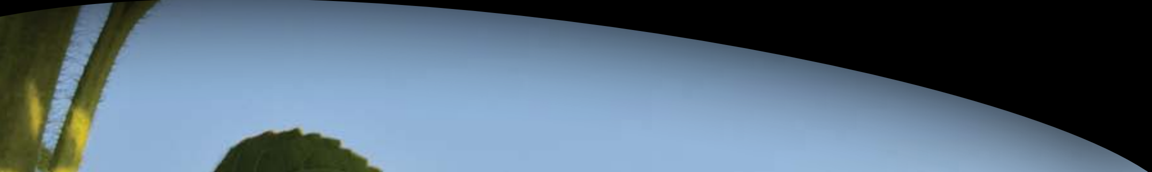
The **Sunflower** Production Guide



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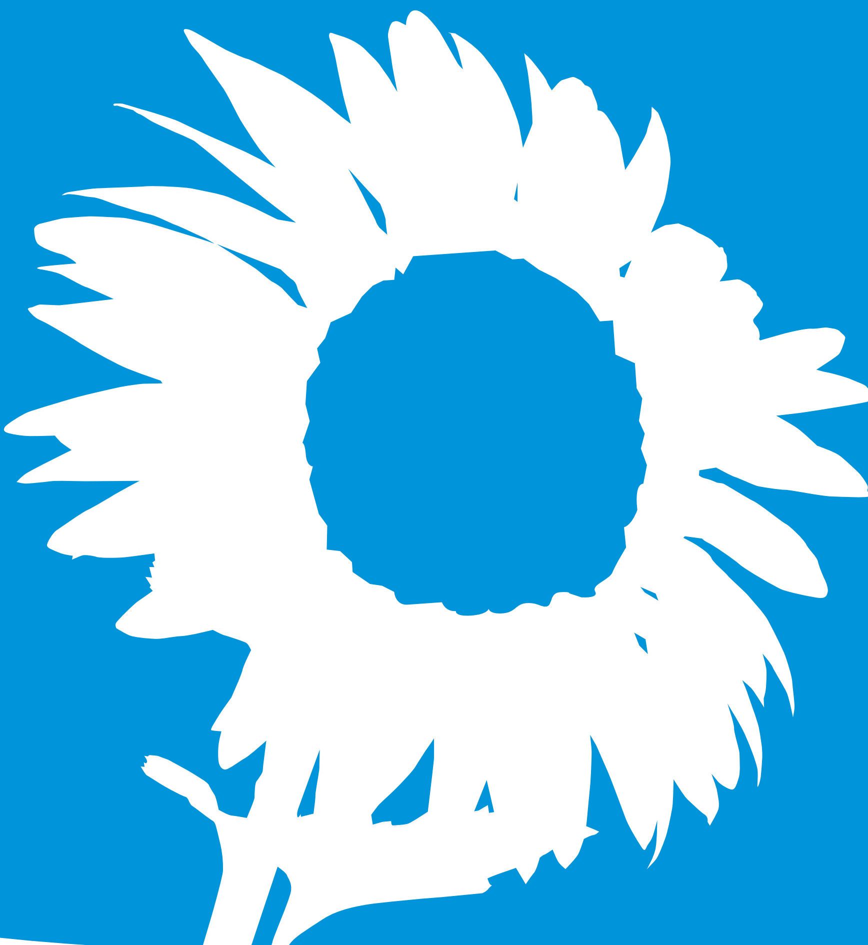


SUNFLOWER INDUSTRY PROFILE

The National Sunflower Association of Canada (NSAC), Inc. was initiated at a meeting in Carman, MB on November 18, 1996. The meeting was organized to address the closure of the sunflower oil crushing plant in Altona, MB in 1995 causing sunflower acreage to drop from a high of more than 300,000 acres during the 1980's to 63,000 acres in 1995. The acreage also shifted to confection types, promoted by processors located throughout Manitoba's Red River Valley and southern Alberta.

The association's mission statement is "to insure the profitability and long term growth of the sunflower crop through industry wide leadership". Membership includes producers, oil and confection type buyers, exporters and processors, pesticide manufacturers and dealers within the seed industry. Since the establishment of the NSAC in 1996, sunflower acreage has climbed to 180,000 acres in 2008. In 2011 the association had approximately 650 members from Manitoba, Saskatchewan, and Alberta.

Approximately 90 percent of all sunflowers grown in Canada are located in Manitoba, but a growing share is finding its way into southeastern Saskatchewan, southern Alberta and southern Ontario. Of all Canadian sunflowers, 65 percent are confection types 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 increasingly accessing markets in Europe, the Middle East and Asia. Oilseed sunflowers are used in both the birdfood and the crushing industry for sunflower oil producing one of the highest quality vegetable oils. Although the birdfood market is mostly the oilseed type, some of the smaller confection seeds are also used for birdseed.

INTRODUCTION

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. The average development of a large number of plants should be considered when determining the growth stage of a sunflower field. Later in the season, for stages R-7 through R-9, use healthy, disease-free heads to determine plant development since some diseases can cause head discoloration. A number or recently released and grown hybrids contain the stay-green characteristic. If this characteristic is present, yellowing or browning of the bracts may not be an accurate indicator of plant maturity. Maturity is typically reached within 2200-2300 growing degree days (Celsius) after planting or 120-150 days.

Table 1. Sunflower growth stages and description

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 (e.g. V-1, V-2, V-3 etc.)	These are determined by counting the number of true leaves at least 4 cm in length beginning as V-1, V-2, V-3, V-4, etc. If senescence of the lower leaves has occurred, count leaf scars (excluding those where the cotyledons were attached) to determine the proper stage.
R-1 Reproductive Stages	The terminal bud forms a miniature floral head rather than a cluster of leaves. When viewed from directly above, the immature bracts have 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 cm above the nearest leaf.
R4	The inflorescence begins to open. When viewed from directly above, immature ray flowers are visible.
R5 (decimal) (e.g., R-5.1, R-5.2, R-5.3, etc.)	This stage is the beginning of flowering. The stage can be divided into sub-stages dependent upon the percent of the head area (disk flowers) that have completed or are in flowering. Ex. R-5.3 (30%), R-5.8 (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.
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 Schneiter, A.A., and J.F. Miller. 1981. Description of Sunflower Growth Stages. Crop Sci. 21:901-903

Figure 1. Stages of sunflower development. (A.A. Schneiter and J.F. Miller)

A-1145

Stages of Sunflower Development

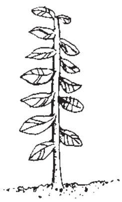
A.A. Schneiter, Professor
J.F. Miller, USDA-ARS
D.R. Berglund, Extension Agronomist

Vegetative Stages

True leaf — 4 cm

V-E

V-2



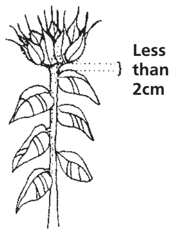
V-12

V-4

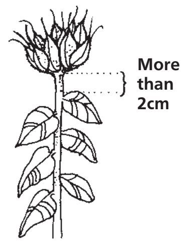
Reproductive Stages

R-1

R-2



R-2



R-3

R-3

R-3 Top View

R-4 Top View

R-5.1

R-5.5

R-5.9

R-6

R-7

R-8

R-9

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FIELD SELECTION

Soils

Sunflowers grow best on well drained, high water-holding capacity soils with a nearly neutral pH (pH 6.5-7.5). The optimum soil classifications for sunflowers are loam, silty loam and silty clay loam soils. Sunflower production performance on reduced agricultural capacity soils such as those affected by salinity, drought potential or wetness, is not ideal, but compares with of other commonly grown commercial crops.

Crop rotation

Having a proper crop rotational sequence is important with all crops, including sunflowers. Extended crop rotations help reduce disease inoculum loads in the soil, allow for herbicide rotation, manage overwintering insect populations, weeds, water usage and fertility management.

Growers who do not have adequate crop rotation, will likely be confronted with one or more of the following yield-reducing problems:

1. Disease and disease-infested fields (e.g. increased sclerotinia)
2. Increased insect risk
3. Increased populations of certain weed species
4. Increased populations of volunteer sunflowers
5. Soil moisture depletion
6. Allelopathy or phytotoxicity of the sunflower residue to the sunflower crop

FERTILIZER

General

Germinating sunflower seeds are very sensitive to seed-placed fertilizer. Starter applications should be placed away from the seed. When sunflowers are seeded with row equipment, all phosphate and potassium should be side banded 2" beside and 2" below the seed during planting. Some or all of the nitrogen can also be sidebanded. The total amount of fertilizer material sidebanded should not exceed 300 lb/ac.

Nitrogen applications can be made pre-plant, at seeding, post-seeding, side-dress or a combination of these methods. Application should be timed so nitrogen is available for rapid plant growth and development. Often, it is logistically advantageous to apply nitrogen in the fall. However, the longer the time period between application and plant use, the greater the possibility for N loss. Fall application is not recommended in sandy soils since the opportunity for leaching is much greater. A side-dress application of N when the sunflower plants are about 12 inches high is often preferable.

Phosphate and potash may be fall or spring applied before a tillage operation. These nutrients are not readily lost from the soil since they attach to the soil forming only slightly soluble compounds. Phosphorus can be applied preplant-broadcast, preplant banded, or banded at seeding. Band applied applications are most efficient, especially when only small amounts are applied in fields low in available phosphorus. Potassium deficiencies normally only occur in sandy soils. Potassium that is band placed is about twice as efficient as broadcast applications.

Table 2. Nutrient uptake and removal by sunflower in Manitoba studies.

Nutrient	Uptake	Removal	Uptake	Removal
	lb nutrient for a 2000 lb crop		lb nutrient per cwt	
Nitrogen (N)	74-122	48-66	3.7-6.1	2.4-3.3
Phosphorus (P_2O_5)	24-56	18-26	1.2 – 2.8	0.9 – 1.3
Potassium (K_2O)	150-172	18-26	7.5 – 8.6	0.9-1.3
Sulphur (S)	8-12	3-4	0.39 – 0.58	0.17-0.22
Calcium (Ca)	54-94	3-4	2.7-4.7	0.15-0.23
Magnesium (Mg)	37-39	6-7	1.86-1.93	0.30-0.36

Fertilizer applications should be made based on a soil test. Recommendations based on soil testing were developed by Manitoba Agriculture, Food and Rural Initiatives (MAFRI) and are listed in Tables 3 and 4 . Recommendations are based on a 0-24" sample for nitrate-nitrogen and sulphate-sulphur. Phosphorus and potassium are based on a 0-6" sample.

Table 3. Nitrogen recommendations for sunflower (based on spring band application).

		TARGET YIELD (lb)			
Fall Soil NO_3-N		1750	2,000	2,250	2,500
lb/ac in 0-24"	**Rating**	**Nitrogen Recommendations (lb/ac)**			
20	VL	40	85	125	170
30	L	20	60	105	145
40	M	0	35	80	120
50	M	0	10	55	100
60	H	0	0	30	75
70	H	0	0	5	50
80	VH	0	0	0	25
90	VH	0	0	0	0
100	VH+	0	0	0	0

Table 4. Phosphorus, potassium and sulphur recommendations for sunflower based on soil test levels and placement.

PHOSPHORUS				POTASSIUM					SULPHUR		
Soil Phosphorus (0-6")			Fertilizer Phosphate (P_2O_5) Recommended (lb/ac)	Soil Potassium (0-6")			Fertilizer Potash (K_2O) Recommended (lb/ac)		Soil sulphate-Sulphur (0-24")		Fertilizer Sulphur (S) Recommended (lb/ac)
ppm	lb/ac	Rating	Sb_2	ppm	lb/ac	Rating	Sb_2	PPI_3	lb/ac	Rating	N/A^3
0	0	VL	40	1	0	VL	30	60	0	VL	20
	5	VL	40	25	50	VL	30	60	5	VL	20
5	10	L	40	50	100	VL	15	30	10	VL	20
	15	L	35	75	150	L	15	30	15	L	20
10	20	M	30	100	200	L	0	0	20	L	20
	25	M	20	125	250	M	0	0	25	M	20
15	30	H	15	150	300	M	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

Sb^2 = Side Banded

PPI^3= broadcast and pre-plant incorporated

N/A^3= placement does not influence effectiveness of sulphate forms of sulphur fertilizer

Adapted from the Manitoba Agriculture Food and Rural Initiatives.

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 (Table 5). These levels should be used for the top one to three most mature leaves at the bud stage. However, if a deficiency is detected at this stage, yield potential has already been affected. This sampling method is best used as an auditing tool to determine if your fertility program is sufficient for the yield potential. If a nutrient deficiency is observed earlier, sample plants and soil from the affected area and contrast results with plant and soil samples from an adjacent, normal looking area. This is considered diagnostic sampling and could be used to correct some in-season deficiencies. Consult with your soil and plant tissue laboratory for guidelines when sampling at other growth stages.

Table 5. Sunflower tissue analysis interpretation

	CONTENT				
Nutrient	**Low**	**Marginal**	**Sufficient**	**High**	**Excess**
Nitrogen % N	1.4	1.5-1.9	2.0-3.4	3.5-3.9	4.0
Phosphorus %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
Manganese ppm (Mn)	9	10-14	15-99	100-249	350
Boron	No provincial guidelines developed. Consult analytical companies				

Special Fertility Considerations

Sunflowers have deep tap roots that can obtain water and nutrients five to six feet (1.5 to 1.8 meters) deep in the soil. These reserves of water and nutrients are unavailable to most other annual crops, making sunflower a good rotational crop. Sunflowers have the ability to scavenge nitrogen that has leached below the rooting depth of other crops.

SEEDING

Planting dates

Sunflower seeding should usually begin anytime after May 1 and ideally be completed by June 1. Seedlings are relatively frost tolerant up to the four-leaf stage. Choose earlier maturing hybrids or oil type hybrids if planting is delayed into the first week of June or for replanting. Oil type hybrids are shorter maturing than confection varieties. Planting date can also affect susceptibility to pests. Consult the following chapters as to when to plant to avoid damage by the most prevalent pest in your area.

Plant Populations and Row Spacing

Seeding rate for sunflowers depends on sunflower type. Oil seed varieties are generally planted at higher populations than confectionary varieties. Oil-type sunflower populations range from 20,000 to 22,000 plants/acre (0.6 plants/ft^2).

Plant Populations and Row Spacing (Continued)

Confection type sunflowers should not exceed 18,000 plants/acre (0.4 plants/ ft^2) to ensure large seed size. Seeding rates for both oil and confection-type sunflowers should be adjusted when germination is low. Refer to tables 6 and 7 for information on plant density and row spacing as well as seed size and weight.

No yield differences have been detected between sunflowers seeded in rows versus solid seeded when adequate weed control exists. Fields with a row spacing less than 20 inches are considered to be solid seeded. Recommended row spacing for solid seeding is 10 to 12 inches (25.4 to 30.5 centimeters) for both confection and oil-type sunflowers. Plant populations should remain the same as stated above regardless of row spacing. Equidistant placement of seeds within the row allows for maximum utilization of resources (e.g. water, nutrients, sunlight) and often results in consistent head size. Sunflower plants compensate for differences in plant populations by adjusting head and seed size. As plant populations increase, head and seed size decrease and vice versa.

Depth

Sunflowers need to be placed in moisture but not deeper than three inches (7.6 cm). The ideal seeding depth is 1 ½ to 2 inches (3.8 to 5 cm) deep. Planting equipment should firm the soil over the seed row to maintain a moist seed bed and ensure good seed to soil contact.

Table 6. Seed spacing required for various populations, assuming 90 percent germination and 10 percent stand loss

	ROW SPACING (inches)					
Plants/acre	**12**	**16**	**18**	**22**	**30**	**36**
--------- Seed spacing within row (inches) ---------						
14,000	30.2	22.6	20.2	16.5	12.1	10.1
16,000	26.5	19.8	17.6	14.4	10.6	8.8
17,000	24.9	18.6	16.6	13.6	10.0	8.3
18,000	23.5	17.6	15.7	12.8	9.4	7.8
19,000	22.3	16.7	14.9	12.2	8.9	7.4
20,000	21.2	15.9	14.1	11.5	8.5	7.1
21,000	20.2	15.1	13.4	11.0	8.1	6.7
22,000	19.2	14.4	12.8	10.5	7.7	6.4
23,000	18.4	13.8	12.3	10.0	7.4	6.1

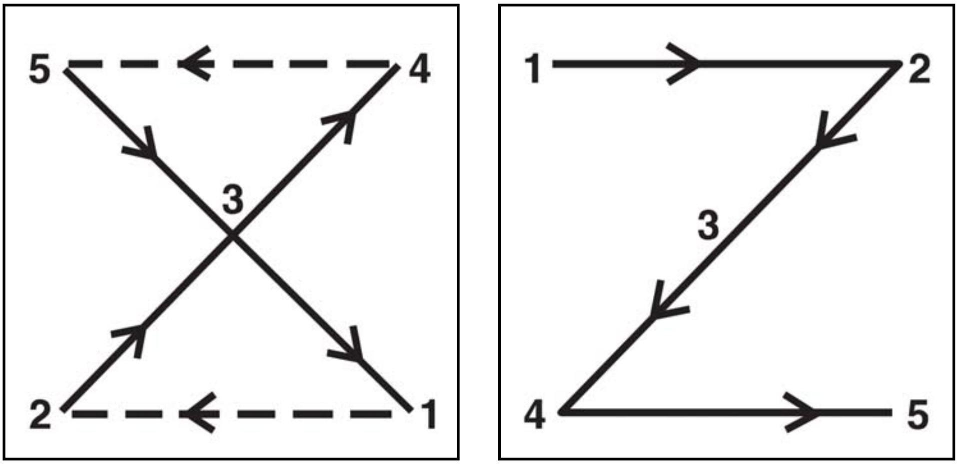
Table 7. Sunflower seed size and associated seed weight

OIL-TYPE SUNFLOWER		CONFECTION SUNFLOWER	
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

FIELD SCOUTING

Sunflower are a host to a number of pests. Fields should be monitored regularly for potential problems, to determine pest species present and if populations are at economic threshold levels. Field scouting involves walking into the field and assessing the overall health of the crop. Sunflower pests tend not to be distributed evenly throughout a field, so fields should be checked in several locations. For example, some pests are more abundant near the field edges rather than in concentrated areas within the field. Determining the extent of a pest population on the basis of what is found in only one or two small areas of a field is impossible. Sampling sites should be at least 75 feet in from the field margin. To determine whether an entire field, or a portion of the field, requires treatment at least five sites per 40-acres should be monitored to collect adequate information on the nature and extent of a pest infestation. The path through the field should follow the Z or X pattern as shown in Figure 2.

Figure 2. The X and Z scouting patterns (NDSU)



TILLAGE

Many tillage regimes are practiced in Canada including conventional, strip, ridge, minimum and zero-tillage. Many factors are to be considered when deciding what tillage regime to utilize, including soil type, climate, fertilizer regime and rotation. Different tillage regimes are associated with different impacts on crop production and the environment. For example, conventional tillage can be utilized to control specific crop pests, however it is also associated with erosion. Minimum- or zero-tillage can be implemented to manage erosion and preserve the soil profile. An understanding of the benefits and drawbacks of each tillage regime is important when deciding which to utilize.

HARVESTING

Timing

Sunflowers are usually the last crop to be harvested in the 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 quicken dry-down of 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. The bract tips turn brown at 40-50% seed moisture which is still too high for desiccation. Proper timing is when most of the bracts have turned brown. At this stage the plant is physiologically mature and seed moisture will be 20 to 50 percent. Refer to the current Guide to Crop Protection for details on desiccation products.

Combining

Sunflowers can be combined when the seed moisture is below 20 percent. Harvesting when seed moisture is greater than 20 percent can result in scuffing during harvesting and shrinkage during drying. It would be preferable to combine seeds at 10 to 13 percent moisture. 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 ¾ inch in rear) to minimize seed breakage and dehulling. Using the slowest cylinder speeds with the largest opening will result in the least seed damage.

Harvesting Attachments

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

There are two types of attachments:

1. The pan header which is mounted on traditional straight cut headers 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 9.5 percent or less. At 10 to 12 percent moisture content, seed can be stored in bins with aeration. Any moisture content over 12 percent 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 8.5 percent moisture can spoil if stored when warm.

PEST MANAGEMENT

INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical and chemical tools to minimize economic, health, and environmental risks. A number of factors influence the abundance and diversity of pests from year to year. Control methods vary in effectiveness, but integration of different pest management tools can minimize pest numbers and the cost of management without unnecessary crop losses. IPM maximizes the effectiveness of chemical pesticides, while minimizing the impact on non-target organisms and the environment.

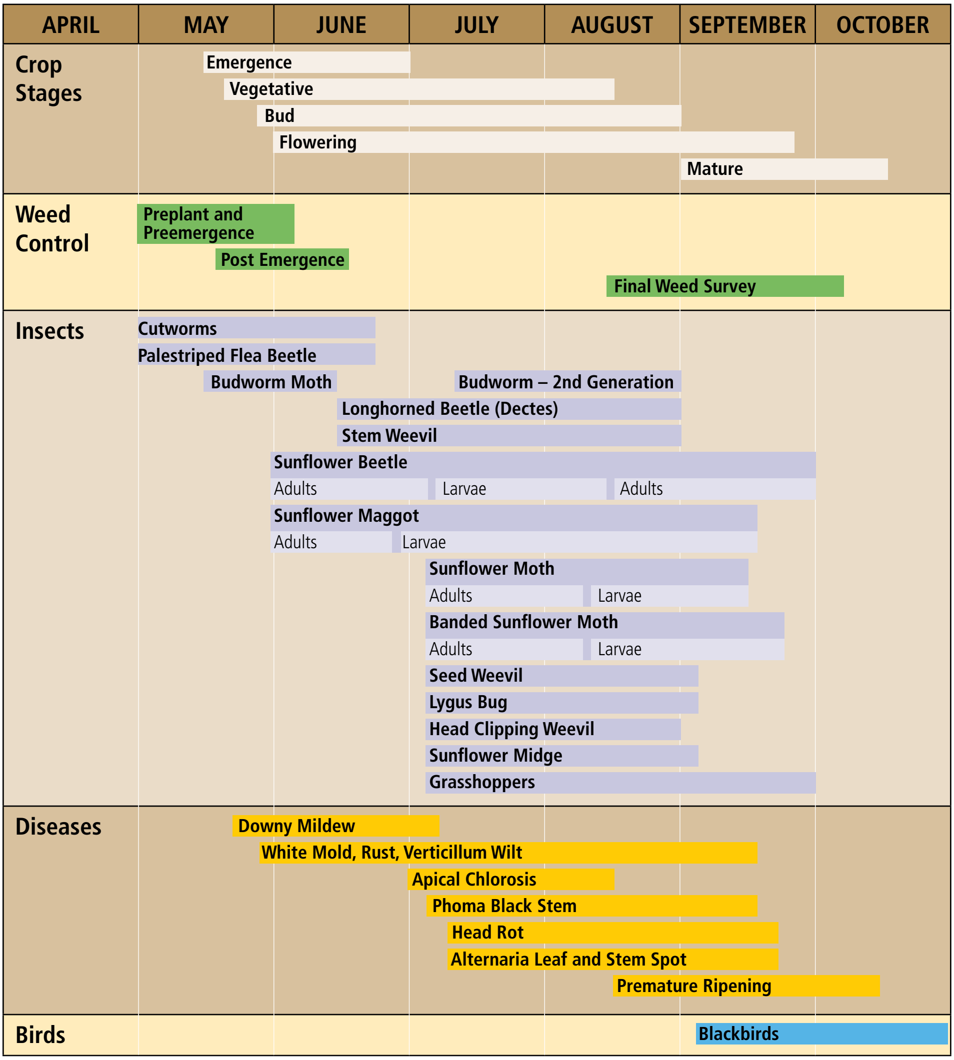
Scouting for potential pests, monitoring fields and keeping notes of pest incidences and densities is required to determine if levels are approaching the Economic Injury Level (EIL) or the Economic Threshold Level (ETL). Economic losses are a result of pest numbers increasing to where they cause crop losses greater than or equal to the cost of controlling the pest. The EIL is the number of pests at which tactics must be applied to prevent an increasing pest population from causing economic losses. The ETL is the level of pests that will cause economic damage and is often lower that the EIL. The ETL varies with crop price, yield potential, crop density, cost of control and environmental conditions. Pests should be identified accurately; control measures and economic injury levels differ between different organisms. Recognizing beneficial organisms is important as they help reduce numbers of damaging insects, which then may not require additional control.

Significant progress within sunflower pest management strategies have been made, and will continue to be made into the future. As new crop management strategies are developed, it is important to weigh crop production benefits versus environmental impacts.

INSECTS

The following sections provide current information on management of insects, diseases, weeds and birds. Below is a growing season calendar that shows the major sunflower pest problems and time of occurrence in the northern Great Plains production area (Figure 3).

Figure 3. A growing season calendar indicating time of occurrence of major sunflower pests. (J. Knodel, NDSU).



SEEDLING AND ROOT FEEDERS

Wireworms

Wireworm larvae feed on germinating seeds or young seedlings. Infestations are more likely to develop where grasses, particularly perennial grasses, have been growing. Stems of young seedlings may emerge shredded and damaged plants may soon wilt and die resulting in thin stands.

Host Crops

Grasses, corn, carrots, potatoes, wheat, barley, pulse crops, sunflowers, and many other crops.

Biology

Wireworm larvae (Figure 4) are slender, smooth and hard-bodied wire-like worms varying from 1.5 to 2 inches (38-50 mm) in length when mature. They have 3 pairs of legs behind the head, are yellowish white to a coppery color and the last abdominal section is flattened and notched. It usually takes 3 to 4 years for wireworms to develop from an egg to an adult beetle. Most of this time is spent as a larva.

Both the wireworm adults and larva overwinter deep in the soil. Larvae move up and down in the soil profile in response to temperature and moisture. After soil temperatures warm to 50°F (10°C), larvae feed within 6 inches (15 cm) of the soil surface. From late May through June the female beetles lay 200 to 1400 eggs in loose soil and under lumps of soil. When soil temperatures become too hot (>80°F, 27°C) or dry, larvae will move deeper into the soil to seek more favorable conditions. Due to this, wireworms inflict most of their damage in early spring when they are near the soil surface.

Scouting Techniques

Soil samples can be collected and sieved in the spring to find wireworms present in the field. Soil should be sampled to a depth of 15 cm (6 inches) and repeated in different areas of the field to determine the average number of larvae per square meter. Baits can also be used to attract wireworms to an area for monitoring. The past history of a field is a good indicator, especially if wireworms have been a problem in previous seasons. Crop rotation may impact population levels.

CONTROL TIPS

If the risk of wireworm damage is high, seeds can be treated with an approved insecticide for protection of germinating seeds and seedlings. Consult the current Guide to Crop Protection. No rescue treatments are available for controlling wireworms after planting.

Figure 4. Wireworm larvae

Cutworms

Cutworms can be a serious problem in many field crops. There are many different species involved, but the most common are the redbacked, darksided and dingy cutworms.

Host Crops

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

Biology

Cutworm larvae (Figure 5) have four sets of abdominal prolegs and curl up when disturbed. Redbacked cutworms (*Euxoa ochragaster*) have two broad red or reddish-brown stripes that extends the entire length of the body. The top-stripes are divided by a dark line with white in the centre. The head is yellowish-brown.

Darksided cutworm (*Euxoa messoria*) larvae are white on the ventral sides and pale brown dorsally. They have numerous indistinct stripes. Dingy cutworm *(Feltia jaculifera)* larvae are dull brown, with a mottle cream color. The dorsal area is pale with traces of oblique shading.

Cutworm moths may lay several hundred eggs in or on the soil. After the eggs hatch, the larvae feed on the host plants. Larvae normally have 6 instar stages. They moult several times, eventually reaching about five centimeters (2 inches) in length. The larvae tunnel into the soil to form earthen cells where they pupate and newly emerged moths exit using the old larval tunnels. Some species overwinter as eggs (e.g. the redbacked cutworm) or 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. One generation of this species is produced per year.

Scouting Techniques

Cutworms are nocturnal, feeding at night and hiding during the day making them hard to detect. Once the crop has emerged, continue scouting on a weekly basis from mid-May to mid-June. Feeding by cutworms results in notched, wilted, dead and cut-off plants (weeds or crop seedlings). Plants may be missing from rows and bare patches may appear in fields as a result of cutworm feeding. Using a small garden trowel and a soil sifter, cutworms can often be found in the soil around plants they have recently damaged. Cutworms may be found down to about 5 cm (2 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 1 cutworm per square foot (30 cm x 30 cm) or if there is a 25 to 30% stand reduction.

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 the entire field as there are differences in susceptibility to insecticides between species of cutworms. Consult the current edition of Guide to Crop Production for registered insecticides.

Young cutworm larvae may be starved before spring seeding by allowing volunteer growth to reach 3 to 5 cm (1.2 to 2 inches), cultivating and then seeding 10 to 14 days later. Many predaceous insects, parasites and birds prey upon cutworms and reduce their populations.

Figure 5. Different species of cutworm larvae.

Sunflower Beetle

Feeding by adult beetles and larva may result in poor seed set, seed filling, reduced yields and delayed maturity.

Host Crops

Sunflower beetles feed on native and cultivated sunflowers.

Biology

Adult sunflower beetles thorax (area behind the head) is a pale cream-color at the top with a reddish-brown patch at the base. Each wing-cover has 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 beetle larvae (Figure 7) are yellowish green with a brown head capsule and humpbacked in appearance. Newly hatched larvae are about 1.5 to 1.75 mm (1/16 inch) long and will grow to about 8 to 10 mm (under half an inch) when fully developed.

Biology (Continued)

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 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 drop to the ground, enter the soil, and pupate in earthen cells. The pupal stage lasts about two 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. When plants are seedlings, scout to determine the average number of adult beetles per plant. For larger plants, determine the average number of larvae per plant and percent defoliation by sampling 20 plants at 5 sites along an X pattern for a total of 100 plants.

Economic Thresholds

The threshold is 1 to 2 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 stages when adult beetles are numerous. Control may be necessary if defoliation caused by either the adults or the larvae reaches 25 to 30 percent, especially if more defoliation is expected. If the majority of the larvae have reached maturity at about 25 percent defoliation, control should not be necessary.

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. Insecticides are available to control sunflower beetle.Consult the current edition of the Guide to Crop Protection for registered insecticides that control sunflower beetle.

Figure 6. Adult – Sunflower beetle

Figure 7. Larva – Sunflower beetle

Thistle Caterpillar

Thistle caterpillar (*Vanessa cardui*) has been an occasional pest of sunflowers. Localized damage of sunflower crops has occurred during sporadic years of high populations.

Host Crops

On Canada thistle, larvae (Figure 8) feed selectively on foliage, leaving only the stem and midrib.

Biology

Adults, commonly known as painted lady butterflies (Figure 9), arrive on the Prairies during early June, depending on speed and pattern of migration, from overwintering sites in tropical and subtropical areas. There is no evidence that they can survive our cold winters. This butterfly lays eggs on Canada thistle and a broad range of host plants. Larvae feed on the leaves producing loose webbing. The larvae are up to 30 mm (1.25 inches) long and dark purple to black in color. They have long spines on each segment of the abdomen.

Scouting Techniques

If populations seem heavy while scouting, sample about 100 scattered plants, noting the percent defoliation on each. Divide the total percent defoliation by the number of plants sampled to obtain an estimate of percent defoliation for the field.

Economic Threshold

The threshold is 25 percent defoliation provided that most of the larvae are still under 3 centimeters (1 1/4 inches) long. If the majority of larvae are fully grown, most of the feeding damage will have already occurred.

CONTROL TIPS

Insecticide use has not been waranted for control of thistle caterpillar.

Figure 8. Thistle caterpillar

Figure 9. Painted lady butterfly

INSECTS IN THE STEM

Sunflower Bud Moth

High populations of this pest have been reported in the past. Despite high populations, the sunflower bud moth may not cause high levels of economic loss.

Biology

Sunflower bud moths (*Suleima helianthana*) have a wingspread of about 16 to 18 millimeters (0.63 inches). Each gray-brown forewing has two dark transverse bands (Figure 10). One band extends across the middle of the wing, and the second band is located near the wing tip. The larva (Figure 11) have a dark head capsule with a smooth, cream-colored body.

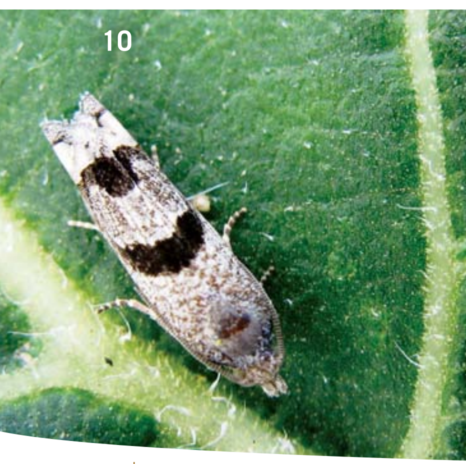
In Manitoba, two generations of sunflower bud moth are produced per year. Adults emerge from overwintering pupae during the last week of May to mid-June. A few days after adult emergence, eggs are deposited on the terminals of immature sunflowers or on the receptacle of mature sunflowers. Eggs also are deposited in leaf axils. 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) (Figure 12). 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.

Figure 10. Adult Sunflower bud moth

Figure 11. Sunflower but moth larvae

Figure 12. Entrance hole of larva

Figure 13. Larva feeding results in deformations of the sunflower head, often a hole is formed.



In early planted sunflower, most of the infestations occur in the stalks, whereas in late planted sunflower, most infestations occur in the pith areas of the head. The only time yield loss is noticeable is when larvae burrow into unopened buds, preventing proper head development. The larvae normally do not feed on developing seeds, but confine feeding activities to the fleshly part of the head. Despite minimal economic losses, the larva cause malformations in both the head and stalk (Figure 13).

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.

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CONTROL TIPS

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

Sunflower Stem Weevil

There are two main stem weevils species, the Spotted Sunflower Stem Weevil and the Black Stem Weevil.

Biology

The Spotted Stem Weevil (*Cylindrocopturus adspersus*) adults are about 4 to 5 millimeters (3/16 inch) long and grayish brown with varying shaped white spots on the wing covers and between the head and abdomen. The snout, eyes and antennae are black. The larvae are 5 to 6 mm (1/4 inch) 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. Eggs are very small (0.51 mm long by 0.33 mm wide). Upon hatching in early July, the first instar (larval growth stage) larvae feed on sub-epidermal and vascular tissue. Feeding is concentrated in the pith tissue as the larvae develop to third and forth 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 larvae. Pupation of the overwintering larva occurs the following year in early June. There is one generation per year.

The Black Stem Weevil (*Apion occidentale*) adults (Figure 14) are black and only 2.5 mm (0.1 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 body. The larvae are very similar in appearance to the spotted stem weevil except they are only 2.5 to 3 mm (0.1 to 0.12 inches) long at maturity and yellowish in color.

The black stem weevil overwinters as adults in soil, plant residue, sod and weed clusters. Upon emergence, the adults feed on volunteer sunflowers in 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 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 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.

These two species are highly suspected in vectoring Phoma black stem, a disease in sunflower fields. 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, 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 the stalks.

Scouting Techniques

Look for stem weevils when scouting sunflower fields in late June and very early July using the X pattern and examining 5 plants per stop for a total of 25 plants at the 8 to 14 leaf stage. Sampling sites should be 75 to 100 feet in from the field margins. The average number of weevils per plant can then be calculated.

When surveying for stem weevils, move slowly to avoid having the adult stem weevils drop to the soil and 'play dead'. Adult feeding by both stem weevil species is considered to cause insignificant mechanical injury.

Economic Thresholds

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 which 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 percent mortality of the stem weevils in the past.

Figure 14. Adult Apion black sunflower stem weevil (NDSU).

Sunflower Maggots

There are three main species that have larval feeding stages that can cause seed sterility or stalk breakage under high populations. Damage is usually negligible.

Biology

The adult forms of all three sunflower maggots (flies) have wings with a distinct brown or yellowish-brown pattern. 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 mm (0.4 inches) long and a wing span of approximately 19 mm (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 8 mm (0.31 inches) at maturity. The larvae (Figure 15) taper from the front to the rear and are yellowish-white in color.

Adults of the sunflower receptacle maggot emerge in late June to early July after sunflower buds reach 5 to 10 cm (2 to 4 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 cm (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 maggot (*Strauzia longipennis*)

Adults (Figure 16) of this species have a wing spread of about 13 mm (0.5 inches) and a body 6 mm (0.25 inches) long. The wings bear broad dark bands that form a fairly distinct F-shaped mark near the tips. The larvae (Figure 15) 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 7 mm (0.28 inches) at maturity.

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.

Sunflower seed maggot (*Neotephritis finalis*)

This sunflower maggot is the smallest of the three species with the adult having a body length of about 6 mm (0.25 inches) and a wing span of approximately 7 mm (0.28 inches). The wings have a brown lace-like appearance. *N. finalis* larvae attain a length of 4.5 mm (0.19 inches) at maturity.

Unlike the other two species of sunflower maggots, sunflower seed maggots complete two generations per year. The first generation pupates 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.

CONTROL TIPS

Insecticides have not been warranted for control of this pest.

Figure 15. Sunflower maggot larva

Figure 16. Adult sunflower maggot

Figure 17. Sunflower maggot larval feeding causes deformations of the head.

INSECTS ON THE HEADS

Sunflower Midge

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

Host Crops

Sunflowers

Biology

The tiny, tan-colored, adult sunflower midge (*Contarinia schulzi*) are only about 2 mm (1/8 inch) long with a wingspan of about 4 mm (0.07 inch). The wings are transparent and void of markings except for the veins. The first peak of first-generation adult emergence occurs in early-to mid-July. A second peak occurs about 7 to 10 days later. The adults prefer to lay their eggs on sunflower buds with a diameter greater than 1 inch. Eggs are laid individually or in groups in depressions between the bracts of the sunflower bud. The midge larva are tiny, being only 3 mm (1/8 inch) long when full-grown and cream to yellowish orange. The newly emerged larvae move to the base of developing seeds or bracts. Presence of the larvae is frequently determined by necrotic areas at the base of, or between, bracts (Figure 18). 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 favorable, 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. The second generation adults lay their eggs among the seeds. Usually, the larvae pupate in the spring. The adults start to emerge in late June. The adult midge only live 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 is usually restricted to field margins but, in severe infestations, damage is present throughout the field. When monitoring sunflower heads, look for midge larvae in the flower head, scarred bracts, and twisted or gnarled flowers. 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 Threshold

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.

Some commercial hybrids are tolerant to sunflower midge. Consult your local seed dealer for information on the most resistant varieties.

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 18. Larvae feeding causes brown necrotic spots at the base of the bracts.

Figure 19. Severe midge damage causes over growth of the sunflower head.

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Sunflower Seed Weevils

Larvae feed on kernels, causing reduced seed weight and oil content. Often the kernels are only partially fed upon, making it difficult to separate healthy from weevil-damaged seed. This causes downgrading of confectionary sunflower seed.

Host Crops

Sunflowers

Biology

There are two species of Seed Weevils that can cause damage in sunflowers in Canada; the red sunflower seed weevil (*Smicronyx fulvus*) and the gray sunflower seed weevil (*Smicronyx sordidus*). The red sunflower seed weevil is the most common of the two species on the Prairies. The adults (Figure 20) are 2.5 to 3.06 mm (1/10 to 1/8 inch), long and are covered with reddish-orange, oval scales. 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% flowering. The egg laying pattern follows seed filling which progresses from the outside to the center of the head. Usually, an infested seed contains a single larva. The larvae are small, cream colored, legless and C-shaped. In late August, the mature larvae chew an exit hole in the seed, drop to the ground directly beneath the sunflower head, and overwinter in the soil.

The gray sunflower seed weevil is not as common and is slightly larger (3 to 3.5 mm or 1/8 inch 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 sunflowers used for oil because of its low population level and low reproductive rate.

May	June	July	August	September
Larvae overwinter 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

Scouting Techniques

Begin scouting for seed weevils as soon as the yellow ray petals appear. Continue counts until the economic threshold level has been reached or most plants have reached 70% pollen shed at which time very few seeds are suitable for egg laying.

When sampling, follow an X or Z pattern in the field. Initiate counts more than 100 feet into the field as 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 5 plants at each site for a total of 25 plants. Brush the face of the heads vigorously to bring the weevils to the surface or spray mosquito repellent containing DEET on the head. This will force the weevils to move out of their hiding spots. Care should be taken to not confuse other insects which may be present on sunflower heads, such as minute pirate bugs (Figure 21) for seed weevils.

Economic Thresholds

In oilseed sunflowers, the threshold is 10 to 12 weevils per plant. In confection sunflowers the threshold is 1 to 2 weevils per plant.

Figure 20. Adult Red Sunflower Seed Weevil

Figure 21. Sunflower seed weevils on top and the much smaller minute pirate bug nymphs below.

CONTROL TIPS

Early planting helps reduce seed damage. When planted early, the sunflowers are completed anthesis (flowering) before peak weevil populations and are no longer susceptible to egg laying.

Insecticides, sometimes in combination with trap cropping, remains the major management tool. Determine the average sunflower plant growth stage before applying an insecticide. The weevil does not begin to lay eggs on sunflower heads before R5.4 (the outer 40% of florets have opened). If treatment is necessary, insecticides should be applied before three out of ten plants reach 40% bloom.

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 7 mm (0.3 inch) long (Figure 22) with 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 mm (0.06 inch) long. As the larvae grow, there is a gradual color change to light pink or yellow, then to reddish or purplish and finally to green at maturity (Figure 23). Full-grown larvae are about 10 mm (0.4 inch) long.

The adult moths start emerging from the soil in mid-July and are present through to mid-August. Moths fly from last year's sunflower fields to the current year's sunflower fields. Adult moths rest in vegetation along field margins during the day and move into the field to lay eggs at twilight. They lay eggs on the bracts of sunflower heads. Eggs hatch in 5 to 8 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 6 to 7 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 has been shown to occur at the edge of the field.

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 m) from the field margin. Count moths on 20 plants from 5 different sites for a total of 100 plants.

Sampling strategies based on scouting for adult moths during daylight hours and for eggs have 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.

NOTE: The Arthur's sunflower moth (*Cochylis arthuri*) is very similar to the banded sunflower moth. The Arthur's sunflower moth larvae also fed on developing seeds in the sunflower head causing similar damage to that of the banded sunflower moth. The adults also have dark banding across the wings, although they can be distinguished from banded sunflower moth. Young larvae are cream colored, mid-instar larvae are light to dark pink, and last- (fifth-) instar larvae are light to dark green.

Figure 22. Banded sunflower moth adults are characterized by the dark band along the middle of the back.

Figure 23. Larva go through 5 instars and feed on the developing kernel within the seed.

Figure 24. Banded sunflower moth larva create a webbing on the face of sunflower heads.


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CONTROL TIPS

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. 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% of overwintering larvae and pupae. At least 4 different species of parasites attack the larvae of the banded sunflower moth.

Lygus Bug

Feeding by lygus bugs on developing seeds can cause kernel brown spot, small brown to black spots on the blunt or distal end of sunflower seeds.

Host Crops

Lygus bugs have been recorded on over 385 crop and weed species.

Biology

Adult lygus bugs (Figure 25) are about 5 mm (0.2 inch) long and 2.5 mm (0.1 inch) wide. They vary in color from pale green to reddish-brown and have a distinct triangle or "V" mark on the wings. First stage nymphs are very small, wingless and bright green. Nymphs (Figure 26) 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 bug 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 only allowed 0.5% 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 to sunflowers from alfalfa, canola or other host crops 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% kernel brown spot, the economic threshold for lygus bugs on sunflowers is likely about 1 lygus bug per 9 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 flowering if adult densities approach the economic threshold. Fields should be monitored for lygus bugs until flowering is completed to reduce incidence of kernel brown spot damage to confection sunflowers.

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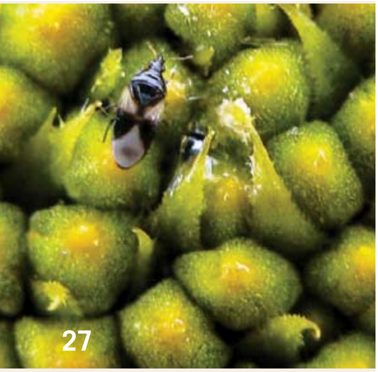
CONTROL TIPS

Insecticide application is most beneficial when applied during early flowering at the R5.1 stage. A second application may be warranted if Lygus bug populations are high in neighboring fields, and populations are expected to migrate to the sunflower field. Consult the current Guide to Crop Protection for registered insecticides.

Figure 25. Adult lygus bugs are characterized by a triangle across the wings.

Figure 26. Lygus bug nymphs resemble the adults but lack wings.

BENEFICIAL INSECTS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Minute Pirate Bug

Both nymphs and adults feed on a variety of sunflower pests including aphids and the eggs and larvae of banded sunflower moth.

Green Lacewing

Adults feed on aphid honeydew, plant pollen and plant nectar.

Green Lacewing Larvae

Predator to a variety of sunflower pests including aphids, sunflower beetle eggs and larvae, and banded sunflower moth eggs and larvae.

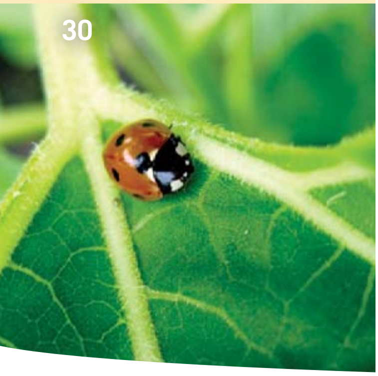
Lady Beetles

Consume sunflower beetle eggs, aphids, and banded sunflower moth eggs and larvae.

Lady Beetles Larvae

Damsel Bugs

Prey on sunflower beetle larvae, and banded sunflower moth eggs and larvae.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⬆ Two-Spotted Stink Bug

Prey on sunflower beetle larvae.

⬆ Parasitic Wasps

Attack both the eggs and young larvae of banded sunflower moth, sunflower seed weevils and sunflower stem weevils.

⬆ Ground Beetles (Carabid Beetles)

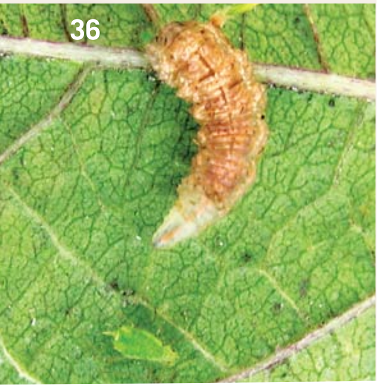
Can destroy 40 percent of overwintering larvae and pupae of sunflower beetles.

⬇ Hover Fly

Increases crop yield by enhancing pollination. Feeds on aphids.

⬇ Honey Bee

Increase yield in sunflower by enhancing pollination.



Pollination

Unlike native sunflowers, current hybrids have been selected for and possess high levels of self-compatibility. Although self-compatible sunflower hybrids usually out-produce self-incompatible cultivars, modern hybrids continue to benefit from insect pollination. Studies have shown that in most sunflower hybrids seed set, yield and oil quantity is increased when pollinators (such as bees) are present.

To achieve maximum yields and quality, often the use of insecticide is required to protect the crop from insect competitors. Unfortunately, many of the major insect pests of sunflower attack the crop during flowering and insecticide applications harm the pollinating bees. Below are some key strategies that can help protect the pollinators.

Key strategies:

❶ Scout fields and apply insecticide only when needed.

❷ Apply Insecticide in the evening - Honey bees are foraging when the sun is up and during the warmer parts of the day and return to the hive at night. When the bees return to the field the next day, the effect on the bees will be significantly reduced.

❸ Less harmful to bees does not necessarily mean less harmful to pests – This is due to the repellent effect on bees from the residue of some insecticides. Select insecticides that provide effective control of the targeted pests while minimizing impact on bees.

❹ Communicate with beekeepers – Contacting the beekeeper about an insecticide application, the insecticide chosen, and the steps taken to reduce harm to pollinators, helps the beekeeper to decide if additional measures should be taken to minimize bee damage.

DISEASES

EARLY SEASON DISEASES

Downy Mildew

Downy mildew is capable of killing or stunting plants, reducing stands and causing severe yield losses during wet years.

Host Crops

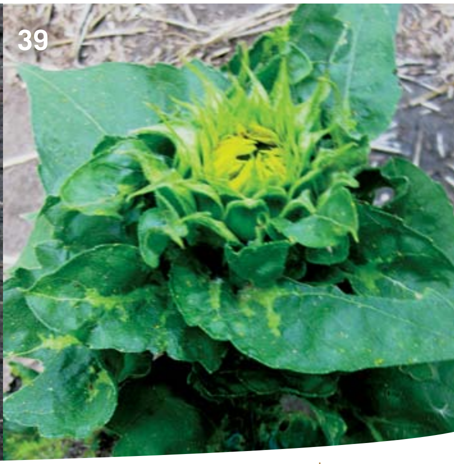
Sunflower

Biology

Downy mildew is caused by a soil-borne, wind-borne and seed-borne fungi *Plasmopara halstedii*, which can survive for up to 10 years in soil. Under cool, water-saturated soil conditions, the spores germinate upon contact with sunflower roots, enter, and spread throughout the entire plant. This is systemic infection. Systemic infection occurs only when the roots are less than 2 inches long when they contact the fungi. Sunflower plants surviving the initial infection will produce white spores on the underside of cholorotic areas on leaves. The white spores are air-borne, and upon landing on sunflower leaves may cause secondary infections. Secondary infections are most common when sunflower leaves remain wet for prolonged periods of time. Plants are susceptible to secondary infections for a much longer period of time versus systemic infections via root infection. As infected plants rot and are tilled into the soil, the fungus forms the resting stage which will germinate during favorable conditions in subsequent years.

Figure 38. Seedling Sunflower with downy mildew.

Figure 39. Downy Mildew causes stunting and heads to face straight upwards.



Symptoms

Symptoms can vary considerably depending on amount of inoculum, the age and host organ attacked and environmental factors. Symptoms can be broadly classified as those caused by systemic or localized infections. Root infection of seedlings or young plants results in systemic infection. Severely infected plants may die before or shortly after emergence or in the seedling stage. Typical systemic symptoms (Figure 38) in seedlings include dwarfing, yellowing of the leaves and the appearance of white, cottony masses on the lower and sometimes upper leaf surface during periods of high humidity. When seedlings are infected several weeks after emergence, or a fungicide seed treatment inhibits rather than prevents infection, the plants start showing symptoms at the four-, six-, or eight- leaf stage; this is termed 'delayed systemic infection'. These plants may or may not develop typical downy mildew leaf symptoms, but are typically stunted with thickened, club like roots. The heads of the few plants reaching maturity face straight upwards and seldom produce viable seed (Figure 39). Airborne downy mildew spores can cause localized small, angular foliar lesions with the white fungal growth on the underside of the leaf. These infections generally have minimal impact on yield.

Yield losses may be substantial. If infected plants are dispersed randomly throughout the field, yield losses probably will not be observed unless infection exceeds 15 percent. Neighboring plants can compensate for severely infected plants by growing larger heads. When the disease is in a localized area, such as a low spot in a field and all plants are infected, yield loss can be substantial.

Scouting Techniques

Infected plants can most often be found alone or in standing water.

CONTROL TIPS

Resistant varieties are available; however, due to the development of new races, resistance may not be a sufficient management tool in all fields. Fungicide seed treatments can be an effective management tool for downy mildew, but as with genetic resistance, the pathogen has developed resistance to metalaxyl and mefanoxam, two of the most commonly used fungicides. Other seed treatment options are available and more will be labeled in the future. Refer to the current issue of the Guide to Crop Protection for updated information on products and rates for application. Other management procedures are to control weed hosts which include wild and volunteer sunflowers to help reduce inoculum.

FOLIAR DISEASES

Rust

Early infection of susceptible varieties can decrease head size, seed size, oil content and yield. Confection hybrids are more susceptible than oil-seed types.

Hosts

Wild sunflower and cultivated sunflower

Biology

Sunflower rust is caused by *Puccinia helianthi*. Infection can occur at any time during the growing season, depending on the inoculum source and environmental conditions. Conditions favorable for infection are free water on the leaves, either from rainfall or dew, and warm temperatures. A minimum of two hours of wet leaves is sufficient for rust infection; six to eight hours of leaf wetness results in the maximum amount of infection. Sunflower rust spores overwinter on the debris from infected sunflower leaves and stems of previous crops. In the spring spores germinate to infect volunteer seedlings, wild sunflower or new young plants in nearby fields. Under favorable conditions, spore production and infection can occur continuously within a year. The 'repeating stage' is the most damaging, as multiple waves of spores are spread by wind to other fields as conditions allow. As the crop ripens, the spores form the overwintering stage which can then re-infect following sunflower crops.

Symptoms

The first signs of rust usually appear when sunflowers are at or past bloom as environmental conditions within the crop canopy are more favorable for infection. The aecial stage (Figure 41) of rust appears late spring to summer as clusters of orange cups. The most common stage of rust (uredinia) (Figure 42) is often observed within two weeks of the aecia. These pustules are small (0.1 to 1 mm), cinnamon-brown, can be rubbed of easily and occur on both the upper and undersides of leaves. As the disease progresses, uredinia may be found on the upper leaves, stem and bracts of the sunflower plant. In response to temperature, the uredinia convert to telia (black spots on the upper surface of leaves) at the end of the season which do not rub off and are the overwintering structures.

Economic Threshold

Rust severity on the upper four leaves is 3 percent or greater.

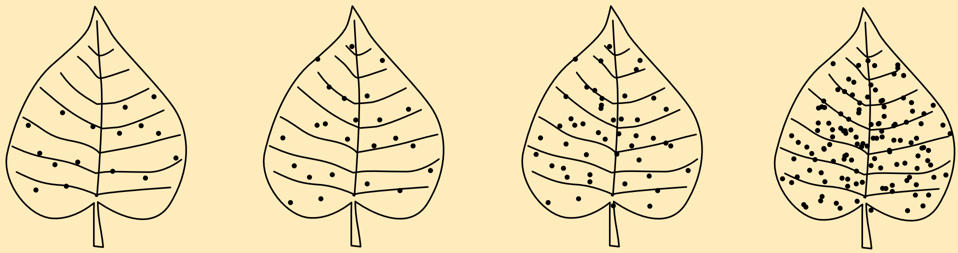


Figure 40. Leaf area infected by rust.

CONTROL TIPS

The most effective way to avoid loss from rust is by planting rust-resistant hybrids. Most oilseed and confectionary hybrids have good to excellent resistance to most races of rust. Rotation to other crops is also a useful tool to minimize infections, as sunflower rust only infects sunflowers. If possible, avoid planting next to a field that had sunflowers last year; manage wild sunflowers or volunteer sunflowers as they are hosts for the disease. Early seeding and short season hybrids can also help minimize disease severity. Any cultural practice which fosters a dense canopy, such as high plant stands and high nitrogen fertilization, which traps dew, increases chances of a severe rust infection and should be avoided if risks are high. Foliar fungicides are registered for rust. Consult the current edition of Guide to Crop Protection for products.

Figure 41. Aecia cups on the underside of sunflower leaf.

Figure 42. Rust uredinia develop on the under-and upper-leaf surfaces.

Alternaria Leaf and Stem Spot

Alternaria leaf spot is a ubiquitous disease on senescing leaves and generally of little concern. Under warm and humid conditions, it can however become a serious defoliating and yield reducing disease.

Host Crops

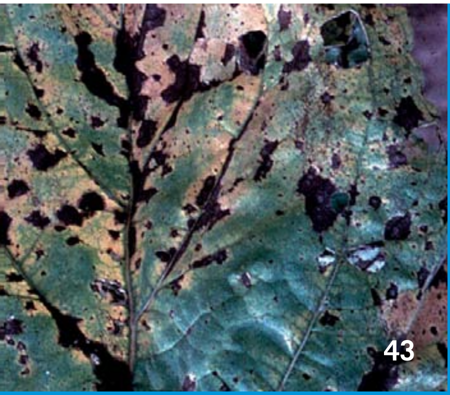
Sunflower, safflower and cocklebur

Biology

Alternaria fungi overwinter on diseased stalks and may be seed-borne at low levels. Seedling blights caused by Alternaria may develop when sunflower plants emerge in rainy weather in Alternaria-infested soil. Alternaria spores are spread by wind and splashing water. The fungi require free water for 4 hours for infection to occur. Leaf symptoms are most frequently observed after flowering as the dense canopy is conducive to infection. Once established, the disease can develop quickly under favorable conditions. In western Canada, climate is not typically conducive for Alternaria epidemics and generally only the lower senescing leaves are affected.

Symptoms

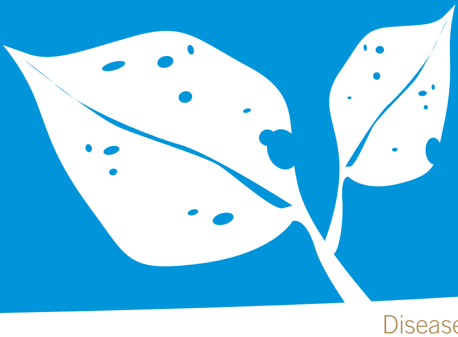
Dark brown irregular spots with dark brown to purple borders and a gray center develop on leaves (Figure 43). The spots on young plants may have a yellow halo. Leaf lesions may coalesce, causing leaves to wither. Stem lesions begin as dark flecks then enlarge to form long, narrow lesions. The stem lesions often join to form large blackened areas which may result in stem breakage. The lesions are located randomly along the stem and not associated with a petiole.



CONTROL TIPS

Crop rotation and burying infested crop residue to hasten decomposition helps minimize Alternaria infection.

Figure 43. Alternaria leaf lesions close up.



Septoria Leaf Spot

Septoria is widely distributed on sunflowers but usually causes little damage. In severe instances it can cause defoliation of the lower leaves.

Host Crops

Cultivated and Wild Sunflower

Biology

Septoria is caused by the fungi *Septoria helianthi*. The fungi survive on infected crop residue and can also be seed-borne. The disease can appear any time during the growing season with initiation favored by moderately high temperatures and abundant rainfall.

Symptoms

Septoria develops first on the lower leaves and spreads upwards through the canopy. The lesions (up to 15 mm in diameter) begin as water-soaked areas which are greasy green in appearance. The spots become angular to diamond shaped, with tan centers and brown margins. Young spots are often surrounded by a narrow halo that gradually merges with the surrounding green tissue (Figure 44). Mature spots contain small black specks or fruiting bodies. This is the best way to distinguish Alternaria from Septoria. The lesions may coalesce in later stages and the leaf may wither and die.

CONTROL TIPS

Crop rotation, incorporation of sunflower residue and use of clean seed are the best management practices to manage Septoria.

Figure 44. Septoria lesions contain small black fruit bodies.

STALK AND ROOT-INFECTING DISEASES

Sclerotinia Wilt and Basal Rot

Infected plants die rapidly, and if the plant dies prior to seed maturity it results in yield loss, lower test weight, and lower oil content.

Host Crops

Sclerotinia has a very wide host range of over 360 species, which includes sunflowers, canola, mustard, dry beans, field peas, lentils and potatoes.

Biology

Sclerotinia overwinters as *Sclerotinia sclerotiorum* in the soil or on plant debris. Sclerotia are irregularly shaped structures which range in size and shape from spherical and 1/8 inch in diameter to Y-shaped and up to 1 inch in length. The sclerotia bodies can survive in the soil for 5 or more years. As sunflower roots grow near sclerotinia in the soil, the sclerotia are stimulated to germinate producing mycelium which infects the lateral roots. Sclerotia form in the decayed stem pith and on the roots as the plant dies. The sclerotia are returned to the soil during tillage operations and serve as sources of inoculum for the next susceptible crop.

Soil moisture and temperature during the growing season are not critical factors affecting the rate of incidence of sclerotinia wilt.

Symptoms

Wilt (Figure 45) can appear at any time between emergence and maturity, but is more prevalent around flowering. Sudden wilt of the plant occurs when infected roots cannot uptake adequate water to meet the demands of the plant. Examination of the stem-root area will reveal a tan-brown, water soaked lesion at the soil surface (Figure 46). The stalks and roots may become covered with white mycelia and hard sclerotia bodies develop under very wet soil conditions.

CONTROL TIPS

Management of sclerotinia is difficult because of the wide host range, but rotation to cereals and corn is the most effective to minimize sclerotinia in the soil. Sunflower hybrids with some levels of resistance are available. The use of a mycoparasites which feed upon other fungi has shown to attack Sclerotinia. One commercially available is *Coniothryium minitans* (Contans). This mycoparasite can kill sclerotia in several months rather than years.

Figure 45. Sclerotinia wilt.

Figure 46. Sclerotinia Basal rot lesion.

Sclerotinia Mid-Stalk Rot

Mid-stalk rot is the disease least often caused by Sclerotinia. Lodging can cause complete yield loss on a per plant basis.

Biology

Under wet soil conditions, the sclerotia in the soil can germinate to form small mushrooms called apothecia that produce air-borne spores. The spores can originate in the sunflower field or can be blown in from adjacent fields. Spores can move by rain splash, various insect carriers and up to 1 km by air. The spores require free water and senescing plant tissue to germinate and infect plants. Mid-stalk infection may result from leaf infection or infection at the leaf axil.

Symptoms

Infection can occur anytime from seedling to maturity depending on the presence of infecting spores and favorable environmental conditions. Mid-stalk rot begins with infection of the leaf, and the fungus progresses internally through the petiole until it reaches the stem. The leaf lesions are not unique enough to identify the fungus, but the stem lesions are identical to that formed by root infection; tan colored and water-soaked (Figure 47). The sclerotia can develop within the stem or on the exterior of the stem. Leaves above the lesion wilt, and the stalk eventually disintegrates becoming shredded as only vascular components of the stem remain (Figure 48).

CONTROL TIPS

The comments made about Sclerotinia wilt also apply to mid-stalk rot management. Cultural practices to avoid high plant densities by reducing populations and high nitrogen fertilization help lower the incidence of infection. Shallow or zero-tillage practices may aid in faster deterioration as sclerotia are left on the ground surface and subject to increased environmental deterioration. Resistance genes have been the most effective approach, and breeding for higher tolerance continues.

Figure 47. Sclerotinia mid-stalk rot lesion

Figure 48. Sclerotia bodies develop within the stem tissue or on the surface of the stem.

Phoma Black Stem

Phoma is the most widespread stalk disease in the northern Great Plains, but yield losses are considered minimal.

Host Crops

Cultivated sunflower

Biology

The fungus (*Phoma macdonaldii*) overwinters in infected debris. Phoma infection occurs throughout the growing season; however, it is not usually noticed until the stem lesions become obvious later in the summer. Leaves can be infected by wind carried spores, rain splashed spores or spores transmitted by insects. Stem weevils are suspected in transmitting the fungi internally and externally. Adult weevils feeding on the leaves cause leaf lesions whereas contaminated larvae spread the fungus as they tunnel throughout the stem. Leaf lesions are not distinctive and can be confused for Alternaria. The leaf infections progress down the petiole to the stalk. Under favorable conditions, the leaf wilts, the petiole turns uniformly black, and the stem lesions expand.

Symptoms

Large, jet black lesions develop on the stem (Figure 49), sometimes reaching about 4 to 5 cm in length. The lesions are uniformly black and shiny with definite borders. Small circular fruiting bodies of the fungus are produced on the surface of the stem but these require a hand lens to see. The fungus may also produce lesions on the back of the head, on the leaves, and at the base of the stalk. Stem lesions do not result in pith damage or lodging and are generally regarded as superficial lesions. If stem weevil larva tunneling spreads Phoma spores within the pith, extensive pith degeneration can occur.

CONTROL TIPS

Cultural practices to minimize Phoma includes a four year rotation to minimize the inoculum load in the soil, delayed planting and avoiding high plant populations and high nitrogen fertilization. Control of stem weevils can help reduce transmission of the fungus but insecticide application is rarely economically justified. Some hybrids are more tolerant than others, but none are immune to the disease.

Figure 49. Phoma black stem lesion

Phomopsis Stem Canker

In recent years Phomopsis has become a very prevalent disease. Yield losses result from smaller heads, lighter seed and lodging due to weakened stems.

Hosts

Sunflower

Biology

The fungi (*Phomopsis helianthii*) overwinter on infected plant debris and spores are rain splashed or windblown onto leaves. The infection initiates at leaf margins of lower leaves, developing into a brown necrotic area bordered by a chlorotic margin. The infection spreads down through the veins to the petiole and finally to the stem. The symptoms are similar to those of Verticillium leaf mottle; however, with Verticillium veins remain green. Stem lesions usually do not appear until flowering. The disease is most severe under conditions of prolonged high temperatures and high rainfall.

Symptoms

First symptoms initiate on lower to middle leaves after flowering as necrotic spots with a chlorotic border on leaf margins. The stem lesions begin as a small brown sunken spot but enlarges rapidly becoming a large tan to light brown lesion or canker centered on a leaf petiole. Lesions are much larger than Phoma black stem, sometimes reaching 6 inches and brown rather than black. Black fruiting bodies (pycnia) form on infected tissue. Phomopsis causes extensive pith degradation and the stalk can usually be crushed under moderate thumb pressure. Phomopsis infected plants are more prone to lodging than Phoma infected plants.

CONTROL TIPS

Thorough incorporation of the sunflower stalks into the soil to bury residue and crop rotation can reduce disease incidence and severity. Crop residue left on the soil surface fosters development of Phomopsis. Hybrids resistant to Phomopsis, developed using parental lines from Europe where the disease is particularly severe, are commercially available.

Figure 50. Phomopsis Stem Canker

Verticillium Leaf Mottle

Verticillium can significantly reduce sunflower yield especially on lighter soils. Quality may also be affected through decreased oil content and seed size.

Host Crops

Various plant species can be infected including sunflowers, potatoes, alfalfa and sweet clover

Biology

The fungus (*Verticillium dahliae*) is seed- and soil-borne. It survives as very small, black, resting bodies (microsclerotia) in diseased sunflower debris and broadleaved weeds, persisting for 5 to 10 years. The microsclerotia germinate in response to root exudates. The root tips of sunflower plants are invaded and, eventually, all parts of the plant become infected. The fungus produces toxins which are translocated throughout the plant causing the chlorotic and necrotic areas between the veins. When the plant dies, the fungus produces black fungal bodies that return to the soil with the plant debris.

Symptoms

Symptoms usually are not observed until flowering, but may appear at the six-leaf stage under severe conditions. Initial symptoms begin as tiny chlorotic flecks that increase in size with time developing into extensive inter-veinal yellowing (Figure 51). Symptoms begin on the lower leaves and progress slowly up the plant and may eventually infect all leaves. Affected leaves quickly become dry. The vascular system may be discolored brown, apparent as a ring around the pith in cross section. In severely infected plants, the pith is blackened with a layer of tiny black fruiting bodies.

CONTROL TIPS

Most oil-seed hybrids contain resistance to Verticillium whereas confection hybrids are generally more susceptible. However, a new strain has recently been identified in Canada and the U.S. which is able to overcome the source of resistance in these varieties. The disease is more severe on lighter land with a history of sunflower cropping than on heavy, clay soil. Rotation is important on lighter soil with a history of sunflower cropping to reduce inoculum load in the soil.

Figure 51. Verticillium Leaf Mottle

HEAD ROT AND DISEASES OF MATURE PLANTS

Sclerotinia Head Rot

Head-rot is considered the most important disease affecting sunflower production, causing yield and quality loss.

Hosts

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

Biology

Sclerotinia head-rot (Figure 52) is quite variable, usually occurring late in the season and influenced primarily by the amount of rainfall from flowering through to harvesting. As with sclerotinia mid stalk rot, head-rot is caused by air-borne spores produced by apothecia (small mushrooms) either within the field or blown from a neighboring field. The spores require free water and a food base such as dead or senescing plant tissue to germinate and infect. Ascospores colonize the dead florets and pollen on the face of the head. After infection it takes several weeks until the appearance of brown lesions on the back of the head.

Symptoms

The first symptoms of head rot usually are the appearance of water-soaked spots or bleached areas on the fleshy back of the head. The fungus can decay the entire head, with the seed layer falling away completely, leaving only a bleached, shredded vascular system interspersed with large sclerotia. The bleached, skeletonized heads resemble straw brooms and are very obvious in the field even from a distance.

Yield loss from head rot on an individual plant can range from minimal to total loss if the head disintegrates and drops all the seed to the ground prior to harvest. Intact but diseased heads will have light and fewer seeds, with lower oil content and will shatter during harvest.

CONTROL TIPS

Sunflower hybrids exhibit variable range of susceptibility to head rot, but no hybrids are commercially available with adequate resistance. Fungicides may help reduce the incidence of head rot, with applications made preventively since several weeks lapse from infection to symptom development. Consult the current edition of the Guide to Crop Protection for product information.

Figure 52. Sclerotinia Head Rot

Rhizopus Head Rot

Rhizopus is a very widespread disease in the central Great Plains. Affected heads will have a lighter test weight, lower oil content and reduced seed yields.

Host Crops

Many hosts for Rhizopus including sunflower, beets and tobacco

Biology

Susceptibility of the head increases from the bud stage up to the full bloom and ripening stages. Spores are disseminated by wind, rain and insects. Rhizopus enters the head through wounds caused by hail, birds, insects and has been associated with sunflower midge damage. Rapid disease development occurs in warm, humid weather. Once the head is fully colonized and all tissue killed, the head dries up and becomes 'mummified'.

Symptoms

Initial symptoms are similar to other head rot diseases; brown, sunken, water soaked lesions on the back of the head. As the lesions enlarge, the interior of the head becomes mushy (Figure 53). The interior of the head becomes filled by mycelium interspersed with black fruiting bodies resembling pepper grains. Once the head dries up it is characterized by a dark brown, peppery appearance of tissues in the receptacle and becomes very hard.

CONTROL TIPS

Controlling head insects is the most efficient method to minimize incidences of Rhizopus head rot. Genetic resistance has been identified, but severity of the disease has not warranted intensive research. Rotation does not help reduce the incidence of Rhizopus due to the number of Rhizopus species. No fungicides are registered for control of Rhizopus head rot.

Figure 53. Rhizopus Head Rot

BLACKBIRDS

Sunflower seeds are particularly vulnerable to predation by blackbirds due to the high nutritional value, easy accessibility, and heads serving as a perch during feeding. Blackbird nests are built in dense vegetation, most often cattails. After nesting, blackbirds form large flocks and begin feeding in grain fields and for this reason, extensive feeding damage often occurs near cattail marches. Feeding begins soon after petal drop and most of the damage occurs during the following three weeks. Peak concentrations of blackbirds occur in mid-September, coinciding with the crop reaching physiological maturity.

Control

A combination of cultural practices may be useful to reduce the risk of blackbird predation on sunflowers. Such practices include:

- Plant at the same time as neighbors – blackbirds are attracted to early maturing sunflowers.
- Do not plant sunflowers near cattail marshes or woodlots - cattail choked sloughs serve as the roosting sites for blackbirds.
- Delayed cultivation of crop stubble increases alternate feeding areas to prevent predation on neighboring sunflower fields.
- Desiccate to advance harvest and reduce the exposure time to blackbirds.
- Decoy cropping to attract blackbirds away from high value confectionary and oilseed varieties.
- Employ scare methods to frighten blackbirds away. Cannons are available from your local Conservation office.
- Cut cattails where viable using a mower or a cattail harvester.

Figure 54. Cattails serve as the roosting sites for blackbirds.

WEEDS

Weeds compete with sunflowers for resources, limiting crop growth and reducing yield. Yield losses caused by weed competition is a factor of weed species, density, relative time of emergence to the crop and environmental conditions. Weed species differ in competitive ability; some causing higher yield losses on a per plant basis.

Sunflowers are a good competitor once the crop is established. Weed competition during the early stages of growth has the largest impact on yield, thus the Critical Period of Weed Control in sunflowers is V-E to V-4.

The following weed sections contains information on specific weed species that are difficult to control in sunflower.

Cocklebur

Cocklebur has the ability to reduce crop yields and quality considerably. It is an annual plant that usually grows in rangelands, along roadsides, and in waste areas. Cocklebur is said to be one of the biggest foreign material problems for confectionary sunflower processors.

Quick ID

Seedling – Long and narrow cotyledons. The stem below the cotyledons is purplish green. First true leaves are triangular with toothed margins. If the plant is pulled up, the remains of the bur can be used to confirm seedling identification.

Juvenile – Cocklebur has an erect, ridged, rough-hairy stem with purplish spots. Leaves have three main veins and are heart-shaped or triangular. Leaves and stems are rough to the touch.

Mature – Female and male flowers are on the same plant, but are separate. The male flowers are spherical and non-spiny. The female flower is green and spiny. If crushed the plant gives off a distinctive odor.

CONTROL TIPS

No in-crop herbicides are available for control of cocklebur in sunflower. Cocklebur plants are shorter and are typically not harvested with the sunflower seed. Use of an all-crop header increases the potential for cocklebur seeds to be collected as it cuts closer to the ground. Crop rotations with small grains and cultivation help manage cocklebur problems.

Figure 55. Mature cocklebur plant

Biennial Wormwood

A native, prolific, small-seeded weed for which both annual and biennial types coexist. Traditionally, biennial wormwood has been classified as a non-crop land weed, and therefore received little attention as a major arable-land weed. Plants typically grow 3 to 7 feet tall with a woody stem averaging 1 to 2 inches (3 to 5 cm) in diameter.

Seedling emergence can occur during the entire growing season under favorable conditions. The plant grows slowly after emergence, remaining as a rosette until midsummer, after which growth becomes rapid. Biennial wormwood is often confused for common ragweed.

Quick ID

Seedling – Cotyledons are oval or oblong and very small (2 to 3 mm). First two leaves are opposite, oval to elongated having 2 small teeth on the leaf margin.

Juvenile – Forms a basal rosette, short-stalked, pinnately divided and re-divided leaves that are coarsely toothed.

Mature – Erect, hairless plant, with a slender stem and little to no branching growing 10 to 175 cm tall. Leaves appear to form a whorl around the stem. Green, inconspicuous clusters of flowers develop on short branches in the axils of small leaves towards the top of the stem. When the upper leaves, stem and flower heads are crushed, they give off an odor resembling a combination of sage and carrot.

Biennial Wormwood VS. Common Ragweed

Biennial wormwood have hairless leaves with sharp edges, where as common ragweed leaves are smooth, hairy and have round edges.

Figure 56. Biennial wormwood seedling

CONTROL TIPS

Biennial wormwood has natural tolerance to many soil-applied and post-emergence broadleaf herbicides. Where possible, pre-emergent followed by post-emergent herbicide applications are the most effective strategy to control biennial wormwood. Since it can germinate season long, a soil applied herbicide with prolonged residual activity is needed to provide optimal management.

Sulfentrazone has shown to have up to 80% control of biennial wormwood in NDSU trials, but no data to support that has yet been established in Canada.

Post-emergent herbicides must be applied to seedlings less than 8 cm tall. No in-crop herbicides are registered for control of biennial wormwood in sunflower. For this reason, crop rotation and planning in previous crops is important to manage the weed. Refer to the Guide to Crop Protection for products that can control biennial wormwood.

Canada Thistle

Is a very aggressive creeping perennial that has the potential to cause significant yield loss. Canada thistle spreads primarily by a deep, horizontal, creeping root system forming dense patches. It thrives in a wide range of soil types, growing best in disturbed areas and overgrazed pasture. A single plant can produce over 6 m of rhizome per year. It is these underground roots that make control of Canada thistle difficult. Canada thistle has separate male and female plants, where only the female plants produce seed. Each plant may produce over 40,000 seeds, which can remain viable in the soil for 21 years.

Quick ID

Seedling - Oblong to broadly oval cotyledons. Shoots that emerge from underground root buds lack cotyledons. First true leaves are ovate with sharp spines along margins (Figure 57).

Juvenile - Irregularly lobed leaves with spines only on the margins. Plants vary in the extent of lobing, length of spines on margins and the presence or absence of hair on the undersides of the leaves. Upper surface is shiny.

Mature – Heads form at the end of stems in clusters made of numerous pinkish purple disc flowers. Bracts are flattened and end in short, weak prickles.

Stems are hollow, erect and smooth; spines may be present near the base of the plant.

CONTROL TIPS

Most of the biomass of Canada thistle plants is below ground; therefore killing the roots is the only effective control method. An integrated management plan is required to reduce infestations. Rhizomes are unaffected by cultivation as they grow below the normal tillage depths. Rhizomes higher in the soil profile that are broken by tillage will produce small root pieces that rapidly develop into new plants. Repeated mowing of the infestation throughout the growing season over several years will deplete the food energy stored in the root system. A variety of herbicides are available for controlling Canada thistle, but residual herbicides are more effective. Fall applications maximize translocation of the chemical into the roots since the plant is putting reserves into the root system to survive the winter. Spring applications just cause re-sprouting of the plants. Most effective control is through a combination of spring-summer mowing, followed by a fall herbicide application.

Figure 57. Canada thistle seedling

Figure 58. Juvenile Canada thistle

Kochia

Kochia is an annual plant, originally introduced as an ornamental garden plant. Since then, kochia has become a major weed problem in many areas of Canada causing severe reductions in yield.

Quick ID

Seedling – Cotyledons are short and narrow, dull-green on the upper surface and bright pink on the underside. The first leaves have many soft hairs. Plants form a basal rosette when not in competition with other vegetation.

Juvenile – Has an erect, purple-striped stem that is heavily branched. Leaves retain the greyish-green appearance and are hairy.

Mature – Leaves become much smaller towards the branch tips resulting in a pyramid-shaped plant. Flowers are green, lack petals, and are inconspicuous in leaf axils. The whole plant turns bright red in the fall. When the plant dries, the stem breaks off at ground level and acts as a tumbleweed, scattering seeds along its path.

CONTROL TIPS

Kochia seeds remain viable in the soil for approximately two years. For this reason, preventing seed production for a few years will nearly eradicate populations. To adequately control kochia, an integrated approach is required. Fallow or short term perennial forage production prevents seed production. Seedlings are controlled by late-spring cultivation. Sulfentrazone (Authority), a pre-seed herbicide, is registered to control kochia. Mow heavy patches of kochia in saline areas to prevent seed production. When spraying seedlings, it is important to maintain water volumes in the upper recommended ranges to achieve sufficient coverage and penetrate hairs on the leaf surface. It is improtant to rotate herbicide groups as kochia can quickly develop herbicide tolerance.

Figure 60. Kochia seedlings

Figure 61. Kochia seedlings have densely haired leaves.

Prairie Sunflower

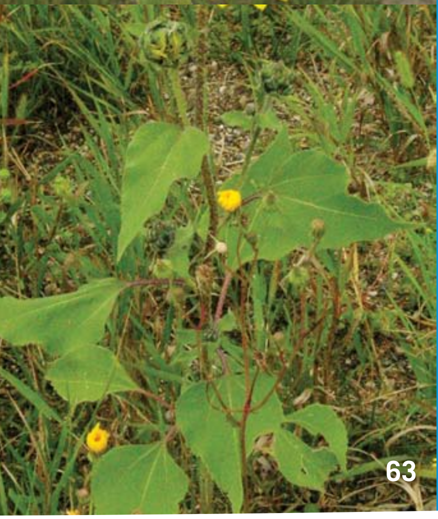
Wild sunflower grows to about the same height as cultivated sunflower, competing for sunlight, space and moisture. It is a host to pests of cultivated sunflower, reducing yield and quality.

Quick ID

Seedlings – Oblong cotyledons and oppositely arranged first leaves. Often found on sandier soils.

Juvenile – Leaves are lanceolate to ovate in shape with a wavy margin, whereas annual sunflowers have distinctly toothed margins. Prairie sunflower stems are covered with short hairs, flattened to the surface. This is contrasting to annual sunflowers which are bristly to the touch.

Mature – The heads of prairie sunflower are smaller than annual sunflower. The central disk flowers are purplish brown and flattened.



CONTROL TIPS

Pre-plant burn down is necessary using any of the labeled products. Solo or Odyssey sprayed in CLEARFIELD hybrids only and Express in ExpressSun hybrids only, has shown to provide control of Prairie Sunflower. Application of these herbicides in non-tolerant hybrids will cause extensive damage. If there are many wild sunflowers growing in CLEARFIELD or ExpressSun sunflower crops, control of the wild species is essential to prevent cross-pollination which could cause the wild sunflower to develop tolerance to these herbicides, diminishing the effectiveness of these technologies. Contact your local seed dealer to find out more about the Crop Stewardship Program.

Figure 62. Wild sunflower

Figure 63. Wild sunflower leaves have a wavy margin.

Wild-Buckwheat

An annual introduced from Europe in contaminated seed, this twining natured plant makes field work difficult. Although not as competitive in sunflower compared to other crops like wheat, a significant seed bank can be produced in sunflower creating problems in future years.

Quick ID

Seedlings – Linear cotyledons attached at 120 degrees to one another. The stem below the cotyledons is often reddish purple. The true leaves are arrow shaped with pointy tips and pointed basal lobes. A papery sheath is found at the base of the first leaves.

Juvenile – Twining growth habit, slender stem branches near the stem. Tangling with crops can cause lodging and make harvest difficult.

Mature – Greenish pink flowers are produced in axillary and terminal clusters.

Field bindweed and wild buckwheat are often confused. The cotyledons of field bindweed are round, leaves have a rounded tip, lacks sheath at the stem nodes, and has a trumpet–shaped flower.

CONTROL TIPS

Between row cultivation or hooded sprayer herbicide application can be used for control in-crop. Pre-emergent herbicide applications including Glyphosate additions offer good control. Several pre-seed herbicides are registered and achieve fair to good control of wild buckwheat. In-crop herbicides such as Assert are rated fair to good. Best control is achieved when plants are 3 inches or smaller. Consult the current Guide to Crop Protection for updated information on registered herbicides and application information.

Figure 64. Wild buckwheat has arrow shaped leaves.

Figure 65. The cotyledons of wild buckwheat are angled at 120 degrees.

Redroot Pigweed

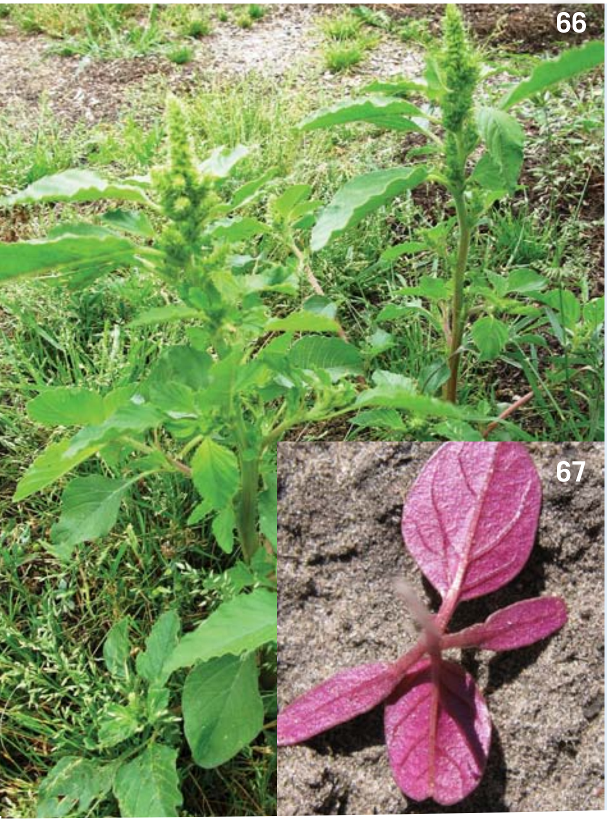
Redroot pigweed is a common weed of cultivated fields, gardens, and waste areas. This weed has an extended germination period, grows rapidly, and has a high rate of seed production. Redroot pigweed thrives and can quickly out-compete suffering crops.

Quick ID

Seedlings – Long narrow cotyledons. First true leaves have a notched tip, into which the midrib extends as a small bristle. The cotyledons and first true leaves are red on the underside. The taproot and stems are also red.

Juvenile – Erect stems, usually hairy and green near the top of the plant while green and smooth near the base. The leaves are diamond shaped, with entire to slightly wavy margins. Prominent white veins on the underside of the leaf.

Mature – Tiny green flowers develop in bristly spikes at the top of the plant. They look and feel bristly.



CONTROL TIPS

Control of redroot pigweed is required continually throughout the crop rotation. Authority has excellent control and can be used in reduced and no tillage systems. The CLEARFIELD and ExpressSun systems also achieve excellent control. Consult the current edition of the Guide to Crop Protection for product information and application tips. Inter-row cultivation or inter-row hooded sprayer applications can also be employed for control; chemical control is most efficacious when made prior to the 4-leaf stage.

Figure 66. Mature redroot pigweed plant

Figure 67. The underside of Redroot pigweed seedling leaves are red.

False Ragweed

Also known as marsh elder, false ragweed is a robust, competitive annual weed of roadsides and waste areas that can grow up to 2 m tall. It produces large amounts of pollen causing hay fever. When not in flower, false ragweed resembles sunflowers.

Quick ID

Seedling – Cotyledons are oval and stalked. The first true leaves are opposite, variably lobed with a soft, hairy texture.

Juvenile – Stems are smooth, much branched and erect. Lower leaves are often three-lobed whereas the upper leaves are broad, almost heart-shaped, with coarse irregular-toothed margins. Leaves are covered with hairs on both surfaces.

Mature – Small, greenish white flowers in branching clusters at the top of the plant.

CONTROL TIPS

Many of the pre-seed herbicides registered for sunflowers achieve good control of false ragweed. Glyphosate burndown at planting and cultivation are the most common control methods. Although it usually germinates before the crop, a cool spring can delay germination. Few post-emergent control options are available. CLEARFIELD sunflowers utilizing Odyssey achieves good control and has residual activity for prolonged control, but not as long as some other “imi” herbicides. Caution is needed with use of residual herbicides and it is important to manage a crop rotation to avoid planting an imi-sensitive crop within the recommended time period. See the Guide to Crop Protection for more details.

Figure 68. Mature false ragweed plant.

Figure 69. False ragweed seedling leaves are hairy.

Green and Yellow Foxtail

Annuals introduced from Europe, green and yellow foxtail are serious weeds of cultivated crops, gardens and roadsides. Seeds germinate throughout the growing season whenever conditions are favorable, making control difficult.

Quick ID

Green Foxtail

Seedling – The first leaves are arched and hairless. Base of the seedling is often reddish.

Juvenile - Leaf blades are flat and light green. The margins and upper surface of leaf blades may feel slightly rough to the touch. The ligule (membrane at the inner base of the leaf where the leaf attaches to the main stem) has an uneven fringe of hairs. Auricles are absent.

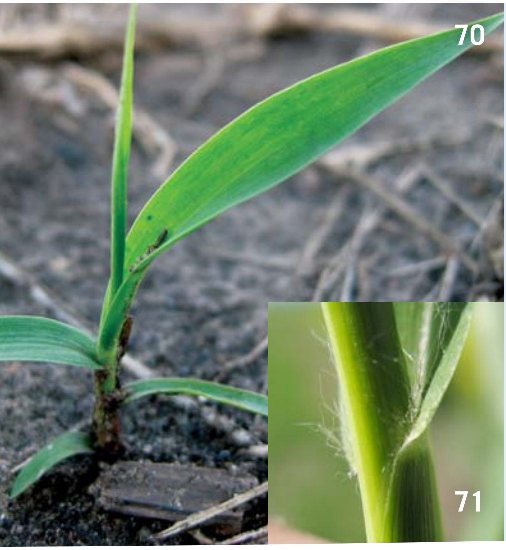
Mature – Soft, green or purple-tinged bristly spike-like panicle resembles a bottle brush.

Yellow Foxtail

Seedling – Arched, hairless early leaves. Base of the seedling is often reddish.

Juvenile – Leaf blades are flat or V-shaped and loosely twisted. Blades are hairless except for long, kinky hairs on the upper surface of the leaves near the base of the blade (completely lacking in Green foxtail). Auricles are absent. Ligule is a fringe of hairs about 3 mm long.

Mature – Spikelets are larger than those of green foxtail



CONTROL TIPS

Pre-plant herbicide options are available that can provide good to excellent control of both these weed species. Post–emergent herbicides are available that provide excellent control. Consult the current issue of the Guide to Crop Protection for control options. Maintaining water volume is important to achieve adequate coverage since the leaves are narrow.

Figure 70. Green foxtail seedling have light green leaves and are completely hairless.

Figure 71. Collar region of Yellow foxtail has long hairs on the upper leaf surface.

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