

THE Sunflower Production GUIDE





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SUNFLOWER INDUSTRY PROFILE

The National Sunflower Association of Canada (NSAC) was created at a meeting in Carman, Manitoba on November 18, 1996.

The meeting was held because the industry's leading oil crushing plant in Altona, Manitoba ceased processing sunflowers in 1995. As a result, sunflower acreage dropped from a high of more than 300,000 acres (121,400 hectares) during the early 80's to less than 75,000 acres (30,350 hectares) in the late 90's. The closure was prompted because a large part of the sunflower acreage had shifted to confection types that were promoted by processors located in various parts of Manitoba's Red River Valley and southern Alberta.

The association addresses the sunflower industry with one voice and membership includes producers, oil and confection type buyers, exporters and processors, pesticide manufacturers and dealers and the seed industry. Today the association has greater than 450 members from Manitoba, where a sunflower check-off is in place, plus 40 additional growers and industries located in Saskatchewan, Alberta and Ontario.

Since the establishment of the NSAC in 1996, sunflower acreage has climbed from 63,000 acres (25,500 hectares) to 187,000 acres (75,700 hectares) in 2005. Approximately 85 per cent of all sunflowers grown in Canada are located in Manitoba, but a growing share is finding its way into southeastern Saskatchewan. Other small pockets of sunflowers are found in south central Alberta and southern Ontario.

Approximately 80 per cent of all Canadian sunflowers are confection type, which are marketed primarily as roasted snack food in the shell or as dehulled seeds for the baking industry. Although a significant percentage of this market is domestic (North America), Canadian processors are accessing an increasing foreign market in Europe, the Middle East and Asia.

Oilseed sunflowers are mainly used in the crushing industry for sunflower oil, one of the highest quality vegetable oils produced today. An excellent cooking oil, sunflower oil is used both in the preparation of snack foods and as a bottled product used in the home. A new development in the U.S. has led to NuSun, a mid-oleic oilseed type sunflower that is quickly taking over this part of the industry and promises to bring back much of the oilseed crushing sunflower acreage lost in 1995.

The third category of sunflower production is destined for the birdfeed market. Although most birdfeed sunflowers are oilseed types, some confection seed also finds its way into this marketplace.

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AGRONOMY

GROWTH STAGES

The total time required for development of a sunflower plant and the time between the various stages of development depends on the genetic background of the plant and the growing environment. When determining the growth stage of a sunflower field, the average development of a large number of plants should be considered. This staging method can also be used for

individual plants. The same system can be used for classifying either a single head or branched sunflower. In the case of branched sunflower, make determinations using only the main branch or head. In stages R7 through R9, use healthy, disease-free heads to determine plant development if possible, because some diseases can cause head discoloration.

STAGE	DESCRIPTION
VE Vegetative Emergence	Seedling has emerged and the first leaf beyond the cotyledons is less than 4 cm long.
V (number) Vegetative Stages (i.e.) V1 V2 V3 etc.	These are determined by counting the number of true leaves at least 4 cm in length beginning as V1, V2, V3, V4, etc. If senescence of the lower leaves has occurred count leaf scars (excluding those where the cotyledons were attached) to determine the proper stage.
R1 Reproductive Stages	The terminal bud forms a miniature floral head rather than a cluster of leaves. When viewed from directly above the immature bracts form a many-pointed star-like appearance.
R2	The immature bud elongates 0.5 to 2.0 cm above the nearest leaf attached to the stem. Disregard leaves attached directly to the back of the bud.
R3	The immature bud elongates more than 2.0 cm above the nearest leaf.
R4	The inflorescence begins to open. When viewed from directly above immature ray flowers are visible.
R5 (decimal) (i.e.) R5.1 R5.2 R5.3 etc.	This stage is beginning of flowering. The stage can be divided into sub-stages dependent upon the per cent of the head area (disk flowers) that has completed or is in flowering. Ex. R5.3 (30%), R5.8 (80%) etc.
R6	Flowering is complete and the ray flowers are wilting.
R7	The back of the head has started to turn a pale yellow color.
R8	The back of the head is yellow but the bracts remain green.
R9	The bracts become yellow and brown. This stage is regarded as physiological maturity.

From Schneider, A. A. and J. F. Miller. 1981. Description of Sunflower Growth Stages. *Crop Sci.* 21:901-903.

FIELD SELECTION

CROP ROTATION

Sunflowers grow best on loam, silty loam and silty clay loam soils with good drainage. Sunflowers have a low tolerance of saline conditions, and therefore soils with moderate to high levels of salinity should be avoided. Sunflowers are sensitive to herbicide residues, such as Lontrel and Pursuit. Consult the product label or the current *Guide to Crop Protection* for specific details.

Crop rotation when growing sunflowers is very important. Sunflowers are very susceptible to sclerotinia as are canola and beans. Refer to Section IV – Diseases for further details on all diseases and crop rotation.

SEEDING

TREATMENTS

Seeds can be treated with a fungicide to control downy mildew but there are no registered treatments for seedling blight. For specific seed treatment information, consult the current *Guide to Crop Protection*

DATES

Sunflower seeding should usually begin anytime after May 1 and ideally be finished by June 1. Seedlings are relatively frost-tolerant up to the four-leaf stage. Confection varieties are longer maturing than oilseed types. If seeding is delayed into the first week in June, switching to oilseed types is recommended as well as choosing earlier-maturing varieties.

RATES

Seeding rate for sunflowers depends on sunflower type. Oil-type sunflower populations range from 20,000-22,000 plants/acre (0.6 plants/ft²), but confection-type sunflowers should not exceed 18,000 plants/acre (0.4 plants/ft²) to ensure large seed size. Seeding rates for both oil and confection-type sunflowers should be adjusted when germination is low and for the number of weed control harrowing operations expected. Refer to Tables 1 and 2 for information on plant density and row spacing as well as seed size and weight.

SOLID SEEDING

Recommended row spacing for solid seeding is 10 to 12 inches (25.4 to 30.5 centimetres) for both confection and oil-type sunflowers. Plant populations should remain the same as stated above regardless of row spacing. The sunflower plant will compensate for differences in plant population through changes in seed and head size. These changes are more noticeable in confections and caution should be taken when calculating the seeding rates.

DEPTH

Sunflowers need to be placed in moisture but not deeper than three inches (7.6 centimetres). The ideal seeding depth is 1 1/2 to two inches (3.8 to five centimetres) deep. Planting equipment should firm the soil over the seed row to maintain a moist seedbed.



TABLE 1. SEED DENSITY OF SUNFLOWERS AS A FUNCTION OF ROW SPACING

	ROW SPACING—INCHES				
	16	18	22	30	36
Plants/acre	Average seed spacing within row—inches				
16,000	23	30	16	12	10
18,000	20	17	14	10	9
20,000	18	16	13	9	8

TABLE 2. SUNFLOWER SEED SIZE AND ASSOCIATED SEED WEIGHT

OIL-TYPE SUNFLOWERS		CONFECTION SUNFLOWERS	
Seed Size	Seeds/lb	Seed Size	Seeds/lb
No. 2	5,000-6,000	Medium	4,000-5,000
No. 3	6,000-7,000	Large	3,000-4,000
No. 4	7,000-9,000	Extra Large	2,000-3,000

FERTILIZER

GENERAL

Have your soil tested for specific recommendations on fertilizer rates. Phosphate and potassium should be side-banded to the sunflower row, along with some or all nitrogen. Nitrogen is often banded between the rows after planting. If soil analysis is not available, a general recommendation is as follows:

Nitrogen (N): Apply 0-30 lb/acre N following fallow or legume breaking, 30-55 lb/acre N following grass and grass-legume breaking and 55-90 lb/acre N following stubble. The primary nitrogen deficiency symptoms are reduced growth (plant height) and general chlorosis, with the lower leaves showing a greater degree of chlorosis than the upper leaves.

Phosphate (P₂O₅): Apply phosphate at 30-40 lb/acre P₂O₅. The primary phosphate deficiency symptom is reduced

growth and dark-grey necrosis of the lower leaves of the plant.

Potassium (K₂O): On sandy textured or organic soils, apply potassium at rates of 15-30 lb/acre K₂O in a sideband or 30-60 lb/acre K₂O broadcast. The primary potassium-deficiency symptom is yellowing, with large necrotic patches on the oldest leaves.

Sulphur (S): Apply sulphate sulphur at 20 lb/acre sulphate on well-drained soils. Sulphur deficiency may occur in many soils and in any area of the province. A soil test is recommended to establish the available sulphur status of fields. The primary sulphur deficiency symptom is a general chlorosis of the plant, with the youngest leaves showing a greater degree of yellowing than the older leaves.

Sunflowers take up and remove modest levels of nutrients compared to barley or canola. Table A indicates the range of nutrients taken up and removed by a crop yielding 2000 lb/acre.

TABLE A. NUTRIENT UPTAKE AND REMOVAL BY SUNFLOWER

Sunflowers at 2000 lb/acre	Nitrogen lb N/ac	Phosphorous lb P ₂ O ₅ /ac	Potassium lb K ₂ O/ac	Sulphur lb S/ac
Uptake ¹	67-82	23-28	33-41	8-9
Removal ²	48-59	14-18	11-13	4-5

Uptake¹ = total nutrients taken up by the crop

Removal² = nutrients removed in the sunflower seed

Compiled by the Canadian Fertilizer Institute

SOIL TEST RECOMMENDATIONS

Fertilizer recommendations based on soil testing were developed and used by Manitoba Agriculture, Food and Rural Initiatives.

Recommendations are based on a zero to six-inch (zero to 15.2-centimetre) sample for phosphorus and potassium, and on a zero to six-inch (zero to 15.2-centimetre) and six to 24-inch (15.2 to 61-centimetre) sample for nitrate-nitrogen and sulphate-sulphur. The fertilizer recommendations are listed in Tables B and C.

Germinating sunflower seeds are sensitive to fertilizer placed with the seed. When sunflowers are seeded with row equipment, all phosphate and potash should be sidebanded two inches (five centimetres)

beside and below the seed at time of seeding. Some or all of the nitrogen may also be sidebanded. The total amount of fertilizer material side-banded should not exceed 300 lb/acre. When sunflowers are solid-seeded in 12 to 24-inch (30.5 to 61-centimetre) row spacing, up to 25 lb/acre P₂O₅ can be applied provided all fertilizer runs are left operating. If all phosphate must be placed with seed, the amount of phosphate should not exceed 15 lb/acre P₂O₅ for 12-inch (30.5-centimetre) row spacing, 10 lb/acre P₂O₅ for 18-inch (45.7-centimetre) row spacing and 5 lb/acre P₂O₅ for 24-inch (61-centimetre) row spacing. Nitrogen requirements not side-banded should be placed away from the seed as a band or broadcast application.

TABLE B. NITROGEN RECOMMENDATIONS FOR SUNFLOWERS (BASED ON SPRING BAND APPLICATION)

Target Yield lb/ac		2,500	2,250	2,000	1,750
Fall Soil NO ₃ -N		NITROGEN RECOMMENDATION (LB/AC)			
lb/ac in 0-24 in	Rating				
20	VL	200	150	100	50
30	L	170	120	70	15
40	M	140	90	40	0
50	M	115	65	10	0
60	H	85	35	0	0
70	H	55	5	0	0
80	VH	25	0	0	0
90	VH	0	0	0	0
100	VH+	0	0	0	0



TABLE C. PHOSPHORUS, POTASSIUM AND SULPHUR RECOMMENDATIONS FOR SUNFLOWER BASED ON SOIL TEST LEVELS AND PLACEMENT

Soil phosphorus (sodium bicarbonate P test)		Fertilizer P ₂ O ₅ lb/ac		Soil potassium (ammonium acetate K test)		Fertilizer K ₂ O lb/ac			Soil Sulphate Sulfur in 0-24 in.		Fertilizer S lb/ac
Ppm	lb/ac	Rating	Sb ¹	ppm	lb/ac	Rating	Sb ¹	PPI ²	lb/ac	Rating	N/A ³
0	0	VL	40	0	0	VL	30	60	0	VL	20
5	VL	40	25	50	VL	30	60	5	VL	20	
5	10	L	40	50	100	L	15	30	10	VL	20
15	L	35	75	150	L	15	30	15	L	20	
10	20	M	30	100	200	M	0	0	20	L	20
25	M	20	125	250	M	0	0	25	M	20	
15	30	H	15	150	300	H	0	0	30	M	20
35	H	10	175	350	H	0	0	35	H	0	
20	40	VH	10	200	400	VH	0	0	40	VH	0
20+	40+	VH+	10	200+	400+	VH+	0	0	40+	VH+	0

Sb¹=side banded

PPI²=broadcast and preplant incorporated

N/A³=placement does not influence effectiveness of sulphate forms of sulphur fertilizer

Plant Tissue Analysis

Plant tissue analysis is an important tool in assessing nutrient status of the growing crop. Following are plant tissue analysis interpretive criteria used by the former Manitoba Agriculture Provincial Testing laboratory. These levels should be used for the top one to three most mature leaves collected at the bud stage. Consult with your soil and plant tissue laboratory for guidelines when sampling at other stages of growth.

SPECIAL CONSIDERATIONS

Sunflowers have deep tap roots that can obtain water and nutrients five to six feet

(1.5 to 1.8 metres) deep in the soil.

These reserves of water and nutrients are unavailable to most other annual crops, making sunflower a good rotational crop.

Sunflowers are very susceptible to seed-placed fertilizer injury. To avoid seedling injury from fertilizer, best results are obtained by placing starter fertilizer in a band two inches (five centimetres) below and beside the seed. The remainder of the fertility should be applied in one of the following ways:

1. Broadcast incorporated prior to seeding
2. Side dressing in crop (nitrogen)
3. Fall or spring banding

TABLE D. SUNFLOWER TISSUE ANALYSIS INTERPRETATION

Nutrient	Content				
	Rating				
	Low	Marginal	Sufficient	High	Excess
Nitrogen % (N)	1.4	1.5-1.9	2.0-3.4	3.5-3.9	4.0
Phosphorous % (P)	0.14	0.15-0.24	0.25-0.49	0.5-0.79	0.8
Potassium % (K)	0.9	1.0-1.4	1.5-2.9	3.0-4.9	5.0
Sulphur % (S)	0.14	0.15-0.19	0.2-0.39	0.4-0.99	1.0
Calcium % (Ca)	0.19	0.2-0.29	0.3-1.9	2.0-2.4	2.5
Magnesium % (Mg)	0.09	0.1-0.19	0.2-1.4	1.5-1.9	2.0
Zinc ppm (Zn)	11	12-14	15-69	70-149	150
Copper ppm (Cu)	2	3-5	6-24	25-74	75
Iron ppm (Fe)	14	15-19	20-249	250-499	500
Manganeses ppm (Mn)	9	10-14	15-99	100-249	250
Boron	No provincial guidelines developed. Consult analytical companies.				

WEEDS

In sunflowers, weeds can be controlled by using pre-emergent herbicides, harrowing before or after crop emergence, inter-row cultivation when the crop is in the five to six leaf stage and post-emergent herbicides. Weeds should be removed within the first four weeks of crop growth to minimize yield losses. For information on identification, economic thresholds and weed control options, consult the *Field Scouting Guide* and *Guide to Crop Protection*.

POLLINATION

Sunflower yields benefit from honeybee pollination. Sunflowers produce a large supply of nectar for honeybees, and therefore colonies located near the field will actively forage and pollinate the crop.

HARVESTING

TIMING

Sunflowers are usually the last crop to be harvested in fall, since fall frosts help in drying down the crop. The period between maturity and harvest should be kept as short as possible to minimize losses from bird damage and head-rot diseases.

DESICCATION

Chemical desiccation is used to hasten dry-down of the sunflower heads. Desiccation is effective before a killing frost in enhancing head dry-down but should not be applied before the back of the sunflower head turns yellow and the bracts are brown and dry. At this stage the plant is said to be physiologically mature and seed moisture will be 20 to 50 per cent. Refer to the current *Guide to Crop Protection* for details on desiccation products.

COMBINING

Sunflowers can be safely combined when the seed moisture reaches about 20 per cent. Sunflowers can easily shatter if heads are very dry, and therefore combine speed must be slowed accordingly. Cylinder speeds range from 300-500 (rpm), with concave settings quite open (one inch in front and 3/4 inch in rear) to minimize seed breakage and dehulling. Using the slowest cylinder speeds with the largest openings will result in the least seed damage.

HARVESTING ATTACHMENTS

Combines that are suitable for harvesting small grain will be adequate to harvest sunflowers. A proper header attachment is necessary to reduce shattering losses and harvest efficiently.

There are two types of attachments:

1. The pan header, which is mounted on traditional straight cut header and is suitable for both row crop and solid seeding.
2. The all crop header, which is only suitable for row crop planting.

STORAGE

Sunflower seed is safe to store at a moisture content of 9 1/2 per cent or less. At 10 to 12 per cent moisture content, seed can be stored in bins with aeration. Any moisture content over 12 per cent will require drying. Oil-type sunflowers can be dried with temperatures of 71-104°C (160-220°F) but confection types may scorch or wrinkle with these temperatures. Sunflower seed should be cooled before storage, since even sunflowers at 8 1/2 per cent moisture can spoil if stored when warm.

FIELD SCOUTING

CHECK FOR POTENTIAL PROBLEMS REGULARLY

Field scouting involves walking into the field and assessing the overall health of the crop. While field scouting, look for plants showing symptoms of insects or diseases, and watch for insects or diseases that may be evident in the field. If a particular insect or disease appears to be of concern in the field, then it is necessary to do a more thorough examination of that specific insect or disease to determine the extent of the problem and whether control measures are possible and economical. Information in the following sections on insects and diseases will provide the details on how to do a more thorough examination for each of the major insect and disease problems in sunflowers, and provide advice on if and when controls are economical.

CHECK FOR BENEFICIAL ORGANISMS

In addition to looking for pests and problems when field scouting, also watch for

beneficial organisms, such as pollinators, and predators and parasites of potential pests. Pollinators can increase yield by enhancing pollination of sunflowers, and natural controls can keep some potential pests below damaging levels.

TRY TO MINIMIZE HARM TO BENEFICIAL ORGANISMS IF PESTS NEED TO BE CONTROLLED

If some pest levels are above economic threshold, and a pesticide application would be economical, consider applying the pesticide at a time and in a method that minimizes harm to the beneficial insects in the field. For example, if applying an insecticide to a sunflower field that is flowering, apply the insecticide in the evening or early morning when the bees are not foraging. If you are aware of any beehives nearby, contacting the beekeeper in advance (i.e. 48 hours) of applying insecticides will allow the beekeeper to move or protect the colonies from insecticide damage.

SCOUTING CALENDAR FOR INSECTS ON SUNFLOWERS

Stage of sunflowers	Insects to look for when monitoring	Diseases to look for when monitoring
Seedling	Cutworms, wireworms, sunflower beetles	Assess incidence of downy mildew
Vegetative stages	Sunflower beetles, thistle caterpillars, stem weevils	Look for first appearance of rust
Flowering stages	Seed weevils, banded sunflower moth, lygus bugs, honey bees	Watch for factors conducive to head blight infection (Sclerotinia) e.g. areas of saturated soil

INSECTS

DEFOLIATORS

CUTWORMS

Cutworms can be a serious problem in many field crops. There are many different species involved but two of the most common ones are the redbacked cutworm and the army cutworm.

HOST CROPS

The redbacked cutworm feeds on practically all field crops, vegetables and home garden plants. It is best known for feeding on cereals, flax, sugar beets, canola and mustard.

The army cutworm feeds on the foliage of wheat, oats, barley, mustard, flax, alfalfa, sweetclover, field peas, cabbage, sugar beets, corn, oats, potatoes, various weeds (notably stinkweed) and grasses. Almost any crop present during the early spring could be a potential host.

• Figure 1



BIOLOGY

Cutworm larvae (Figure 1) have four sets of abdominal prolegs and curl up when disturbed. Red-backed cutworms are dull-gray to brown in colour and have a pink, red or reddish-brown top-stripe that extends the entire length of the body. The top-stripe is divided by a dark line and bordered by darker bands. The head is yellowish-brown. Army cutworms are pale greenish-gray to brown in colour. They have pale stripes down the back and a mottled pattern. They also have a lighter band along the sides.

Cutworm moths may lay several hundred eggs in or on the soil. After the eggs hatch, the larvae feed on the host plants. They moult several times, eventually reaching about five centimetres (two inches) in length. The larvae tunnel into the soil to form earthen cells where they pupate. The new moths emerge, exiting through the soil using the old larval

tunnels. Some species overwinter as eggs (e.g., the red-backed cutworm); others, as larvae or pupae. Still others do not overwinter in the Prairies but rather re-invade annually from the U.S., aided by southerly winds. Most of our pest species have only one generation per year.

SCOUTING TECHNIQUES

Inspect the seedlings on at least a weekly basis, from mid-May to mid-June. Feeding by cutworms results in notched wilted, dead and cut-off plants (weed or crop seedlings). Plants may be missing from rows and bare patches may appear in fields as a result of cutworm feeding. Often cutworms will be close to the cut of shriveled plants they have just damaged and can be found by digging around these plants. Cutworms will sometimes be most abundant in patches or a specific area of a field. A garden trowel and a soil sifter are useful tools for collecting cutworm larvae. Cutworms may be found down to about five centimetres (two inches) below the soil surface. The small, worm-like

larvae curl up or attempt to hide in the debris. Pupae may also be collected in this way.

ECONOMIC THRESHOLDS

Treatment is warranted when cutworm densities exceed 10/m². Insecticides are available to control cutworms. Consult the *Guide to Crop Protection* for product information.

CONTROL TIPS

Best results occur if insecticide applications are made in the evening. Sometimes it is most economical to just treat infested patches and not entire fields.

Young cutworm larvae may be starved before spring seeding by allowing volunteer growth to reach three to five centimetres (1.2 to two inches), cultivating and then seeding 10 to 14 days later.

Many predaceous insects, parasites and birds prey upon cutworms and reduce their populations.

Overwintering eggs begin to hatch	Larval feeding begins	Larval feeding continues, pupation begins	New moths emerge, lay eggs	Eggs overwinter
May	June	July	August	September

SUNFLOWER BEETLE

Feeding by adult beetles and larvae may result in extensive damage, causing poor seed set or seed filling, reduced yields and delayed maturity.

HOST CROPS

Sunflower beetles feed on native and cultivated sunflowers.

BIOLOGY

Adult sunflower beetles (*Zygogramma exclamationis*) (Figure 1) are about six to eight-millimetres (1/4 to 3/8-inches) long. The head is reddish-brown and the shoulder is pale yellow with a reddish-brown patch at the base. Each wing-cover has

• Figure 1



three dark-brown stripes that extend the length of the back. The fourth stripe ends at the middle of the wing in a small dot that resembles an exclamation point.

Sunflower beetles overwinter as adults in the soil. Usually, their emergence from the soil in the spring coincides with the time that sunflower seedlings begin to appear in late May. The beetles feed throughout the day on the emerging seedlings. Eggs (Figure 2) hatch about a week after they are laid and the young larvae feed on the leaves at night. They hide among the bracts of the flower bud and in the axils of the leaves during the day. The larvae feed for about two weeks but, because of the long egg laying period, larvae may be present in the field for about six weeks.

The mature larvae (Figure 3) drop to the ground, enter the soil, and pupate in earthen cells. The pupal stage lasts about two

• Figure 2



weeks. Adults of the new generation emerge and feed for a short period in late August and early September. They feed on the uppermost leaves or bracts of the plant before re-entering the soil to overwinter.

SCOUTING TECHNIQUES

Noticeable damage is often first seen on plants near the margins of sunflower fields. Both the larvae and adults are easily seen and counted on seedlings and young plants. Monitor in at least two locations on each side of a field with one or two sampling sites near the centre. Twenty plants should be examined at each sampling site.

ECONOMIC THRESHOLDS

Insecticides are available to control sunflower beetle. Consult the *Guide to Crop Protection* for product information. The threshold is one to two adult beetles per seedling at the two to six leaf stage or 10 to 15 larvae per plant during the summer. Severe leaf damage may occur to plants in the two to six leaf stage when adult beetles are numerous. Control may be necessary if defoliation caused by either the adults or the larvae reaches 25 to 30 per cent, especially if more defoliation is expected. If the majority of the larvae have reached maturity at about 25 per cent defoliation, control should not be necessary.



• Figure 3

CONTROL TIPS

Natural controls usually keep sunflower beetle populations below damaging levels. Sunflower beetle eggs are eaten by the thirteen spotted lady beetle and the convergent lady beetle. Larvae of the common green lacewing consume both eggs and larvae. Damsel bugs and the two spotted stink bug may also prey on larvae of sunflower beetles. Parasitoids attack sunflower beetle eggs, larvae and adults.

Overwintering adults become active, start feeding	Adults continue feeding, lay eggs	Larval feeding on leaves	Larval feeding ends, pupation in soil begins, new adults emerge	New adults emerge and feed, enter soil to overwinter
May	June	July	August	September

THISTLE CATERPILLAR

Thistle caterpillar (*Vanessa cardui*) has been an occasional pest of sunflowers. Sporadic outbreaks in the Prairies have resulted in localized damage of sunflower crops.

HOST CROPS

Larvae (Figure 1) feed primarily on Canada thistle foliage, leaving the stem and midrib. Feeding temporarily inhibits the weeds but new growth usually develops in the fall. They also feed on about 60 other hosts, including sunflowers and canola.

BIOLOGY

Adults, commonly known as painted lady butterflies (Figure 2), migrate into the Prairies from overwintering sites in Mexico, arriving in early June. There is no evidence that they can survive our cold winters. This butterfly normally prefers to lay eggs on Canada thistle plants, but under some conditions will lay eggs on other plants as well. Larvae feed on the leaves producing a loose webbing. The larvae are up to 30-millimetres (1.25-inches) long and dark purple to black in colour. They have long spines on each segment of the abdomen.

SCOUTING TECHNIQUES

While scouting sunflowers, if populations seem heavy, sample about 100 scattered plants, noting the per cent defoliation on



• Figure 1



• Figure 2

each. Divide the total per cent defoliation by the number of plants sampled to obtain an estimate of per cent defoliation for the field.

ECONOMIC THRESHOLDS

The threshold is 25 per cent defoliation in sunflowers provided that most of the larvae are still under about three centimetres (1 1/4 inches) long. If the majority of larvae are fully grown, most of the feeding damage will have already occurred.

	Butterflies arrive and egg laying and larval feeding begins	Larval feeding continues, pupation starts	Pupation continues, new moths emerge	Populations die off
May	June	July	August	September

INSECTS

IN THE STEM

SUNFLOWER BUD MOTH

Very high populations of this pest have been reported in the past, however, the sunflower bud moth does not cause high levels of economic loss. The bud moth is detected by the presence of frass (insect excrement) around an entrance hole either in the stalk or the back of the sunflower head.

BIOLOGY

Sunflower bud moths (*Suleima helianthana*) have a wingspread of about 16 to 18 millimetres (0.63 inches). Each gray-brown forewing has two dark transverse bands. One band extends across the middle of the wing, and the second band is located near the wing tip. The larva (Figure 3) has a dark head capsule with a smooth, cream-coloured body. Two generations of sunflower bud moth are produced per year in Manitoba. Adults from overwintering pupae emerge during the last week of May to mid June. A few days after adult emergence, eggs are deposited on the terminals of immature sunflower or on the receptacle of mature sunflower. Eggs also are deposited in leaf axils.

• Figure 2

• Figure 3



• Figure 1

The hatched larvae begin tunneling into the sunflower plant. The initial infestation in mid-June is characterized by an entrance hole surrounded by black frass (insect excrement) (Figures 1 and 2). Mature larvae pupate within the sunflower plant. Pupae move to the opening of the entrance holes formed in the stem or head tissue so that adults can emerge easily.

The second generation adults appear in July and August. Infestations by the second generation larvae are not economically important.

SCOUTING TECHNIQUES

A field monitoring scheme for this insect has not been established since it is not of economic significance.

ECONOMIC THRESHOLD

None has been determined.

CONTROL TIPS

Insecticide use has not been warranted for control of sunflower bud moth.

SUNFLOWER STEM WEEVIL

There are two main stem weevil species, the Spotted Sunflower Stem Weevil (*Cylindrocopturus adspersus*) and the Black Sunflower Stem Weevil (*Apion occidentale*).

BIOLOGY

The Spotted Stem Weevil adults (Figure 2) are about four to five millimetres (0.19 inches) long and grayish-brown with varying shaped white spots on the elytron (wing covers) and thorax (area between head and abdomen). The snout, eyes and antennae are black. The larvae (Figure 1) are five to six millimetres (0.25 inches) long at maturity and creamy white with a small, brown head capsule. The larvae will normally be in a curled or C-shape position when found in sunflower stalk tissue. The spotted stem weevil adults emerge in mid- to late June and feed on the epidermal tissue of the sunflower foliage and stem. This feeding does not affect plant vigor. Mating occurs soon after emergence of adults. Just prior to egg laying, females descend to the lower portion of the plant to deposit eggs individually in the epidermal tissue of the stem. Approximately 50 per cent of oviposition occurs by mid-July. Upon hatching in early July, the first instar (larval growth stage) larvae feed on subepidermal and vascular tissue. Feeding is concentrated in the pith tissue as the larvae develop to third and fourth instars.

By the last week in August, the larvae have descended while feeding to just above the soil surface. A rudimentary chamber is constructed in the stem, and the weevils overwinter in this chamber as fifth instar



• Figure 1

larvae. Pupation of the overwintering larva occurs the following year in early June. There is one generation per year.

The Black Stem Weevil adults (Figure 3) are black and only 2.5 millimetres (0.09 inches) long from the tip of the snout to the tip of the abdomen. The snout is very narrow and protrudes forward from the head, which is small in relation to the rather large, almost globose body. The larvae are very similar in appearance to the spotted stem weevil except they are only 2.5 to three millimetres (0.09 to 0.12 inches) long at maturity and yellowish in colour.

The black stem weevil overwinters as an adult in soil, plant residue, sod and weed clusters, and begins to emerge and feed on volunteer sunflower as soon as the plants reach the early seedling stage. Adult feeding on cultivated sunflower begins at the two- to four-leaf stage. Females deposit eggs under the epidermis of the stem. Larvae emerging from these eggs tunnel in the pith area of the stem, pupate and emerge as adults in early August.

Little or no *Apion* adult activity is observed for about two weeks in late July and early August. *Apion* adults emerging in August also feed on the leaves and stems of the

• Figure 2



plant. But as the plant matures and the leaves begin to die, the adults move under the bracts of the sunflower heads where they can be observed feeding until the plants are harvested.

SCOUTING TECHNIQUES

Look for stem weevils when scouting sunflower fields in late June and very early July. Sampling sites should be 23 to 31 metres (75 to 100 feet) in from the field margins. The field should be scouted using the X pattern and examining five plants per stop for a total of 25 plants at the eight- to 14- leaf stage. The average number of weevils per plant can then be calculated.

NOTE: When surveying for stem weevils, the scout must move through the field slowly to avoid having the adult stem weevils drop to the soil and 'play dead' as they typically will do if care is not taken during survey and counting efforts. Adult feeding by both stem weevil species is considered to cause insignificant mechanical injury. However, since the *Phoma macdonaldii* *Boerma* organism has been isolated from the adults of both *A. occidentale* and *C. adspersus*, these two species are highly suspect in vectoring *Phoma* black stem disease in sunflower fields. *A. occidentale* has transmitted *P. macdonaldii* to sunflower as a result of their feeding activity under greenhouse conditions. Research is underway to determine whether or not this occurs in the field.

The only species of stem weevil larva that has been found to cause serious stalk breakage is the spotted stem weevil. When larval infestations of this species reach 25 to 30 or more per stalk, considerable weakening of stem tissue can result,



• Figure 3

especially when these larvae begin to create their overwintering cells in the base of the sunflower stalks. Breakage is most likely to occur when plants are under drought stress and/or during periods of high wind. The breakage typically occurs at or slightly above the soil surface in contrast to breakage attributed to stalk disease, which normally occurs farther up on the stalks.

ECONOMIC THRESHOLD

The economic threshold for the spotted sunflower stem weevil is one adult per three plants.

CONTROL TIPS

No insecticides are currently registered for control of sunflower stem weevils in Manitoba.

Delayed planting of sunflower until late May or early June has been effective in reducing densities of larvae in the stem. Fall tillage practices that either bury or break up sunflower stalks will help increase winter mortality of stem weevil larvae.

Natural enemies of the stem weevil include three species of larval parasitoids and one egg parasitoid. These wasps have accounted for approximately 30 per cent mortality of the stem weevils in the past.

SUNFLOWER MAGGOTS

There are three main species that all have larval feeding stages that can cause seed sterility and stalk breakage under high populations. However damage is usually negligible.

BIOLOGY

The adult forms of all three sunflower maggots (flies) have wings with a distinct brown or yellowish-brown pattern. The name 'picture-wing fly' has been given to flies of this type. While all three fly species are similar in appearance, they do have distinguishing differences.

Sunflower receptacle maggot

(*Gymnocarena diffusa*) – This species is the largest of the three with a body about 10 millimetres (0.4 inches) long and a wing span of approximately 19 millimetres

• Figure 1



(0.75 inches). The eyes of this species are bright green and the wings have a yellowish-brown and somewhat mottled appearance. Sunflower receptacle maggot larvae attain a length of nearly eight millimetres (0.31 inches) at maturity. The larvae (Figure 1) taper from the front to rear and are yellowish-white in color.

Sunflower maggot (*Strauzia longipennis*) – Adults (Figure 2) of this species have a wing spread of about 13 millimetres (0.5 inches) and a body six millimetres (0.25 inches) long. The wings bear broad dark bands that form a fairly distinct F-shaped mark near the tips. The larvae (Figure 3) of sunflower maggot are creamy white, headless and legless, as are the other two species. They taper slightly at both ends and attain a length of about seven millimetres (0.28 inches) at maturity.

Sunflower seed maggot (*Neotephritis finalis*) – This sunflower maggot is the smallest of the three species with the adult having a body length of about six millimetres (0.25 inches) and a wing span of approximately seven millimetres (0.28 inches). The wings have a brown lace-like appearance. *N. finalis* larvae attain a length of 4.5 millimetres (0.19 inches) at maturity.

Adults of the sunflower receptacle maggot emerge in late June to early July after sunflower buds reach five to 10 centimetres (two to four inches) in diameter. Eggs are laid on the bracts of the developing sunflower heads. Egg laying occurs from mid-July through August. The hatched larvae tunnel into the spongy tissue of the receptacle. Damage to the head is negligible. After 30 days, the mature larvae cut a small emergence hole on the underside of

the receptacle and drop into the soil to pupate. Overwintering pupae are found about 19 centimetres (7.5 inches) deep in the soil by August or early September. Some larvae will pupate in the sunflower head. There is only one generation per year in Manitoba.

Sunflower maggots have one generation per year. This insect overwinters as larvae in plant debris in the soil. Pupation and adult emergence are completed in early June. Females lay eggs in stem tissue of young sunflower, and larvae feed in the pith tissue for much of the growing season.

Unlike the other two species of sunflower maggots, two complete generations per year of sunflower seed maggots occurs. The first generation pupate in the head; the second generation overwinters in the soil as pupae.

SCOUTING TECHNIQUES

Scouting techniques have not been developed for sunflower maggots because they cause negligible damage.

ECONOMIC THRESHOLD

None established.

Damage by sunflower receptacle maggots and sunflower seed maggot has been negligible. The magnitude of damage to sunflower seeds by sunflower seed maggot larvae is largely dependent upon the stage of larval and seed development. Seed sterility occurs when newly hatched larvae tunnel into the corolla of young blooms. Observations indicate that a single larva feeding on young flowers will tunnel through 12 ovaries. Mature larvae feeding on older sunflower heads will destroy only one to three seeds.



• Figure 2



• Figure 3

While infestation levels of sunflower maggots have occasionally reached near 100 per cent, damage from larval feeding is usually light. Part of a commercial sunflower field next to a grassed waterway or other water source sometimes supports a higher than usual infestation. Under these conditions, high larval numbers of eight to 10 per stalk may be found and stalk breakage can occur. Stalk breakage of up to 30 per cent of the plants has been recorded.

CONTROL TIPS

Insecticide use has not been warranted for control of sunflower maggots.

INSECTS

ON THE HEADS

SUNFLOWER MIDGE

Midge larvae can affect the growth of sunflower heads. Heavily-damaged heads are gnarled and cupped inwardly, producing few seeds.

HOST CROPS

Sunflower

BIOLOGY

The tiny, tan-coloured, adult sunflower midge (*Contarinia schulzi*) is only about two-millimetres (1/8-inches) long. Eggs are laid individually or in groups in depressions between the bracts of the sunflower bud. The featureless midge larva is tiny, only about three-millimetres (1/8-inches) long when full-grown. The newly-emerged larvae move to the bases of developing seeds or bracts. They use their rasping mouthparts to feed on the plant tissues in these locations.

Mature larvae drop from the head and burrow into the soil. If conditions are favourable, they pupate and emerge the same season. Otherwise, they remain in the soil and overwinter as larvae in cocoons or, in some cases, as pupae. Usually, the larvae pupate in the spring. The adults start to emerge in late-June. The adult midge live only for two to three days and are difficult to find in the field.

SCOUTING TECHNIQUES

Although damage may be severe, it is usually sporadic and localized. Damage to heads (Figure 1) is usually restricted to field margins but, in severe infestations, damage is present throughout the field.

When monitoring sunflower heads, look for the midge larvae in the flower head; scarred bracts; and twisted or gnarled heads. The larvae may be found at the base of the bracts or feeding in the flower, at the base of the florets. A 10x magnifier helps in locating the tiny larvae.

ECONOMIC THRESHOLDS

No threshold has been established for this pest in either oil type or confection sunflowers.

CONTROL TIPS

Delayed planting (until late May) may avoid the first major emergence of the overwintering population. However, later infestations can still be severe.

Insecticides do not work well against this pest. They provide inconsistent and inadequate control of the adults and larvae. Because the larvae crawl into the bud soon after hatching, they are protected from foliar applications. Insecticides can control the sunflower midge only if they are applied to the foliage just before the adults emerge. However, because this emergence cannot be accurately predicted, insecticide applications are ineffective.



• Figure 1

Overwintering larvae pupate	Adult midges emerge, egg laying begins	Larval feeding	Larvae move into soil	Overwinter as larvae or pupae
May	June	July	August	September

SUNFLOWER SEED WEEVILS

Larval feeding reduces seed weight and oil content. Because most seeds are only partially fed upon, it is difficult to separate healthy from weevil-damaged seed. This causes downgrading of confectionary sunflower seed.

HOST CROPS

Sunflowers

BIOLOGY

The red sunflower seed weevil (*Smicronyx fulvus*) is the most common of the two species that can occur in the Prairies. The adults (Figure 1) are 2.5 to three millimetres (1/10 to 1/8 inches) long and are covered with reddish-orange, oval scales. The larvae occur in the upper third portion of developing sunflower seeds.

• Figure 1



The adults appear during late June on volunteer sunflowers and feed on the bracts where they form pinpoint holes. As the bud develops and opens, adults move to the inflorescence and feed on pollen produced by the disk flowers. Females lay their eggs inside the seed coat of developing seeds. Populations are highest on plants at 50 per cent anthesis. The egg laying pattern follows seed filling which progresses from the outside to the centre of the head. Usually, an infested seed contains a single larva. The larvae are small, cream-coloured, legless and C-shaped in appearance.

In late August, the mature larva chews an exit hole in the seed, (Figure 2) drops to the ground directly beneath the sunflower head, and overwinters in the soil. Pupation occurs in the soil during early June through early July.

The gray sunflower seed weevil (*Smicronyx sordidus*) is not as common and is slightly larger (3 to 3.5 millimetres or 1/8 inches long) than the red seed weevil larvae. Seeds infested by the larvae enlarge, protruding above the surrounding seeds, and lack a kernel. The damage caused by a single larva of this species exceeds that of the red seed weevil because of the loss of the entire kernel. However, it usually does not cause economic damage to sunflower used for oil because of its low population level and low reproductive rate.

SCOUTING TECHNIQUES

Begin scouting for seed weevils as soon as the yellow ray petals are beginning to show. Counts should continue until the economic threshold level has been reached or most plants have reached 70 per cent pollen shed at which time very few seeds are suitable for egg laying.

When sampling, follow an X or Z pattern in the field. Begin counting at least 30 metres (100 feet) into the field to avoid field margin effects. Counts taken along the field margin will lead to abnormally high weevil counts that will not be representative of the field. Count the number of weevils on five plants at each site for a total of 25 plants.

For accurate checking of individual sunflower heads, brush the face of the heads vigorously in order to bring the weevils to the surface or spray mosquito repellent on the head. This will force the weevils to move out of their hiding spots.

Care should be taken while looking for seed weevils not to confuse other insects which may be present on sunflower heads, such as minute pirate bugs (Figure 1), for seed weevils.

ECONOMIC THRESHOLDS

Insecticides are available to control sunflower seed weevils. Consult the *Guide to Crop Protection* for product information. In sunflower grown for oil, the threshold is 10 to 12 weevils per plant. In sunflower grown for confection, the threshold is one to two weevils per plant.

CONTROL TIPS

Insecticides, sometimes in combination with trap-cropping, remain the major management tool to reduce damage in a year when populations are high. Determine the



• Figure 2

sunflower plant growth stage before applying an insecticide. The weevil does not begin to lay its eggs on sunflower heads before heads reach 40 per cent bloom (the outer 40 per cent of the florets have opened).

If treatment is necessary, insecticides should be applied before three out of 10 plants reach 40 per cent bloom. Remember that 40 per cent of the plants in the field are blooming. To minimize harm to bees, insecticide applications should be done in the late evening or early morning. Check fields in two to three days to determine control levels.

Early planting helps to reduce seed damage because early planted sunflowers complete anthesis and are no longer susceptible to egg laying at the time of peak weevil populations. Fall or spring discing can reduce adult emergence.

Natural enemies of larvae in the seed include several species of parasitic wasps and flies and a fungus found in the soil.

Larvae over-winter in soil	Larvae pupate, new adults feed on volunteer sunflowers	Females lay eggs in developing seeds, eggs hatch	Larval feeding, larvae move into soil	Larvae overwinter in soil
May	June	July	August	September

BANDED SUNFLOWER MOTH

Larvae feed on sunflower florets and seeds.

HOST CROPS

Commercial sunflowers. Several species of wild sunflowers are also known hosts of banded sunflower moth.

BIOLOGY

The banded sunflower moth (*Cochylis hospes*) is a small, straw-colored moth about seven millimetres (0.3 inches) long (Figure 1). It has a brown triangular area in the middle portion of the front wings. Newly hatched larvae are off-white with a dark-brown head capsule and about 1.5 millimetres (0.06 inches) long. As the larvae grow, there is a gradual colour change to light pink or yellow, then to reddish or purplish and finally to green at maturity

• Figure 1



(Figure 2). Full-grown larvae are about 10 millimetres (0.4 inches) long.

The adult moths are present from about mid-July to mid-August. Moths fly from last year's sunflower fields to the current year's sunflower fields. Although some moths are in the sunflower field during the day, many rest in vegetation along field margins. At twilight, females move into the field to lay eggs. They lay eggs on the bracts of sunflower heads. Eggs hatch in five to eight days. Larvae can be present in sunflower heads from about mid-July to mid-September. Mature larvae drop to the ground and spin cocoons in the soil where winter is passed. Pupation takes place in late June or early July the following year.

Newly hatched larvae move from the bracts to the florets of the sunflower head, where they enter open florets to feed. If eggs hatch prior to the opening of the florets, larvae will feed on bract tissue before moving to the florets. Larvae continue to feed in the florets until the third instar, reducing the total number of mature seeds produced. During later stages of development, the larvae tunnel through developing seeds, usually entering at the top and leaving after the contents are eaten. Each larva may destroy six to seven mature seeds in addition to the florets eaten by the earlier instar larvae. Since the seed kernel is entirely consumed by the larva, the seed will normally pass through the combine.

The greatest damage by banded sunflower moth larvae occurs at the edge of the field.



• Figure 2

SCOUTING TECHNIQUES

Fields should be monitored when plants are in the late bud (R-4) to early bloom stage (R-5.1) of development.

Monitor for adult moths in early evening or early morning when the moths are most active. Sampling sites should be at least 75 to 100 feet (23 to 30 metres) from the field margin. Count moths on 20 plants from five different sites for a total of 100 plants.

A sampling strategy based on scouting for adult moths during daylight hours has also been developed.

ECONOMIC THRESHOLD

If monitoring in the early evening or early morning, one banded sunflower moth per two plants is a reasonable economic threshold.

If monitoring for adult moths during daylight hours, tables for determining economic threshold can be found at: <http://www.ext.nodak.edu/extpubs/plantsci/pests/e823w.htm>

If treatment is warranted, it should be applied at the R5.1 sunflower plant growth stage. Insecticides should be applied early in the morning or late in the day to minimize the adverse effect on bees and other pollinators.

CONTROL TIPS

Parasitic wasps attack both the eggs and larvae and general predators in the sunflower field also consume both larvae and eggs. Minute pirate bugs feed on the eggs and young larvae. Ground beetles can destroy about 40 per cent of overwintering larvae and pupae. At least four different species of parasites attack the larvae of the banded sunflower moth.

LYGUS BUG

Feeding by lygus bugs on developing sunflower seeds can cause small brown to black spots on the seeds, known as kernel brown spot. Typically a kernel will have only one spot, on the blunt or distal end.

HOST CROPS

Lygus bugs have been recorded from over 385 crop plants and weeds.

BIOLOGY

Adult lygus bugs (Figure 1) are about five millimetres (0.2 inches) long and 2.5 millimetres (0.1 inches) wide. They vary in colour from pale green to reddish-brown and have a distinct triangle or "V" mark about one-third of the distance down the back, just in front of the wings. First-stage nymphs are very small, wingless and bright green. Young nymphs (Figure 2) may look similar to aphids but are much more mobile.

Lygus bugs feed on plants by injecting plant tissue with digestive enzymes, and then extracting nutrients with their needle-like mouthparts. Lygus bugs feeding on developing sunflower seeds can cause scarring on the seeds, known as kernel brown spot. While brown spot is not known to affect yield, this quality issue can be significant in confection sunflowers because processors are allowed only 0.5 per cent damage in the finished product. Lygus bug feeding can also result in a bitter taste to the seeds. While brown spot is visible on dehulled kernels, there is usually no sign on the exterior of the hull that the kernel has brown spot.

Lygus bugs are mobile and can be found on many crops. Lygus bugs probably move



• Figure 1

to sunflowers from alfalfa or canola when those crops have either been harvested or senesced.

SCOUTING TECHNIQUES

Scout for adults or nymphs on the sunflower heads or foliage.

ECONOMIC THRESHOLDS

Lygus bugs are capable of damaging 30 to 35 seeds per head per adult. With the industry standard allowing for a maximum of 0.5 per cent kernel brown spot, the economic threshold for lygus bugs on sunflowers is likely about one lygus bug per nine heads.

In research trials, damage to sunflower heads was approximately twice as severe when infestations occurred at late bud and early bloom compared to stages when heads had completed flowering. Thus, lygus bug management should be initiated prior to or at the beginning of the bloom stage if adult densities approach the economic threshold. Also, fields should be monitored for lygus bugs until flowering is completed to reduce incidence of kernel brown spot damage to confection sunflowers.


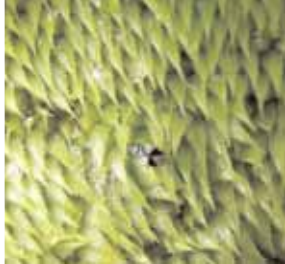





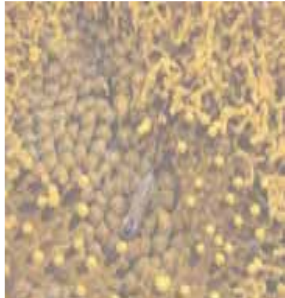
• Figure 2



INSECTS

BENEFICIAL

BENEFICIAL INSECTS OFTEN FOUND IN SUNFLOWER FIELDS

 <p>Minute Pirate Bug (Nymph) Do not confuse with adult sunflower seed weevils</p>	 <p>Minute Pirate Bug (Adult)</p>	 <p>Green Lacewing</p>
 <p>Lady beetle (larva)</p>	 <p>Lady beetle (Adult)</p>	 <p>Damsel Bug</p>
 <p>Hover Fly</p>	 <p>Honey Bee Honey bees and wild bees increase yield in sunflowers by enhancing pollination</p>	 <p>Parasitic Wasps The wasp in this picture is <i>Glypta prognatha</i>, a parasite of banded sunflower moth larvae</p>

DISEASES

DOWNY MILDEW

Downy mildew can cause severe yield losses during wet years, especially in poorly-drained fields.

HOST CROPS

Sunflower

BIOLOGY

The fungus is soil-borne, wind-borne and seed-borne. The fungus may persist in the soil for five to 10 years. Under cool, water-saturated soil conditions, the spores, upon contact with sunflower roots, germinate and enter the seedling's roots and spread throughout the entire plant. When infected plants rot and are tilled into the soil, the fungus forms the resting stage. It will germinate again when conditions are favourable.

• *Figure 1*

If seedlings are infected several weeks after emergence, they exhibit the typical leaf symptoms of downy mildew (Figure 2) but do not exhibit the stunting that is usually associated with the disease. Plants infected after the four-leaf stage may develop a thickened, club-like root, become stunted, and show foliar symptoms (Figure 1). These plants are prone to drought stress and lodging. Mature plants are often stunted, producing normal sized heads with few if any seeds. Secondary spread of spores (ie., by wind) may result in the development of small, localized, angular chlorotic spots on the leaves. These spots may coalesce and resemble a systemic infection. However, the foliar lesions rarely produce a true systemic infection.

SYMPTOMS OF DAMAGE

Symptoms can be seen at all growth stages. Seedlings appear dwarfed and

chlorotic (yellowed) and may have thickened, leathery leaves (Figure 1 and Figure 2). In high humidity, the undersides of leaves may be covered with white, cottony growth.

Yield losses from downy mildew can be substantial depending on the percentage of infected plants and their distribution within the field. If infected plants are scattered randomly throughout a field, yield losses probably will not be observed until infection exceeds 15 per cent due to the compensating ability of healthy plants adjacent to infected plants. When the disease is in a localized area, such as a low spot in a field and all plants are infected, the yield loss will be much greater.

SCOUTING TECHNIQUES

Diseased plants are most often noticed alone or in standing water. Severely infected plants may die before or shortly after emergence or in the seedling stage. The few plants reaching maturity seldom produce viable seed. The heads on these plants usually face straight up, making them more vulnerable to bird feeding.

Note: Dwarfing and distortion of leaves also are symptoms typical of herbicide drift damage, especially 2,4-D and related phenoxy compounds. However, herbicide damage never exhibits the white appearance (fungal growth) on the underside of the leaves nor the chlorosis typical of downy mildew.

ECONOMIC THRESHOLDS

None available.



• *Figure 2*

CONTROL TIPS

Use resistant varieties. Many commercial hybrids are resistant to several but not all races of downy mildew. Use an extended crop rotation of four years between sunflower crops.

Do not seed sunflower in lowlands that flood frequently and maintain high inoculum levels from alternate hosts.

Control volunteer sunflower. Delay planting until soil temperatures favour rapid seedling growth.

Use a fungicide seed treatment to protect against root infection. The seed treatment does not protect against foliar infection.



PHOMA

Infected sunflowers are weakened, produce smaller heads and are susceptible to lodging.

HOST CROPS

Sunflowers

BIOLOGY

This soil-borne fungus overwinters in infected debris and is spread by splashing rain and by insects. Adult stem weevils feeding on the leaves cause leaf lesions and continue to spread the fungus as they tunnel through the stem. Disease transmission through contaminated seed is minor. Yield losses are variable, but in conjunction with stem weevil infestation, can become quite significant.

SYMPTOMS OF DAMAGE

Phoma black stem is characterized by large, jet-black lesions on the stem, up to five centimetres (two inches) in length (Figure 1). The fungus also produces lesions on the leaves, on the back of the head, at the crown or base of the stalk, and occasionally on the leaf petioles.

Lesions usually originate at the base of the leaf petiole and spread to form spots with more or less definite margins. Under favourable conditions, the leaves wilt, petioles turn black, and the stem lesions expand to form a large, shiny, black patch. Small circular fruiting bodies of the fungus, produced on the surface of the stem, are visible with a hand lens.



• Figure 1

SCOUTING TECHNIQUES

Phoma infections occur throughout the growing season but they are usually more pronounced after flowering and noticed when the stem lesions become obvious later in the summer.

ECONOMIC THRESHOLDS

None available.

CONTROL TIPS

Failure to rotate fields amplifies problems with phoma (and other diseases). A four-year rotation to other crops will minimize the concentration of phoma within the soil.

Although some hybrids may be more tolerant than others, none are resistant.

Controlling high populations of stem weevils may help to reduce disease transmission.

RUSTS

Early infection of susceptible varieties can cause serious reduction in seed yield and oil content. Later infections cause less damage. Late planted fields of susceptible hybrids are generally more severely damaged by rust than earlier planted fields.

HOST CROPS

Sunflower, wild sunflower

BIOLOGY

Sunflower rust spores overwinter on the debris from infected sunflower leaves and stems. In the spring, the spores germinate to infect volunteer seedlings, wild sunflower or new young plants in nearby fields.

Spore production and infection occur continuously. This “repeating stage” is the most

• Figure 2



damaging with spores being spread by wind to other fields. As the crop ripens, the spores form the overwintering stage which can re-infect next year's crop.

Rust multiplies rapidly during warm, moist weather. High nitrogen levels and abnormally high seeding rates promote excessive foliage. This, in turn, increases the humidity within the canopy and favours rust development.

SYMPTOMS OF DAMAGE

Early symptoms on volunteers and seedlings appear as small orange-brown spots on the upper surfaces of leaves, followed by spots appearing on the lower surfaces of leaves (Figure 2). A heavy infection can cause the entire leaf to die. Rust spots may also be found on the stems, petioles, bracts and back of the head (Figure 1). In July and August, rust appears

as dark-brown, dusty pustules on surface of leaves, leaf petioles and the back of heads. This is the most damaging stage of rust infection during the season. The black pustules of over wintering spores will be found on all plant parts towards the end of the season.

SCOUTING TECHNIQUES

Look for dense masses of brown, powdery pustules that are scattered on all of the green parts of the plant, especially the leaves. Heavily-rusted leaves appear withered.

ECONOMIC THRESHOLDS

None available.

CONTROL TIPS

Grow rust resistant varieties. Most oilseed and confectionary hybrids have good to excellent resistance to most races of rust.

Rotate to other crops. Destroy wild sunflowers or volunteer sunflowers. Early seeding may minimize the disease.



• Figure 2

SCLEROTINIA

Sclerotinia wilt and head rot are the most important diseases affecting sunflowers.

HOST CROPS

Sunflowers, canola, mustard, dry beans, field peas, lentils, potatoes

BIOLOGY

Sclerotinia survives in the soil for up to four years as irregularly-shaped fungal bodies called sclerotia. The sclerotia germinate in the summer, producing mycelia that infect sunflower roots causing wilt or mushroom-like structures that release wind-borne spores that infect the head causing head rot. The disease is favoured by extended periods of rain, several weeks prior to and during flowering.

The symptoms of sclerotinia wilt usually appear during flowering.

The diseased plants may occur singly or in patches. The upper leaves droop, dry out and die. The entire plant dies quickly. Young wilted plants often turn black whereas mature plants usually remain light brown. Small irregularly-shaped bodies can be found inside the stem near the soil line. Surviving plants may or may not produce seed, depending on when the infection occurs. The heads on wilted plants generally are smaller than those on healthy plants and seed weights are lower.

Head rot (Figure 3) is caused by wind-borne spores of the same fungus. It usually occurs late in the season, after initial flowering and extended periods of wet weather. Dead petals, on the backs of the heads, provide a place for the spores



• Figure 1



• Figure 2

to germinate. The affected heads decay, become soft, and black sclerotia form within the heads.

Head rot also causes a decrease in oil content and an increase in free fatty acid content. The sclerotia that form in diseased stalks and heads are returned to the soil at harvest and can cause sclerotinia diseases in sunflower or other susceptible crops in following years.

SYMPTOMS OF DAMAGE

In general, the symptoms of damage include drooping, brown or dead upper leaves; plants that turn brown or black and die prematurely (Figure 1); fungal bodies (sclerotia) in the stem at the soil line (Figure 2); soft, rotting heads (Figure 3) with only fibrous tissue remaining; and black sclerotia in the heads. The characteristic symptoms of sclerotinia wilt include sudden wilting of leaves, root rot, and a basal stem canker. The first wilted plants are usually seen just before flowering but most appear in patches during and after flowering. The time required from incipient wilt to complete wilting may be four to seven days.

The first symptoms of head rot usually are the appearance of water-soaked spots or bleached areas on receptacles (the fleshy back of the head). The fungus can decay the entire receptacle and the seed layer falls away leaving only a bleached, shredded skeleton interspersed with large sclerotia.

SCOUTING TECHNIQUES

With sclerotinia wilt, young wilted plants often turn black. Mature plants usually remain light brown. Small, irregularly-shaped, sclerotia can be found inside the stem, near the soil line.

The bleached, skeletonized heads associated with head rot are very obvious in the field, even from a distance. Infected heads usually shatter during combining and any remaining seeds are lost. Usually, the seeds are not decayed but many are empty. The large sclerotia in the heads may be 12 millimetres (1/2 inch) or greater in diameter and many are harvested along with the seed. Large sclerotia mixed in with seed confirms that a field contained head rot.



• Figure 3

ECONOMIC THRESHOLDS

Fungicides are not effective in controlling sclerotinia rot. Wilt occurs whenever sunflower is planted on sclerotinia-infested soil and can cause severe yield loss. On average, infected plants yield less than 50 per cent of healthy plants. Sclerotinia wilt also leads to increased levels of sclerotia in the soil which, in turn, can result in the removal of fields from sunflower production for many years.

CONTROL TIPS

The key to managing these diseases is to plant in non-infested soil and prevent the buildup of sclerotia in soil.

Monitor fields for sclerotinia diseases and rotate crops. Follow a crop rotation of four years between susceptible crops.

To minimize head rot, plant to maximize air circulation. Locate new plantings as far away as possible from fields where sclerotinia was known to be a problem in the previous four years. Although no resistant hybrids are available, progress is being made in reducing the susceptibility of sunflower to sclerotinia.

VERTICILLIUM WILT

Verticillium wilt can reduce sunflower yields on lighter soils by up to 50 per cent.

HOST CROPS

Sunflowers, potatoes, alfalfa, sweet clover

BIOLOGY

The fungus is seed- and soil-borne. It survives as very small, black, resting bodies (Microsclerotia) in diseased sunflower debris and broadleaved weeds. The root

• Figure 1



tips of sunflower plants are invaded and, eventually, all parts of the plant become affected. When the plant dies, the fungus produces the black fungal bodies that return to the soil with the plant debris. The fungus is able to survive in the soil for several years.

SYMPTOMS OF DAMAGE

The symptoms may appear early in the season but are most common near the time of flowering. Diseased plants usually occur in groups of a few to many plants. Symptoms develop first on the lower leaves and gradually appear on leaves farther up the stem. The leaf tissue between the veins yellows and becomes necrotic, while the areas near the veins remain green (Figure 1). This produces a mottling effect.

Cross-sections of the stem reveal a brown discoloration of the vascular tissue (visible as a brown ring). Severely-diseased plants die early, before seed development. They exhibit brown, withered leaves and black streaks at the base of the stem. Masses of tiny, black, fruiting bodies are produced inside the stalk. With light infestations, the diseased plants also die prematurely but the leaves may only be yellow and not exhibit the typical mottling.



GROWING **Opportunities**