Western Committee on Crop Pests Guide to Integrated Control of Insect Pests of Crops

Insect Management In
Oilseed Crops in Western Canada
(Canola, mustard, flax, sunflowers, safflower)

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Note: For pesticide toxicity to bees see the chapter in this guide on: "Hazards and Safeguards in Applying Insecticides to Crops in Bloom"; the link for this reads "Bee Poisoning".

Alfalfa Looper — *Autographa californica* (Speyer) (Lepidoptera: Noctuidae)

Alfalfa Looper (canola)

Economic threshold - No thresholds have been determined for the alfalfa looper in canola but check threshold levels for the Bertha armyworm as a guideline.

Chemical Control –

IPM status of insecticides – All the insecticides registered in Canada for alfalfa looper in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Rate (vol/acre)	Rate (vol/ha)	Preharvest Interval (days)	References
Chlorpyrifos Lorsban/ Pyrinex /Nufos /Citadel /Warhawk	0.3 - 0.4 L	0.75-1.0 L	21	1-3
Methomyl Lannate Toss-N-Go	87 - 206 g	216-510 g	8	1-3

References -

1. Dolinski *et al*., Pest. Res. Rep. 1973:136.
2. Jacobson *et al*., Pest. Res. Rep. 1973:137.
3. McDonald, Pest. Res. Rep. 1973:252.

Aphids — (Hemiptera: Aphididae)

Main species of aphids on crop:
Flax: Potato aphid, *Macrosiphum euphorbiae* (Thos.) (Hemiptera: Aphididae)

Canola: Turnip aphid, *Lipaphis erysimi* (Kltb.) (Hemiptera: Aphididae)

Monitoring-

Flax - Flax should be sampled for aphids when the crop is in full bloom, and assessed again at the green boll stage if aphid densities are near the threshold but not controlled (3). Sample 25 plants at full bloom or 20 plants at early green boll growth stage (4). Sequential sampling plans are available for aphids in flax (4). Potato aphids are easily dislodged from flax by tapping a plant against a hard surface such as a tray (4).

Potato aphids emigrate from flax in mid-August. Farmers need not sample or control the potato aphid in flax after mid-August (5).

Economic Threshold -

Flax – The economic threshold for the potato aphid in flax is 3 aphids per plant at full bloom and 8 aphids per plant at the green boll stage (3).

The yield loss of flax is 0.021 t/ha per aphid per plant for crops sampled at full bloom and 0.008 t/ha per aphid per plant for crops sampled at the green boll stage (3).

Potato aphids can cause yield losses of 20% or more in flax when it reaches densities of 50 or more aphids per plant, but reduce the weight of individual seeds only slightly and has no effect on oil quality (3).

Canola - Control aphids in canola if densities exceed 25 aphids/10 cm shoot tip after flowering (1). To estimate aphid densities, randomly collect a minimum of 20 shoot tips.

Chemical Control -

Apply to canola only if aphids are found in clusters on the shoot tips.

IPM status of insecticides – All the insecticides registered in Canada for aphids in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Dimethoate Lagon /Cygon	canola flax	344 - 364 177	850-900 437	21	2

References -

1. Sekon and Bakhetia, GCIRC Int. Rapeseed Congress, 1991.
2. Wise, Pest Mgmt. Res. Rep. 1991: 48, 49.
3. Wise *et al*. 1995. Can Entomol. 213-224.
4. Wise and Lamb. 1995. Can. Entomol. 967-976.
5. Lamb et al. 1997. Can. Entomol. 1049-1058.

Aster Leafhopper *Macrosteles quadrilineatus* Fbs. (Hemiptera: Cicadellidae)

The aster leafhopper is the main vector of the phytoplasma that causes aster yellows, which can infect many crops including canola, flax and sunflowers.

Symptoms of aster yellows in canola generally include stunting, virescence (the abnormal development of green pigmentation in plant parts that are not normally green), leaf yellowing or purpling, phyllody (the abnormal development of floral parts into leafy structures), and formation of bladder-like siliques (1).

Chemical Control –

IPM status of insecticides – All the insecticides registered in Canada for aster leafhopper in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Dimethoate Lagon /Cygon	Canola	344 – 364	850-900	21	

References -

1. Olivier *et al*. 2006. Plant Disease. 6: 832

Banded Sunflower Moth – see section on Sunflower Moths

Beet Webworm *Loxostege sticticalis* (Linnaeus) (Lepidoptera: Crambidae)

Beet webworm (canola, mustard and flax)

Economic threshold -
No thresholds have been determined.

Chemical Control –

IPM status of insecticides – All the insecticides registered in Canada for beet webworm in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (vol/acre)	Rate (vol/ha)	Preharvest Interval (days)	References
Methomyl Lannate Toss-N-Go	canola	87 - 206 g	216-510 g	8	1
Deltamethrin Decis 5EC Poleci	canola, mustard, flax	40 - 60 ml (Decis) 81 – 121 ml (Poleci)	100-150 ml (Decis) 200-300 ml (Poleci)	7 (canola, mustard) 40 (flax)	1

References -

1. Harris, Pest. Mgmt. Res. Rep. 1990:36.

Bertha Armyworm *Mamestra configurata* Walker (Lepidoptera: Noctuidae)

Bertha Armyworm (canola, mustard and flax)

Monitoring -

Larvae- Monitor for larvae when plants are in the early pod stage (stages 5.1-5.2). Count the number of larvae in a 0.25m^2 area in 10 to 15 different locations in the field (1). A 3-sided frame can be used to define the area to be sampled. Plants within each sampling unit should be shaken by hand, then the soil surface examined for larvae and earthen lumps and plant debris moved to expose hidden larvae (2). Bertha armyworm larvae were found to have a moderately clumped distribution in canola (1), thus samples should be from different areas of the field.

Adults- Adult male moths can be monitored during June and July using pheromone-baited traps. These traps can determine the presence of adults, but do not predict larval levels in a particular field (3).

Development rates: Day-degrees for the development of various stages of bertha armyworm have been determined (23). With a development threshold of 7°C, 82, 356, and 352 accumulated day-degrees above the threshold are required for development of eggs, larvae, and pupae, respectively.

Economic Thresholds -

A loss in canola of 0.058 Bu/acre for each larvae/m^2 can be expected (4). From this, the following table of economic injury levels for bertha armyworm in canola has been calculated:

Economic Injury Levels For Bertha Armyworm In Canola

Insecticide Application Cost - $/ac	**Expected seed value - $/bushel**										
	6	7	8	9	10	11	12	13	14	15	16
	# Larvae/metre^2										
7	20	17	15	13	12	11	10	9	9	8	8
8	23	20	17	15	14	13	11	11	10	9	9
9	26	22	19	17	16	14	13	12	11	10	10
10	29	25	22	19	17	16	14	13	12	11	11
11	32	27	24	21	19	17	16	15	14	13	12
12	34	30	26	23	21	19	17	16	15	14	13
13	37	32	28	25	22	20	19	17	16	15	14
14	40	35	31	27	24	22	20	19	17	16	15
15	43	37	32	29	26	23	22	20	19	17	16

Thresholds apply to both Argentine and Polish type canola and not to mustards, which are higher because they are a less preferred host (5) and have a greater ability to compensate for feeding damage (6).

Drought stress on canola may result in early dropping of leaves. Lack of leaves may cause more pod feeding by the larvae and affect yield more directly. Also, canola may not compensate as well for tissue loss under stressed conditions. Thus, under moisture stress, economic thresholds for bertha armyworm may be lower than indicated in the above table. Under severe drought stress, dividing the economic thresholds above by 1.48 may give more appropriate economic thresholds (4).

Cultural control -

Fall tillage may increase the overwintering mortality of bertha armyworm pupae (7).

Biological Control-
Parasitism by the ichneumon wasp *Banchus flavescens* may exceeds 40%, and a tachinid fly, *Athrycia cineria*, may kill over 20% of bertha armyworm (8).
Pathogens isolated from bertha armyworm larvae include the fungus *Entomophthora* sp., and a nuclear polyhedrosis virus (9). Infection by the nuclear polyhedrosis virus in more than 95% of the bertha armyworm population have been recorded (10).

Chemical Control –

IPM status of insecticides – Chlorantraniliprole is not harmful to some beneficial insects, such as parasitic Hymenoptera (24). All the other insecticides registered for bertha armyworm in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (vol/acre)	Rate (vol/ha)	Preharvest Interval (days)	References
Chlorantraniliprole Coragen	Canola, mustard, flax	51 – 152 ml	125 – 375 ml	1	
Deltamethrin Decis 5EC Poleci	Canola, mustard	40 - 60 ml (Decis); 81-121 ml (Poleci)	100-150 ml (Decis) 200-300 ml (Poleci)	7	11-16
Cypermethrin Mako UP-Cyde	Canola	28 - 36 ml 81-113 ml	70 - 90 ml 200-280 ml	30	-
Lambda-cyhalothrin Matador /Silencer	Canola, mustard	34 ml	83 ml	7	-
Lambda-cyhalothrin + Chlorantraniliprole Voliam Xpress	Canola, mustard, flax	91 ml	225 ml	7	-
Methomyl Lannate Toss-N-Go	Canola, flax	87 - 206 g 89-109	216-510 g 220-270 g	8	17-22
Chlorpyrifos Lorsban /Pyrinex /Nufos /Citadel /Warhawk	Canola, flax	304-405 ml	750 ml – 1L	21	17,20-22

Restrictions -
Decis, Matador: Apply when temperatures are below 25°C.

References -

1. Wise et al. 2009. Can. Entomol. 619-626.
2. Turnock and Bilodeau. 1985. Can. Entomol. 1065-1066.
3. Turnock. 1987. Can. Entomol. 167-178.
4. Bracken and Bucher. 1977. J. Econ. Entomol. 70:701-705.
5. Ulmer *et al.* 2001. Can. Entomol.133: 509-20.

6. Gavloski and Lamb. 2000. Env. Entomol. 1258-67.
7. Turnock and Bilodeau. 1984. Can. Entomol. 257-267.
8. Wylie and Bucher. 1977. Can. Entomol. 823-837.
9. Mason et al. 1998. Can. Entomol. 321-336.
10. Erlandson. 1990. Journal of Invertebrate Pathology. 47-56.
11. Derksen and Blouw, Pest. Res. Rep. 1980:121, 122, 123.
12. McVicar and MacKenzie, Pest. Res. Rep. 1980:124.
13. McVicar and Makowski, Pest. Res. Rep. 1980:125.
14. Wise and Kitson, Pest. Res. Rep. 1980:128.
15. Wise and McVicar, Pest. Res. Rep. 1980:129, 130.
16. Wise, McVicar and Kitson, Pest Res. Rep. 1980:131.
17. Putnam, Pest. Res. Rep. 1970:126.
18. McDonald *et al*., Pest. Res. Rep. 1971:177.
19. Peterson *et al*., Pest. Rep. Rep. 1971:143.
20. Lee *et al*. 1972. Can. Entomol. 104:1745.
21. Stewart, Pest. Res. Rep. 1972:166.
22. Harris and Turnbull. 1975. Can. Entomol. 107:865.
23. Bailey. 1976. The Canadian Entomologist. 108: 1339-1344.
24. Brugger *et al*. 2010. Pest Management Science. 66: 1075-1081.

Blister Beetles (Coleoptera: Meloidae)

The Nuttall blister beetle, *Lytta nuttalli* Say, a large purple and green blister beetle, may feed on canola, particularly near caragana, *Caragana arborescens* Lam, hedges (1). They are gregarious and may feed on leaves, stems and flower heads of canola.

Another species of blister beetle, *Epicauta ferruginea* (Say), may also feed on the blossoms of canola (1).

Chemical Control – There are no insecticides registered for blister beetles on oilseed crops in Canada.

References -

1. Burgess. 1983. The Canadian Entomologist. 115: 875-876.

Cabbage Seedpod Weevil *Ceutorhynchus obstrictus* (Marsham) (Coleoptera: Curculionidae)

Cabbage seedpod weevil (canola and mustard)

Economic threshold -

Control is required at densities of 3 to 4 adult weevils per one 180° sweep net sample (1). Apply by air or ground when crops are in 10 to 20% flowering stage to prevent egg-laying into newly formed pods (1,2). This is the stage when 70% of plants in the field have at least 3 to 10 open flowers.

Cultural Control –

Plant Resistance: Yellow mustard (*Sinapis alba*) is resistant to cabbage seedpod weevil; oriental and brown mustards (*Brassica juncea*) are susceptible to feeding by cabbage seedpod weevil (3).

Trap crops: If a trap crop of *Brassica rapa* is planted at the same time as the main crop of *Brassica napus*, the *B. rapa* should flower several days earlier and effectively concentrate the weevils, which can be sprayed with an insecticide if needed (4).

Chemical control –

IPM status of insecticides – All the insecticides registered in Canada for cabbage seedpod weevil in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Lambda-cyhalothrin Matador /Silencer	Canola, mustard	34	83	7	5
Deltamethrin Decis 5EC Poleci	Canola, mustard	80 ml (Decis); 162 ml (Poleci)	200 ml (Decis); 400 ml (Poleci)	7	5
Lambda-cyhalothrin + Chlorantraniliprole Voliam Xpress	Canola, mustard	91 ml	225 ml	7	-

Restrictions -

Spray late in the day to minimize harmful effects to bees and other beneficial insects.
Do not make more than 1 application per year by air.

References -

1. Dosdall, 2000 AAFRD Tech. Rep. 98M301, 65 pp.
2. Dosdall *et al.* 2001. Alta. Agr. Agdex 622-21, 4 pp.
3. Cárcamo *et al* 2007. Can. Entomol. 139 : 658-669.
4. Cárcamo *et al* 2007, Crop Protection 26: 1325-1334
5. Cárcamo *et al* 2005, Can. Entomol. 137: 476-87

Clover Cutworm *Discestra trifolii* (Hufnagel) (Lepidoptera: Noctuidae)

Clover cutworm (canola, mustard, and flax)

Economic thresholds – None, but as a nominal threshold check threshold levels for bertha armyworm as a guideline to determine if control measures are needed in canola.

Chemical Control –

IPM status of insecticides – All the insecticides registered in Canada for clover cutworm in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids, and predaceous insects.

Insecticide	Crop	Rate (vol/acre)	Rate (vol/ha)	Preharvest Interval (days)	References
Methomyl Lannate Toss-N-Go	canola	87 - 206 g	216-510 g	8	1
Deltamethrin Decis 5EC Poleci	canola, mustard	40 - 60 ml (Decis); 81-121 ml (Poleci)	100-150 ml (Decis) 200-300 ml (Poleci)	7	2-5
	flax	40 - 60 ml (Decis) 81-121 ml (Poleci)	100-150 ml	40	

References -

1. Dixon, Pest. Res. Rep. 1971:176.
2. Catellier and Wise, Pest. Res. Rep. 1982:99.
3. Catellier and Wise, Pest. Res. Rep. 1982:100.
4. McDonald, Pest. Res. Rep. 1975:260.
5. McDonald, Pest. Res. Rep. 1979:354.

Cutworms (Lepidoptera: Noctuidae)

Redbacked cutworm (*Euxoa ochrogaster*)
Army cutworm (*Euxoa auxiliaries*)
Dingy cutworm (*Feltia jaculifera*),
Pale Western cutworm (*Agrotis orthogonia*)

Economic threshold -

Pale western or redbacked cutworm - Apply an insecticide if densities exceed 4-5 larvae/m² in flax (8) or 10/m² in sunflowers (9). No thresholds have been established in canola but threshold levels in flax can serve as a guideline.

Army cutworm - No thresholds have been determined. Larval densities of less than one-half cutworm per square foot destroyed a mustard crop (10).

Cultural Control -

To prevent egg laying by pale western cutworm adults in summerfallow fields, destroy all plant growth in July and allow soil surface to crust until September 15. In areas where redbacked adults are present, avoid weedy growth in August and weedy patches in crops.

Spring cultivation: Studies and observations from Alberta show that pale western cutworm populations can be reduced by cultivating the soil and keeping it free of all plant growth for a 10-day period after the cutworms had hatched and before the crop was seeded (11).

Seeding Date: Larvae of the army cutworm usually cease feeding by June 1, thus crop seeded in the last week of May or later will escape feeding and damage by the larvae (10).

Chemical Control –

IPM status of insecticides – Chlorantraniliprole is not harmful to some beneficial insects, such as parasitic Hymenoptera (13). Seed treatments containing cyantraniliprole also preserve some beneficial insects. All the other insecticides registered for cutworms in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids, and predaceous insects.

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Seed Treatments					
Cyantraniliprole Lumiderm[1] Fortenza[1]	Canola, mustard	Sold as a component of a seed treatment that also includes either Prosper EverGol or Helix Vibrance			
Foliar Sprays					
Chlorantraniliprole Coragen	Canola, mustard, flax, sunflowers, safflower	101	250	1	
Deltamethrin Decis 5EC Poleci	Flax	80 ml (Decis) 162 ml (Poleci)	200 ml (Decis) 400 ml (Poleci)	40	6,7
Lambda-cyhalothrin Matador	Canola, mustard, flax	34 ml	83 ml	7	-
Permethrin Pounce /Perm-UP Ambush	canola, flax sunflowers	73 – 158 57 - 121	180-390 140-300	<6 leaf stage	-
Chlorpyrifos Lorsban 4EC /Pyrinex /Nufos /Citadel /Warhawk	canola, flax sunflowers	354 - 486 486	875-1200 1200	21 42	1-5

[1]Do not apply any subsequent applications of a group 28 insecticide (such as Coragen) for a minimum of 60 days after planting seed treated with Lumiderm or Fortenza.

It may take several days for optimum control using insecticides. Not all cutworms will surface to feed on any given night and come in contact with the insecticide on the soil and plants. One of the reasons is that during moulting periods (between larval stages) the cutworms are inactive (12).

Restrictions -

Pounce, Decis: Do not apply at temperatures above 25°C.

References -

1. McDonald, J. Econ. Entomol. 62:30, 1968;65:533, 1972.
2. Askew *et al*., Pest. Res. Rep. 1973:151.
3. McDonald, Pest. Res. Rep. 1974:251.
4. Askew *et al*., Pest Res. Rep. 1974:244.
5. Philip and Dolinski, Pest. Res. Rep.1977:215.
6. McVicar and Wise, Pest. Res. Rep. 1982:113.
7. Wise and Long, Pest. Res. Rep. 1985:95.
8. Ayre. 1990. Can. Entomol. 122: 21-28.
9. NDSU Extension Service #E-1143
10. Jacobsen, J. Econ. Entomol. 1962. 55: 408.
11. Salt and Seamans, 1945. Can. Entomol. 77: 150-155.
12. Byers *et al*. 1992. J. Econ. Entomol. 85: 1146-1149.

13. Brugger *et al*. 2010. Pest Management Science. 66: 1075-1081.

Diamondback Moth *Plutella xylostella* (Linnaeus) (Lepidoptera: Plutellidae)

Diamondback moth (canola and mustard)

Monitoring-

Adults- Adult male moths can be monitored using pheromone-baited traps. These traps can determine the presence of adults, but moth numbers are not directly related to larval density (7). Traps baited with pheromone released from gray rubber septa capture more males than those baited with red rubber septa (8). However, the most attractive commercially available sex pheromone lures tested attracted fewer diamondback moth males than calling virgin female moths (9).

Wind trajectories from potential source regions of diamondback moth can occasionally successfully predict movement of diamondback moth between regions (10). Used in conjunction with a network of pheromone-baited traps, wind trajectories may help provide alerts of early northward movement of diamondback moth.

Larvae- Larvae can be monitored by removing the plants in an area measuring 0.1 square metre area (about 1 foot square), beating them on a clean surface, and counting the number of larvae dislodged from the plants. This procedure should be repeated in at least five locations in the field.

Sampling with a sweep-net can determine the presence of general abundance of diamondback moth in the field, but is currently not a useful means for making management decisions because no studies have been conducted to relate levels caught in a sweep net to levels per foot square or yield loss. High levels of diamondback moth caught in sweep sampling can, however, prompt producers to perform counts of larvae per unit area (11).

Economic Thresholds -

Research does not exist to allow for economic thresholds for diamondback moth in canola and mustard to be established. Nominal thresholds have been suggested for canola if larvae exceed 100-150/m^2 in immature to flowering plants and 200-300/m^2 in plants with flowers and pods (2). A nominal threshold of 25-33% defoliation, with larvae still present on plants, can be applied for canola at seedling stage (5). Threshold at all crop stages may be lower for Polish type canolas than for Argentine type canolas (3) and higher for mustard (5).

Biological Control-

Over a 10 year period (1961-70) in Saskatchewan, 35 to 81% of first generation larvae of the diamondback moth were parasitized by the ichneumonid *Diadegma insularis* and the braconid *Microplitis plutellae,* averaging 68% (6).

Larvae of green lacewings have been observed feeding on early-instar larvae and cocoons containing prepupae of diamondback moth (14).

Rainfall may be a major mortality factor of eggs and early instars of diamondback moth (12). The larvae are very susceptible to drowning, and may be washed or wriggle to leaf axils or the ground where they drown in accumulated water (12). In cabbage, increased rainfall droplet density and diameter resulted in increased larvae falling from plants (13). Mortality rates of up to 74% have been reported from intense rain (12).

Chemical Control –

IPM status of insecticides – Chlorantraniliprole is not harmful to some beneficial insects, such as parasitic

Hymenoptera (15). All the other insecticides registered for diamondback moth in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Chlorantraniliprole Coragen	Canola, mustard	51	125	1	
Deltamethrin Decis 5EC Poleci	canola, mustard	40-60 (Decis); 81-121 (Poleci)	100-150 (Decis); 200-300 (Poleci)	7	4
Lamba-cyhalothrin Matador /Silencer	canola, mustard	34	83	7	
Lambda-cyhalothrin + Chlorantraniliprole Voliam Xpress	Canola, mustard	91 ml	225 ml	7	-
Malathion Malathion 500 Malathion 85E	Canola (500 & 85E), mustard (85E)	220- 345 109-168	550-850 270-415	7	1
Chlorpyrifos Lorsban /Pyrinex /Nufos /Citadel /Warhawk	canola	405 - 607	1000–1,500	21	

Restrictions -

deltamethrin: Do not apply at temperatures above 25°C.
malathion: Do not apply at air temperatures below 20°C.

References -

1. Putnam, Pest. Res. Rep. 1962:126.
2. Putnam, unpublished, 1976.
3. Harris, Sask. Agric., Regina, Sask. 1990.
4. Wise and Leader, Res. Rep. 1985:84,85.
5. Gavloski and Lamb. 2000. Env. Entomol. 1258-67.
6. Putnam, 1973. Can. J. Plant Sci. 911-914.
7. Miluch *et al*. 2013. Crop Protection. 89-97.
8. Miluch *et al*. 2014. J. Econ. Entomol. 2067-2076.
9. Evenden and Gries. 2010. J. Econ. Entomol. 103:654-661.
10. Hopkinson and Soroka. 2010. Agricultural and Forest Meteorology. 150: 1-11.
11. Dosdall *et al*., 2011. Prairie Soils and Crops Journal. 4: 66-76.
12. Harcourt. 1963. Can. Entomol. Soc. Mem. 32: 55–66.
13. Kobori and Amano. 2003. Applied Entomology and Zoology. 38: 249-253.
14. Harcourt. 1960. The Canadian Entomologist. 92: 419-428.
15. Brugger *et al*. 2010. Pest Management Science. 66: 1075-1081.

Flax Bollworm *Heliothis ononis* (Denis & Schiffermüller) (Lepidoptera: Noctuidae)

Flax bollworm (flax)

Economic threshold – Research does not exist to allow for economic thresholds for flax bollworm to be established. Nominal thresholds have been suggested for flax if 3% or more of bolls are infested. Infestations on flax are generally very rare.

Chemical Control - No insecticides presently are registered.

Flea Beetles: Crucifer flea beetle (*Phyllotreta cruciferae* (Goeze)) and Striped flea beetle (*Phyllotreta striolata* (F.)) (Coleoptera: Chrysomelidae)

Flea beetles (canola and mustard)

<u>Most Susceptible Crop Stages:</u> Yield of canola was reduced most by flea beetles when plants were damaged from the seeding stage to when the second true leaf was expanded, 5 to 10 days after germination, but was not reduced when they were damaged after reaching the stages where the third and fourth true leaves were expanded, 20 days after germination (1).

Flea beetle feeding on canola in late-summer is rarely an economic concern. Flea beetle feeding that occurs when seeds in lower pods of canola are at the green stage or beyond is unlikely to affect seed yields regardless of the infestation rate of flea beetles (2). Even when seeds are translucent to green, numbers higher than 100 flea beetles per plant, and for some cultivars higher than 350 per plant, may be necessary to cause significant yield reductions.

<u>Conditions favouring increased feeding:</u> Flea beetles feed most actively on canola when the weather is sunny, warm, and dry; cool damp weather reduces the intensity of feeding and aids plant growth (3).

Cultural control- <u>Tillage:</u> Damage to canola is greater under conventional tillage than with zero tillage (4,5).

<u>Seeding rates and row spacing</u>: In conventional tillage flea beetle damage to seedlings may be reduced by increasing seeding rates to 10 kg/ha and widening row spacings to 25 cm. (5). In zero tillage optimal seeding rates to reduce flea beetle damage are about 8 kg/ha.

Plant Resistance- Yellow mustard (*Sinapis alba*) seedlings are highly resistant to feeding by flea beetles, and *Brassica juncea* is partially resistant (6).

Seedlings from large canola seeds were more tolerant to damage from flea beetles than seedlings from medium or small seeds for both *Brassica rapa* (18) and *B. napus* (7). This was because of a higher initial shoot biomass and higher growth rate when flea beetle damage was severe.

Chemical Control –

IPM status of insecticides – The seed treatments registered for flea beetles will preserve some beneficial insects. All foliar insecticides registered for flea beetles in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Seed Treatments

Insecticide	Crop	Rate (vol/kg seed)	References
Thiamethoxam Helix Vibrance[1]	Canola, mustard	15 ml	8, 9, 10
Clothianidin Prosper EverGol[1] Nipsit	Canola, mustard (Prosper EverGol); Canola (Nipsit)		9, 10
Imidacloprid Gaucho Canola System[1] Gaucho Platinum[1] Sombrero[1]	Canola, mustard Canola, mustard Canola, mustard	8.3 ml 16.7 ml 6.7 – 13.3 ml	11
Cyantraniliprole Lumiderm[1,2] Fortenza[1,2]	Canola, mustard	960 – 1600 ml / 100 kg seed (Lumiderm); 500 – 1,333 ml / 100 kg seed (Fortenza)	
Sulfoxaflor Visivio[3]	Canola, mustard		

[1]For use by commercial seed treaters only.
[2]Do not apply any subsequent applications of a group 28 insecticide (such as Coragen) for a minimum of 60 days after planting seed treated with Lumiderm or Fortenza. Lumiderm is sold as a component of a seed treatment that also includes either Prosper EverGol or Helix Vibrance. Fortenza is sold as a component of a seed treatment that also includes Helix Vibrance.
[3]Visivio is a combination of Rascendo (sulfoxaflor) and Helix Vibrance. Visivio can be combined with Fortenza if cutworm management is needed.

Foliar Sprays

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Deltamethrin Decis 5EC Poleci	Canola, mustard	40 – 60 (Decis); 81-121 (Poleci)	100 – 150 (Decis); 200-300 (Poleci)	7	12, 13
Lambda- cyhalothrin Matador /Silencer	Canola, mustard	34	83	7	-
Cypermethrin	Canola	20	50	30	14

Mako UP-Cyde		56.6	140		
Permethrin Pounce Ambush	Canola	 36 – 73 28 - 57	 90 – 180 70 - 140		15
Lambda-cyhalothrin + Chlorantraniliprole Voliam Xpress	Canola, mustard	91 ml	225 ml	7	-
Malathion Malathion 500 Malathion 85E	Canola (500 and 85E) Mustard (85E)	450 217-346	1120 535-855	7	15, 16

Restrictions -

Matador: Apply only one application per year by air.
Decis / Poleci: Do not apply at temperatures above 25°C.
Malathion: Do not apply at air temperatures below 20°C.

Notes - In greenhouse experiments, *P. cruciferae* had higher mortality and fed less when exposed to seed treatments with thiamethoxam and clothianidin than did *P. striolata* (9).

References -

1. Bracken and Bucher. 1986. The Canadian Entomologist. 118: 319-324.
2. Soroka and Grenkow. 2012. Can. J. Plant Sci. 92: 97-107.
3. Burgess. 1977. The Canadian Entomologist. 109: 21-32.
4. Milbraith *et al*. 1995. Can. Entomol. 127: 289-93.
5. Dosdall *et al*. 1999. Crop Protection 18: 217-224.
6. Brandt and Lamb. 1993. The Canadian Entomologist. 125: 1011-1021.
7. Elliott *et al*. 2008. Can. J. Plant Sci. 88: 207-217.
8. Antwi *et al*. 2007. J. Econ. Entomol. 100: 1201-1209.
9. Tansey *et al*. 2008. J. Econ. Entomol. 101 : 159-167.
10. Knodel *et al*. 2009. Arthropod Management Tests. 34: F10.
11. Wise, Pest. Man. Res. Rep. 1993:26, 1995:32.
12. Wise, Pest. Res. Rep. 1983: 95.
13. Elliott *et al*. 2007. Can. Entomol. 139: 534-544.
14. Romanow *et al*., Pest. Res. Rep. 1977:151; 1982:84; 1983:83.
15. Weiss *et al*. 1991. J. Econ. Entomol. 84: 1597-1603.
16. Askew *et al*., Pest Res. Rep. 1974:226,228; 1976:127,129,131; 1977:144.
17. Westdal *et al*., Pest. Res. Rep. 1976:134,136; 1980:115.
18. Elliott *et al*. 2007. Can. J. Plant Sci. 87: 385-393.

Grasshoppers (Orthoptera: Acrididae)

Cultural Control -

- Fall stubble cultivation may reduce egg pod survival.
- Destroying green growth on stubble in the spring at the time hatching may help to starve young grasshoppers.
- Barrier strips of a non-preferred crop like oats next to an infested area at the margin of fields may delay young grasshoppers from feeding on susceptible crops (2).
- Trap crops or weeds in an adjacent summerfallow field can attract grasshoppers where they can be controlled with an insecticide (3).

Chemical Control –

IPM status of insecticides – Eco Bran Bait will preserve most beneficial insects (4). Chlorantraniliprole is not harmful to some beneficial insects, such as parasitic Hymenoptera (5). All other foliar insecticides registered for grasshoppers in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Trade Name	Crop	Rate (vol/acre)	Rate (vol/ha)	Preharvest Interval (days)	References
Carbaryl Eco Bran Bait	Canola	0.8 – 1.6 kg	2 - 4 kg	Seedlings only	-
Chlorantraniliprole Coragen	Canola, mustard, flax, sunflowers, safflower	51 – 101 ml	125 – 250 ml	1	
Deltamethrin Decis 5EC Poleci	canola, mustard, flax	Decis: 40-60 ml (ground), 60 ml (air) Poleci: 81-121 ml (ground), 121 ml (air)	Decis: 100-150 ml (ground), 150 ml (air) Poleci: 200-300 ml (ground), 300 ml (air)	7 (canola, mustard); 40 (flax)	
Lambda- cyhalothrin Matador /Silencer	canola, flax & mustard	25 - 34 ml (Ground) 34 ml (Air)	63-83 ml	7	-
Cypermethrin Mako UP-Cyde	Canola	20 – 28 ml 33 – 46 ml	50 – 70 ml 81 - 114 ml	30	
Lambda-cyhalothrin + Chlorantraniliprole Voliam Xpress	Canola, mustard, flax, sunflowers, safflower	91 ml	225 ml	7	-
Malathion Malathion 500	canola, flax & mustard	450 - 680 ml	1100-1680 ml	7	1

Malathion 85E	(85E only)	217-346	535-855		
Chlorpyrifos Lorsban 4E /Pyrinex /Nufos /Citadel /Warhawk	Canola	235 - 354	580-875 ml	21	1
Dimethoate Cygon /Lagon	canola, safflowers	340 - 364 ml 222 - 450 ml	850-900 ml 550-1100 ml	21	-

Restrictions -

Do not apply when bees are present (with the exception of Eco Bran and chlorantraniliprole).
Apply higher rates when foliage is dense or if grasshopper nymphs are past the third instar stage.
Do not apply Malathion at air temperatures below 20°C or Matador and Decis above 25°C.

References -

1. Charnetski, Pest. Res. Rep. 1975: 210.
2. Olfert, Grasslands and Grassland Health, 2000: 61-70.
3. Olfert. 1986. Can. Entomol. 133-140.
4. George *et al*. 1992. Environmental Entomology. 21: 1239-1247.
5. Brugger *et al*. 2010. Pest Management Science. 66: 1075-1081.

Lygus Bugs (Hemiptera: Miridae)

Lygus bugs (canola, mustard, flax, confectionary sunflowers)

Monitoring-

Canola - Thresholds are based on the number of lygus bugs sampled per 10 sweeps with a 38 cm diameter sweep net (2). Canola should be sampled when flowering is complete and seeds are enlarging in the lower pods (stage 4.4), particularly if precipitation is low. If densities are near but less than the threshold at stage 4.4, canola should be resampled at stage 5.1 (when seeds in the lower pods are full size, translucent). If densities are sufficiently high, control is still warranted at stage 5.2 (seeds in lower pods green).

Lygus bug densities should be determined from a minimum of 15 samples of 10 sweeps or 10 samples of 20 sweeps per field (3). Samples can be collected from along the edge or at right angles from the edge of the field. Research has shown that samples taken along the edge of commercial fields and at various distances into the field all gave similar estimates of plant bug density (3). Sampling along the edge reduces effort during years when thick crop growth impedes access to the field. For edge sampling, the area selected for sampling should be at a crop stage similar to that in the main part of the field.

Economic thresholds -

Economic thresholds when flowering is complete in canola are calculated based on an assumed loss of 0.1235 bu/acre for each lygus bug per 10 sweeps (2).

Application Cost		Flowering Complete (Canola Crop Stages 4.4 - 5.1)[1]					
$ / ha	**$/ ac**	**Economic Injury Level**					
22	8.00	11	8	7	5	5	4
25	10.00	13	10	8	7	6	5
27	12.00	16	12	10	8	7	6
30	14.00	19	14	11	9	8	7
32	16.00	22	16	13	11	9	8
35	18.00	24	18	15	12	10	9
Canola Price ($/bu)		6.00	8.00	10.00	12.00	14.00	16.00

At crop stages prior to flowering being complete, feeding by lygus bugs on canola does not generally result in economic damage

Economic threshold at pod ripening in canola are calculated based on an assumed loss of 0.0882 bu/acre for each lygus bug per 10 sweeps (2).

Application Cost		Seeds in lower pods green (Canola Crop Stage 5.2)[1]					
$ / ha	**$/ ac**	**Economic Injury Level**					
22	8.00	15	12	9	8	7	6
25	10.00	19	14	11	10	8	7
27	12.00	23	17	14	11	10	9
30	14.00	27	20	16	13	11	10
32	16.00	30	23	18	15	13	11
35	18.00	34	26	20	17	15	13
Canola Price ($/bu)		6.00	8.00	10.00	12.00	14.00	16.00

[1]Crop stages of Harper and Berkencamp (1975). Can. J. Plant Sci. 55: 657-658.
4.4 is flowering complete, seeds enlarging in lower pods;
5.1 is when seeds in the lower pods are full size, translucent;
5.2 is when seeds in the lower pods are green.
5.3 is when seeds in the lower pods are green-brown mottled.

When precipitation is greater than 100 mm from the onset of bud formation to the end of flowering, the plant may partially compensate for damage by lygus bugs (2).

Confectionary sunflowers – Research in North Dakota found that feeding by adult lygus bugs resulted in 32.7 damaged seeds per head (4). Approximately 5% of seeds in a head were damaged per adult. Damage to sunflower heads was approximately twice as severe when infestations occurred at growth stages R4 and

R5 compared with stages R6 and R7.
One adult lygus bug per 9 heads can result in economic loss through the reduction of seed quality. Lygus bug management should be initiated between the R4 to R5.1 stage if adult densities reach the economic injury level (4). **Note**: Because the most appropriate timing of insecticides to control Lygus bugs in sunflowers includes flowering stages, steps to minimize harm to pollinators should be taken and insecticides should only be used when economic thresholds are exceeded.

Oilseed Sunflowers - No control is needed in oilseed sunflowers not used for human consumption.

Flax: Although Lygus bugs can occasionally reach high densities in flax, flax is tolerant of their feeding damage under good growing conditions. A study in Manitoba found that under good growing conditions, populations of up to 100 per 10 sweeps did not reduce yield (5).

Chemical Control –

IPM status of insecticides – All the insecticides registered and sold in Canada for Lygus bugs in oilseed crops are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Deltamethrin Decis 5EC Poleci	canola, mustard	60 (Decis); 121 (Poleci)	150 (Decis); 300 (Poleci)	7	1
Lambda- cyhalothrin Matador /Silencer	canola, sunflowers (Matador only)	34	83	7	-
Lambda-cyhalothrin + Chlorantraniliprole Voliam Xpress	Canola, mustard, flax, sunflowers	91 ml	225 ml	7	-
Chlorpyrifos Lorsban /Citadel / Pyrinex /Nufos /Warhawk	canola	200 - 400	500-1000	21	1

References -

1. Wise, Pest. Res. Rep. 1988: 65, 66.
2. Wise and Lamb. 1998. Can. Entomol. 130: 825-36.
3. Wise and Lamb. 1998. Can. Entomol. 130: 837-51.
4. Charlet. 2003. Helia. 26: 83-92.
5. Wise and Lamb. 2000. Can. Entomol. 132: 369-371.

Painted Lady Butterfly — *Vanessa cardui* (L.) (Lepidoptera: Nymphalidae)

Painted lady butterfly (sunflowers, canola, mustard)

Larvae (sometimes referred to as thistle caterpillars) feed chiefly on Canada thistle (*Cirsium arvense* (L.))

in the Canadian portion of their range, and are thus beneficial in this regard (1,2). Occasionally, when large migrations occur, larvae may feed on sunflowers (1), canola and mustard (2), and borage (3). Contamination of canola and mustard seed by frass of thistle caterpillars has occurred (2) but is likely to be an infrequent occurrence as it is only a potential problem in years when thistle caterpillar is abundant and when the larvae have not matured well in advance of harvest.

Biological Control –
Usually heavily parasitized, and is also subject to bacterial disease (1).

References -

1. Westdal, 1975. Insect Pests of Sunflowers. In, Oilseed and Pulse Crops in Western Canada. pp.475-495.
2. Byers *et al*., 1984. Can. Entomol. 116: 1431-1432.
3. Miranpuri *et al*., 1993. J. of Applied Entomology. 116: 156-162.

Red Turnip Beetle — *Entomoscelis americana* Brown (Coleoptera: Chrysomelidae)

Red turnip beetle (canola, mustard)

Cultural Control -
The eggs are layed on the soil late in the summer beneath canola or related plants. They hatch in the spring and the larvae feed on volunteer canola or winter annual weeds such as flixweed and mustards. Destruction of these food plants while they are still in the early larval stages may starve larvae. Adults are very mobile and will migrate to canola in summer to feed.

Chemical Control – No insecticides are registered for use on red turnip beetles.

Root Maggots — *Delia* spp. (Diptera: Anthomyiidae)

Root Maggots (canola)
A complex of 5 root maggot species in the genus *Delia* occur in canola field in Western Canada: *D. floralis* (the turnip maggot), *D. radicum* (the cabbage maggot), *D. platura* (seed corn maggot), *D. florilega* (bean seed maggot), and *D. planipalpis*.

Cultural Control -
Variety selection: Comparisons on the level of susceptibility of cultivars of canola and mustard to root maggots demonstrated that varieties of Polish canola (*B. rapa*) were most susceptible, *Brassica napus* (Argentine canola) and *B. juncea* were intermediate in susceptibility, and yellow mustard (*S. alba*) was least susceptible (1,2). *S. alba* has both antibiotic and antixenotic effects on root maggots (7).
Cultivation: Cultivating prior to seeding reduces adult emergence from overwintered pupae (3). Root maggot infestations are greater under zero-till systems than under conventional tillage, but yields under zero tillage usually still exceed those with conventional tillage (5).
Seeding Rate and Row Spacing: Seeding at approximately twice the recommended rate (10 kg/ha) (4), and at a row spacing of 20 or 30 cm (5) reduces damage from root maggots and results in

improved yields.

Biological Control –
The rove beetle *Aleochara bilineata* is a predator of root maggot eggs and larvae, and larvae of *A. bilineata* are parasites of root maggot pupae (6). A single adult of *A. bilineata* is capable of consuming an average of 23.8 eggs or 2.6 larvae per day (6).

Chemical Control - No insecticides are registered for control of roots maggots in canola.

References -

1.Griffiths, Proc. GCIRC Congress, 1991:528-535.
2. Dosdall *et al.* 1994. Can. Ent. 126: 251-260.
3. Dosdall *et al.* 1996. Can. Ent. 128:1157-1165.
4. Dosdall *et al.*, Can. J. Plant Sci. 76: 169-177.
5. Dosdall and Dolinski. AARI Tech. Rep. 95M723, 1997: 40pp.
6. Read, D.C. 1962. Can. Ent. 94: 417-424.
7. Jyoti *et al*. 2001. J. Econ. Entomol. 94: 942-949.

Sunflower Beetle — *Zygogramma exclamationis* (F.) (Coleoptera: Chrysomelidae)

Sunflower beetle (sunflowers)

Economic Thresholds -
Control is required in sunflowers with 1 - 2 adults/seedling or 10 - 15 larvae/plant (1). Count larvae in the plant tops where they rest during the day. Sample a minimum of 20 plants to estimate larval densities.

Cultural Control –
Research in North Dakota found that sunflower beetle adult and larval populations decreased as planting date was delayed (2). Delaying planting did not reduce the effectiveness of the parasitic fly *Myiopharus macellus* which attacks the sunflower beetle larvae.

Biological Control-
The tachinid fly *Myiopharus macellus* is an important natural enemy of sunflower beetle larvae (3).

Chemical Control –

IPM status of insecticides – The seed treatment registered for sunflower beetles will preserve most beneficial insects. All foliar insecticides registered for sunflower beetles are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Thiamethoxam Cruiser Maxx Sunflowers	A seed treatment. Sunflower seeds can not be treated with Cruiser Maxx Sunflowers in Canada.			
Deltamethrin Decis 5EC Poleci	40 (Decis) 81 (Poleci)	100 (Decis); 200 (Poleci)	70	4, 5
Lambda-cyhalothrin Matador / Silencer	17 – 25 (ground) 34 (air)	42 - 63 83	7	-

Cypermethrin Mako UP-Cyde	 28 40	 70 100	70	5, 6
Lambda-cyhalothrin + Chlorantraniliprole Voliam Xpress	91 ml	225 ml	7	-

Restrictions -

cyhalothrin-lambda: Only one application by air per year.
cypermethrin: Avoid application at temperatures above 27°C. Only one application by air.
deltamethrin: Do not apply at temperatures above 25°C.

References -

1. Deedat, Ph.D. Thesis, Univ. of Manitoba. 1987:92.
2. Charlet and Knodel. 2003. J. Econ. Entomol. 96: 706-713.
3. Charlet. 1992. J. Econ. Entomol. 85: 766-771.
4. Westdal *et al*., Pest. Res. Rep. 1980:130.
5. Romanow and Askew, Pest. Res. Rep. 1983:144.
6. Emilson, Pest. Res. Rep. 1983:141,142,143; 1984:160,161,162,163.

Sunflower Bud Moth — *Suleima helianthana* (Riley) (Lepidoptera: Tortricidae)

Sunflower bud moth (sunflowers)

Larvae feed in the pith area of either the stalk or receptacle (head). Larvae can cause seed loss when they occur in either the terminal of small plants or in small heads (1).
Larvae keep the burrow open and continually push frass its entrance. As larvae grow, frass accumulates at the entrance of the burrow.

Cultural Control – Research in North Dakota found that late planting dates (early to mid-June) of sunflowers reduced the percentage of heads damaged by sunflower bud moth compared with early planting dates (2).

Reference -

1. Rogers. 1979. Environmental Entomology. 8: 113-116.
2. Knodel *et al*. 2011. J. Econ. Entomol. 104: 1236-1244.

Sunflower Maggots — (Diptera: Tephritidae)

Sunflower maggot – *Strauzia longipennis* (Wied)
Neotephritis finalis (Loew)
Gymnocarena diffusa Snow

Larvae of *Strauzia longipennis* tunnel in the pith of sunflower stalks. Depending on the number of maggots, tunnelling may vary from one short tunnel to complete destruction of the pith (1). The plants can remain healthy and vigorous in appearance even when there is complete pith destruction (1).

Larvae of *Neotephritis finalis* feed on developing seeds of sunflowers (2).

Larvae of *Gymnocarena diffusa* inhabit and feed on the spongy tissue of the sunflower receptacle (3).

Cultural Control – Research in North Dakota found that late planting dates (early to mid-June) reduced damage from *Neotephritis finalis* compared with early planting dates (mid- to late May) (4).

Chemical Control – Insecticides are not registered for sunflower maggots in Canada.

References –

1. Westdal and Barrett. 1960. Can. Ent. 481-488.
2. Arthur and Mason. 1989. Can. Ent. 729-735.
3. Kamali and Schulz. Annals of the Ent. Soc. America. 1973: 288-291.
4. Knodel *et al*. 2011. J. Econ. Entomol. 104: 1236-1244.

Sunflower Midge — *Contarinia schulzi* Gagné (Diptera: Cecidomyiidae)

Sunflower Midge (Sunflowers)

Economic Threshold -

Destruction of seeds and distortion of heads can cause serious losses in fields in the Red River Valley of Manitoba. Losses are more severe around field edges. Losses can be estimated by sampling heads and classifying them by the degree of head cupping and the relative area of seed destroyed (1).

Cultural Control -

Some cultivars show some resistance to feeding by sunflower midge (2,3).

Chemical Control -

No chemical control is feasible because the larvae feed within the head.

Reference -

5. Bracken. 1991. Can. J. Plant Sci. 71: 81-85.
6. Anderson and Brewer. 1991. J. Econ. Entomol. 84: 1060-1067.
7. North Dakota Field Crop Insect Management Guide – 2009. http://www.ag.ndsu.edu/pubs/plantsci/pests/e1143w1.htm

Sunflower Moths

Banded sunflower moth - *Cochylis hospes* Walsingham (Lepidoptera: Tortricidae) on sunflowers
Sunflower moth - *Homoeosoma electellum* Hulst (Lepidoptera: Pyralidae) on sunflowers.

Monitoring -

Pheromone traps can be used to determine when adults of the banded sunflower moth and sunflower moth are present (3).

Methods of determining the economic injury level of the banded sunflower moth based on sampling adult

(4) and eggs (5) have been developed. Egg sampling is best done using a head-mounted 3.5X magnifier (available from most IPM suppliers) to leave both hands free for manipulating the buds being observed. To sample eggs, divide each side of the field into 2 sections; sample the centre of each section at 20 feet into the field from the field edge; randomly select 5 buds, and for each bud randomly select 6 bracts form the outer whorl and count the eggs on each bract.

Economic threshold:
Sunflower moth - For field scouting, 1 to 2 moths per 5 plants is necessary for treatment. For pheromone traps, an average of 4 moths per trap per day has been suggested as needed for an insecticide application (1).
Banded Sunflower moth – Formulas for economic injury levels for both the egg sampling and adult moth sampling techniques are available, see:
http://library.ndsu.edu/tools/dspace/load/?file=/repository/bitstream/handle/10365/4798/e823.pdf?sequence=1
Because banded sunflower moth levels are often higher on field margins, if the average egg count equals of exceeds the economic threshold, a second calculation for economic distance determines the extent of the economic injury level into the field.

Cultural Control – Research in North Dakota has shown that delaying the planting of sunflowers until late May or early June can reduce levels of damage by banded sunflower moth (2).

Biological Control – Research in North Dakota found that honey bees, *Apis mellifera* L., can vector *Bacillus thuringiensis* variety *kurstaki* from hives equipped with a pathogen applicator to sunflower heads and the amount of *B. thuringiensis* deposited on the head is sufficient to result in high mortality of larvae of the banded sunflower moth (7).

Chemical Control - Do not apply an insecticide if insects are not found within 2 weeks of flowering. Apply when 20-50% of the heads are in bloom.

IPM status of insecticides – Bacillus thuringiensis kurstaki is specific in killing larvae of Lepidoptera, and will not harm populations of beneficial insects. Chlorantraniliprole is not harmful to some beneficial insects, such as parasitic Hymenoptera (6).

Insecticide	Crop	Rate (g/acre)	Rate (g/ha)	Preharvest Interval (days)	References
Bacillus thuringiensis kurstaki Dipel 2X DF (sunflower moth)	Sunflowers	127 - 253	315-625	None	-
Chlorantraniliprole Coragen (banded sunflower moth)	Sunflowers	101 - 152	250 - 375	1	

References -

1. NDSU Extension Service, Pub. # E-1143.
2. Oseto et al. 1989. J. Econ. Entomol. 82: 910-912.
3. Underhill *et al*. 1986. Environ. Entomol. 15: 1063-1066.
4. Charlet and Barker. 1995. Helia. 18: 59-66.
5. Mundal and Brewer. 2008. J. Econ. Entomol. 101: 969-975.

6. Brugger *et al*. 2010. Pest Management Science. 66: 1075-1081.
7. Jyoti and Brewer. 1999. Environmental Entomology. 28: 1172-1176.

Sunflower Seed Weevils (Coleoptera: Curculionidae)

Red sunflower seed weevil - *Smicronyx fulvus* LeConte, and
Gray sunflower seed weevil - *Smicronyx sordidus* LeConte

Momitoring - Count the number of weevils found on a minimum of 25 plants when the yellow ray petals are beginning to show (2).

Economic Threshold -

One to two adults/head in confectionery sunflower and 12-14 adults/head in oilseed sunflowers for plant densities of 45 000 - 55 000/ha (1).

Cultural Controls-

Research in North Dakota showed that planting sunflowers in early to mid May will help reduce damage by red sunflower seed weevil (3). However, early planting may increase the risk of damage by other insects on sunflowers.

Chemical Control –

Optimal Spray Timing: Early anthesis, when 30 - 70% of sunflower heads are in early pollen formation, i.e. R-5.1 stage (for example, when 3 - 7/10 plants show ray petals and at least one row of disc flowers). Reinfestation of the field may occur in areas with a high weevil population. Fields at 70% pollen shed stage are no longer susceptible to economic damage (2).

IPM status of insecticides – All insecticides registered for sunflower seed weevils are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Because the most appropriate timing of insecticides to control sunflower seed weevils is during the flowering stage, steps to minimize harm to pollinators should be taken and insecticides should only be used when economic thresholds are exceeded.

Insecticide	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Cypermethrin				
Mako	28	70	70	-
UP-Cyde	40	100		
Chlorpyrifos Lorsban /Pyrinex /Nufos /Citadel	485	1200	42	-

Reference -

1. Peng and Brewer. 1995. Can. Entomol. 127: 561-568.
2. N. Dakota State Univ. Coop. Ext. Serv. Publ. #E-817.
3. Oseto et al. 1987. J. Econ. Entomol. 80 : 190-192.

Swede Midge *Contarinia nasturtii* (Kieffer) (Diptera: Cecidomyiidae)

Swede midge (canola)

Swede midge is an introduced insect in North America, which was first identified in Ontario in 2000 (1). A bioclimatic model indicated that swede midge population growth in the Prairie Ecozone of Western Canada would be greatest in years with above average precipitation (2).

Monitoring – Pheromone-baited traps can be used to attract and catch male swede midge (3).
A predictive model, MidgeEmerge, can accurately predict swede midge emergence in Ontario and Québec (4).

Cultural Control – Extremely wet or dry soil significantly hinders emergence of swede midge, regardless of soil type (5).
Most swede midge pupate within the top 1 cm of soil. Greater than 5 cm of soil cover was found to effectively reduce the proportion of adult emergence and delayed the time of emergence (5). Soil manipulation (moisture content and cultivation practices) may be a possible component of an integrated management program for swede midge.

Chemical Control –

IPM status of insecticides – Chlorantraniliprole is not harmful to some beneficial insects, such as parasitic Hymenoptera (7). All the other insecticides registered for swede midge in canola are more general in their impact on insect communities, also being harmful to pollinators, parasitoids and predaceous insects.

Insecticide	Crop	Rate (ml/acre)	Rate (ml/ha)	Preharvest Interval (days)	References
Chlorantraniliprole Coragen	Canola	101	250	1	
Lamba-cyhalothrin Matador /Silencer	canola	34	83	7	6

Reference -

1. Hallett and Heal. 2001. Can. Entomol. 133: 713-715.
2. Olfert et al. 2006. Entomologia Experimentalis et Applicata. 120 : 221-228.
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Zebra Caterpillar *Melanchra picta* (Harris) (Lepidoptera: Noctuidae)

Larvae of zebra caterpillar will feed on many crop and non-crop plants including canola and flax.

Biological Control-
A study of zebra caterpillar collected from blueberries in British Columbia found that 50% were parasitized by the braconid wasp *Microplitis mamestra*e (1).

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