alfalfa, dry beans, soybeans, potatoes and other vegetable crops. They are found sporadically in pockets, but generally are a very minor pest problem. Adults and nymphs feed on plant tissues with piercing and sucking mouth parts. Severe infestations can cause between 5 and 20% damage to the seed late in the season.

Life Cycle: Adult lygus bugs overwinter in protected areas such as leaf litter, plant debris and under bark in hedgerows and borders. They emerge in early spring and females lay eggs into the petioles of alfalfa, weeds and vegetables. The eggs hatch in 7-10 days and nymphs develop through 5 instars or growth stages into adults in 3-4 weeks.

Pest Management

Chemical control: An in-crop chemical control product such as dimethoate can be used.

Cultural control: Destroying affected plant debris as soon as possible and following proper rotations with other non-host crops will reduce the incidence of lygus bugs.

Alternative controls: None identified.

Resistant cultivars: None available.

Issues for Lygus Bug/Tarnished Plant Bug

None identified

Seed Corn Maggot *(Delia platura)*

Pest Information

Damage: Seed corn maggots attack corn, dry beans and vegetable crops. The maggots burrow into and feed on seeds or on cotyledons emerging from seeds.

Life cycle: The seed corn maggot overwinters as pupae in the soil. Adults emerge in the early spring and lay eggs in soil with abundant decaying organic matter and on seeds or seedlings. The eggs hatch in 2-4 days in temperatures as low as 10º C and the larvae feed and develop over a large temperature range (11-33º C). Generally, seed corn maggots complete their life cycle within three weeks and have two-three generations a year. The first generation causes the most crop damage.

Pest Management

Chemical controls: An insecticide/fungicide seed treatment containing captan, diazinon and lindane can be used.

Cultural controls: Since damage from seed corn maggots is most severe when conditions delay germination and seedling emergence, planting when conditions favour quick, even emergence will minimize damage. Since seed corn maggot adults are attracted to decaying organic matter, minimizing crop residues left on a field will help reduce seed corn maggot numbers. Note that decomposing green manure crops and recent manure applications make fields more attractive for egg laying. If maggot pressure is extremely high, a field may have to be replanted, although this is not usually an option in Manitoba and Alberta due to the shorter growing season.

Alternative Controls: None identified.

Resistant cultivars: None available.

Issues for Corn Maggot

1. There is a need for a reduced risk alternative insecticide to organophosphates for this insect.

Wireworm (Elateridae)

Pest Information

Damage: Wireworms burrow into shoots causing plants to become stunted, wilt or die. Wireworms prefer annual and perennial grasses, but can also be found in canola, cereals, corn, potatoes, sugar beets and sunflowers.

Life cycle: Wireworms are larvae of a group of beetles commonly called click beetles. Larval development takes two to six years or more to complete. When fully grown, usually in July, the larvae pupate about 5 to 10 cm below the soil surface. Adults do not emerge until the following spring.

Pest Management

Chemical controls: A seed treatment containing diazinon will reduce wireworm injury.

Cultural controls: Early, shallow planting into a warm seedbed which favours germination and emergence of the crop, will help to minimize wireworm injury. Avoiding other susceptible crops in the rotation also is beneficial. If wireworm injury is severe, replanting may be

necessary. Replanting is not usually an option in Manitoba and Alberta due to the shorter growing seasons.

Alternative Controls: None identified.

Resistant cultivars: None available.

Issues for Wireworm

1. There is a need for a reduced risk insecticide for this insect.

Table 6. Insect control products, classification and performance for Canadian dry bean production

Control product (active ingredient / organism)[1]	Classification[2]	Mode of action – resistance group[3]	PMRA status of active ingredient[4]	Pests or group of pests targeted	Performance of product according to recommended use[5]	Notes
carbaryl	carbamate	1A	R	Potato Leafhopper	A	
				Lygus Bug	A	
dimethoate	organophosphate	1B	R	Potato Leafhoppers	A	
				Grasshopper	A	
				Lygus Bug	A	
disulfoton	organophosphate	1B	R	Potato Leafhopper	A	
endosulfan	cyclodiene organochlorine	2A	R	Potato Leafhopper	A	
malathion	organophosphate	1B	R	Potato Leafhopper	A	
methoxychlor	cyclodiene organochlorine	2A	DI	Potato Leafhopper	A	
phorate	organophosphate	1B	DI	Lygus Bug	A	
ST - 15% captan, 15% diazinon, 25% lindane	organochlorines	-	DI	Seed Corn Maggot	A	
				Wireworm	A	
trichlorfon	organophosphate	1B	R	Lygus Bug	A	

[1] Common trade name(s), if provided brackets, are for the purpose of product identification only. No endorsement of any product in particular is implied.

[2] Chemical classification according to "The Compendium of Pesticide Common Names", see http://www.hclrss.demon.co.uk/class_pesticides.html

[3] The mode of action group is based on the classification presented in the Pest Management Regulatory Agency Regulatory Directive DIR99-06, *Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action*

[4] R-full registration (non-reduced risk), RE-under re-evaluation, DI-discontinued, BI-biological, RR-reduced risk, OP-organophosphate replacement, NR-not registered. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Individual product labels should be consulted for up to date accurate information concerning specific registration details. The information in these tables should not be relied upon for pesticide application decisions. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Consult individual product labels for specific registration details. The following website can be consulted for more information on pesticide registrations: http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp

[5] A – Adequate (the pest control product (PCP), according to recommended use, maintains disease below economic threshold OR provides acceptable control), A^P – Provisionally adequate (the PCP, while having the ability to provide acceptable control, possesses qualities which may make it unsustainable for some or all uses), I – Inadequate (the PCP, according to recommended use, does not maintain disease below economic threshold OR provides unacceptable control)

Source(s): Provincial Crop Production Guides; Pulse Canada

Table 7. Availability and use of insect pest management approaches for Canadian dry bean production

	Practice \ Pest	Potato leafhopper
Prevention	tillage	
	residue removal / management	
	water management	
	equipment sanitation	
	row spacing / seeding depth	
	removal of alternative hosts (weeds/volunteers)	
	mowing / mulching / flaming	
Avoidance	resistant varieties	
	planting / harvest date adjustment	
	crop rotation	
	trap crops - perimeter spraying	
	use of disease-free seed	
	optimizing fertilization	
	reducing mechanical damage / insect damage	
	thinning / pruning	
Monitoring	scouting - trapping	
	records to track pests	
	field mapping of weeds	
	soil analysis	
	weather monitoring for disease forecasting	
	grading out infected produce	
Suppression	use of thresholds for application decisions	
	biological pesticides	
	pheromones	
	sterile mating technique	
	beneficial organisms & habitat management	
	pesticide rotation for resistance management	
	ground cover / physical barriers	
	controlled atmosphere storage	
	forecasting for applications	

no information regarding the practice is available
available/used
available/not used
not available
Source(s): Information in the crop profile for individual pests

Weeds

Field beans are not competitive and severe yield losses will occur even from low weed pressure. Producers must consider the weed population when planning their rotation due to the lack of effective controls, in crop, for some weeds. Weeds may also harbour diseases that can be transmitted to the crop. Green weeds and high moisture weed seeds (ie. berries, etc) present at harvest can reduce crop quality through staining of the beans. Dry beans are very sensitive to residues from several commonly used herbicides and should not be seeded into a field that has had certain herbicides applied for the last 1-2 years.

Key Issues

- Resistance problems of both broadleaf and grassy weeds to commonly used herbicides is a growing concern, especially because of the limited number of herbicides registered on beans.
- The lack of alternatives for broadleaf weed control is a concern. The development of new herbicides is "drying up" due to the deflated soybean input market.
- Management of nightshade and redroot pigweed.
- Minimum tillage systems have led to increased problems with perennial weeds in general.
- There is concern over the limited control options for volunteer broadleaf crop.

Table 8. Degree of occurrence of weed pests in Canadian dry bean production

	Weed Occurrence		
Weed	**AB**	**MB**	**ON**
Perennial broadleaf	E	E	
Perennial Grasses	E	E	
Annual Grasses	E	E	E
Annual Broadleaf	E	E	E
Perennial broadleaf	**AB**	**MB**	**ON**
Volunteer crops	E	E	E
Herbicide resistant weeds	D	D	D
Widespread yearly occurrence with high pest pressure			
Localized yearly occurrence with high pest pressure OR widespread sporadic occurrence with high pest pressure			
Widespread yearly occurrence with low to moderate pest pressure			
Localized yearly occurrence with low to moderate pest pressure OR widespread sporadic occurrence with low to moderate pest pressure			
Pest not present			
E – established			
D – invasion expected or dispersing			

Source(s): Pulse Canada

Major Weeds

Annual Broadleaves and Grasses

Pest Information

Common annual broadleaf weeds: Wild buckwheat (*Polygonum convolvulus*), ragweed (*Ambrosia artemisiifolia*), nightshade (*Solanum* sp.), redroot pigweed (*Amaranthus retroflexus*), lamb's-quarters (*Chenopodium album*). Common annual grassy weeds: Barnyardgrass (*Echinochloa crusgalli*), green foxtail (*Setaria viridis*) in Manitoba, crabgrass (*Digitaria* sp.), proso millet (*Panicum miliaceum*), fall panicum (*Panicum dichotomiflorum*), witchgrass (*Panicum capillare*) and, wild oats (*Avena fatua* L.).

Damage: Annual weeds compete with the crop for moisture and nutrients and can cause yield losses as well as affect the quality of seed harvested. The more favourable the growing conditions, the more weed pressure put on the crop. There are no specific survey numbers available which provide actual infestation levels.

Life Cycle: Annual weeds complete their development from seed, through vegetative growth, flowering, seed set and maturation, and death, in one growing season.

Pest Management

Chemical Control: Annual weeds can be partially controlled with a pre-seeding burn off with glyphosate. For broadleaf weed control, Pursuit® (imazethapyr) (for Pinto, Pink and Red classes only), Select® (clethodim), Basagran® (bentazon) or AssureII® (quizalofop) are available. Reflex® (fomesan) may be used in Manitoba and Ontario. An application of Poast Ultra® (sethoxydim) or a similar product, will give good control of annual grassy weeds.

Cultural Controls: Beans should be planted only in fields with low weed populations.

Alternative Controls: None

Issues for Annual Broadleaves and Grasses

1. Problems with resistance of both broadleaf and grassy weeds to commonly used herbicides is a growing concern, especially because of the limited number of herbicides registered on beans.
2. The lack of alternatives for broadleaf weed control is a concern. The development of new herbicides is "drying up" due to the deflated soybean input market.
3. Management of nightshade and redroot pigweed.

Perennial Weeds

Pest Information

Common perennial broadleaf weeds: Canada thistle (*Cirsium arvense*) and sow thistle (*Sonchus arvensis*). Common perennial grasses: Quack grass (*Elytrigia repens,* syn. *Agropyron repens*).

Damage: Perennial weeds compete with the crop for water and nutrients and can decrease yields. Although there are no specific survey numbers available with respect to actual infestation levels, perennial weeds are widespread.

Life Cycle: Perennial weeds survive for many seasons, flowering and producing seed each year. Growth each spring is initiated by seed or from overwintering root systems or crowns.

Perennial weeds spread by seed or vegetative means. Perennial weeds tend to have extensive, creeping rootstocks which frequently produce shoots and new plants. Some weed seeds remain viable in the soil for up to twenty years.

Pest Management

Chemical controls: Season long control of *Agropyron repens* is achieved by using sethoxydim or quizalofop. There are no chemical controls available for perennial, broadleaf weeds.

Cultural Controls Fields with low or no perennial weeds are used to grow dry beans. Control of perennial weeds is usually carried out in the year before beans are planted.

Alternative Controls: None

Issues for Perennial Weeds

1. Minimum tillage systems have led to increased problems with perennial weeds in general.

Minor Weeds

Volunteer Crops (Canola, cereals and corn)

Pest Information

Damage: Volunteer crops compete with beans for moisture and nutrients and can affect the quality of the seeds harvested by staining from weed seed berries and green weeds and dirt tagging. There are no specific survey numbers available with respect to actual infestation levels.

Life Cycle:

Pest Management

Chemical Controls: Annual weeds can be partially controlled with a pre-seeding burn off with a glyphosate product. An application of Poast Ultra® (sethoxydim) or a similar product, can give good control of volunteer cereals and corn. Pursuit® (imazethapyr; for Pinto, Pink and Red classes only) can be used to control broadleaf volunteer weeds such as canola, provided the canola is not Pursuit tolerant.

Cultural Controls: Beans should follow a cereal crop in the rotation, as volunteer cereals are easy to control in beans. Ensuring a minimum of seed is lost during combining, will also minimize volunteer crops the following year.

Alternative Controls: None identified.

Issues for Volunteer Crops

1. There is concern over the limited control options for volunteer broadleaf crops.

Table 9. Weed control products, classification and performance for Canadian dry bean production

Control product (active ingredient / organism)[1]	Classification[2]	Mode of action – resistance group[3]	PMRA status of active ingredient[4]	Pests or group of pests targeted	Performance of product according to recommended use[5]	Notes
bentazon	benzothiadiazinone	6	R	annual broadleaf	A	
Clethodomin	cyclohexanediones	1	R	annual grasses	A[P]	Select will be less effective when plants are stressed by lack of moisture, excessive moisture, low temperature and/or very low relative humidity. Regrowth of tillers may occur if this stress is present.
diclofop-methyl	aryloxyphenoxy-propionate	A	R	annual grasses	A[P]	Reduced effectiveness when applied under hot (above 28°C) or drought conditions.
dimethanamid	chloroacetamides	K3	R	annual grasses	A[P]	Pre-emergent, affected by the weather, incorporation, etc
EPTC	thiocarbamate	N	R	annual grasses	A[P]	Pre-emergent, affected by the weather, incorporation, etc
ethalfluralin	dinitroanaline	K1	R	annual grasses	A[P]	Pre-emergent, affected by the weather, incorporation, etc
				annual broadleaf	A[P]	
Fenoxaprop-p-ethyl	aryloxyphenoxy-propionate	1	R	perennial grasses	A[P]	
fomesafen	diphenyl ether	E	R	annual broadleaf	A	

Control product (active ingredient / organism)[1]	Classification[2]	Mode of action – resistance group[3]	PMRA status of active ingredient[4]	Pests or group of pests targeted	Performance of product according to recommended use[5]	Notes
imazethapyr	imidazilinone	B	R	annual broadleaf	A^P	
metolachlor	chloroacetamides	K3	R	annual grasses	A	Pre-emergent, affected by the weather, incorporation, etc
sethoxydim	cyclohexanediones	A	R	annual grasses	A^P	
				perennial grasses	A^P	
trifluralin	dinitroanaline	K1	R	annual grasses	A^P	Pre-emergent, affected by the weather, incorporation, etc
quizalofop-p-ethyl	aryloxyphenoxy-propionate	1	R	annual grasses	A	
				perennial grasses	A^P	

[1] Common trade name(s), if provided brackets, are for the purpose of product identification only. No endorsement of any product in particular is implied.
[2] Chemical classification according to "The Compendium of Pesticide Common Names", see http://www.hclrss.demon.co.uk/class_pesticides.html
[3] The mode of action group is based on the classification presented in the Pest Management Regulatory Agency Regulatory Directive DIR99-06, *Voluntary Pesticide Resistance-Management Labelling Based on Target Site/Mode of Action*
[4] R-full registration (non-reduced risk), RE-under re-evaluation, DI-discontinued, BI-biological, RR-reduced risk, OP-organophosphate replacement, NR-not registered. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Individual product labels should be consulted for up to date accurate information concerning specific registration details. The information in these tables should not be relied upon for pesticide application decisions. Not all end-use products will be classed as reduced-risk. Not all end use products containing this active ingredient may be registered for use on this crop. Consult individual product labels for specific registration details. The following website can be consulted for more information on pesticide registrations: http://www.eddenet.pmra-arla.gc.ca/4.0/4.0.asp
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Source(s): Provincial Crop Production Guides; Pulse Canada

Table 10. Availability and use of weed pest management approaches for Canadian dry bean production

	Practice / Pest	Perennial broadleaf	Perennial grass	Annual grass	Annual broadleaf
Prevention	tillage				
	residue removal / management				
	water management				
	equipment sanitation				
	row spacing / seeding depth				
	removal of alternative hosts (weeds/volunteers)				
	mowing / mulching / flaming				
	Planting where weed populations are already low				
Avoidance	resistant varieties				
	planting / harvest date adjustment				
	crop rotation				
	trap crops - perimeter spraying				
	use of disease-free seed				
	optimizing fertilization				
	reducing mechanical damage / insect damage				
	thinning / pruning				
Monitoring	scouting - trapping				
	records to track pests				
	field mapping of weeds				
	soil analysis				
	weather monitoring for disease forecasting				
	grading out infected produce				
Suppression	use of thresholds for application decisions				
	biological pesticides				
	pheromones				
	sterile mating technique				
	beneficial organisms & habitat management				
	pesticide rotation for resistance management				
	ground cover / physical barriers				
	controlled atmosphere storage				
	forecasting for applications				

no information regarding the practice is available
available/used
available/not used
not available
Source(s): Information in the crop profile for individual pests

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Parent Seed Farm, Dennis Lange, Agronomist, St Joseph, MB

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Ontario White Bean Producers Association

Pulse Canada www.pulsecanada.com

Manitoba Agriculture and Food
Pulse Specialist, Carman, Manitoba

Manitoba Crop Insurance Corporation, Portage la Prairie, MB

Ridgetown College, Chris Gillard, Professor,

Statistics Canada www.statcan.ca

Stratus Agrimarketing Inc, Guelph Ontario

Table 11. Research contacts related to pest management in Canadian dry bean production

Institution	Area of expertise
Brandon Research Station, Brandon, MB	Agronomy/Fertility/Pathology/Weeds
Brooks Research Station, Alberta Agriculture, Brooks AB	Agronomy/Pathology
Greenhouse & Processing Crops Research Centre, Harrow Station, AAFC, Harrow, ON	Pathology/Agronomy/Breeding/ food science/ molecular biology, Entomology
Indian Head Research Station, AAFC, Indian Head SK	Agronomy/Weeds
Lethbridge Research Station, AAFC, Lethbridge AB	Weeds/Pathology/breeding
Morden Research Station, AAFC, Morden, MB	Pathology/Agronomy/breeding
University of Guelph, Main Campus	Entomology, Agronomy, Pathology, Weed science, cropping systems, soil science, breeding, molecular biology, food science etc
University of Guelph/ Ridgetown College, ON	Entomology, Agronomy, Pathology/ Weeds/ cropping systems / food science/ soil science
University of Saskatchewan, Saskatoon SK	Breeding/Pathology/Weeds/Agronomy