Best Management Practices for Sunflower Production

Edited by Febina Mathew, Ruth Beck, Patrick Wagner and Adam Varenhorst

South Dakota State University
College of Agriculture, Food and Environmental Sciences

South Dakota State University Extension
South Dakota Agricultural Experiment Station

Forward, Acknowledgements and Contributors

Foreword

The first edition of "Sunflower Production" was published by South Dakota State University (College of Agricultural and Biological Sciences and Cooperative Extension Service) in 2000 (Grady, K. 2000. Sunflower Production. Extension Circulars. 478. http://openprairie.sdstate.edu/extension_circ/478). This publication replaces the first edition of "Sunflower Production". The purpose of this production guide is to update information on commercial sunflower production and pest management for sunflower farmers in South Dakota. However, the information can apply to other sunflower producing areas of the United States. Recommendations for pesticides labelled on sunflower are provided in the South Dakota Pest Management Guide for Alfalfa & Oilseeds (https://extension.sdstate.edu/south-dakota-pest-management-guides). This pest management guide is updated every year and has the list of chemicals labeled for use on sunflower in South Dakota.

Acknowledgments

The editors of the sunflower production guide are grateful to the South Dakota sunflower producers as well as the contributors from South Dakota State University, North Dakota State University, University of Nebraska-Lincoln and South Dakota School of Mines and Technology for writing different sections of this publication.

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South Dakota OILSEEDS COUNCIL

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History

The sunflower crop is native to North America and was first grown by Native Americans over 4,500 years ago for food, medicine, dye, paint, etc. The Spanish explorers introduced sunflower in Spain, following which the crop spread to countries such as England, France, Italy, Egypt, Afghanistan, India, China and Russia. Crop improvement in sunflower began at different places of its introduction, including in Russia, where the scientists worked on increasing the sunflower oil content by more than 40%. In the United States, sunflower was recognized as an economically important oilseed crop in 1966.

In South Dakota and other U.S. states in the Prairies, sunflower was grown for silage during 1920s-1930s and for birdfeed in 1950s. Although the crop was cultivated for oilseed in 1940s in Minnesota and Canada, sunflower production in the northern Great Plains commercially increased in the late 1960s after the introduction of Russian varieties with high oil content. In 1970s, a major expansion in sunflower acreage took place in South Dakota and other U.S. states. To date, at least 75% of the U.S. commercial sunflower production has taken place in Minnesota, North Dakota and South Dakota.

Taxonomy

Cultivated sunflower (*Helianthus annuus* L.) belongs to the *Helianthus* genus and is a member of the Compositae (Asteraceae) family. The *Helianthus* species contain 17 basic chromosomes. While many of the *Helianthus* species are perennial, there are about 12 annual species. A few *Helianthus* species are domesticated for food production or use as ornamentals and the remaining are considered weeds. Over the years, plant breeders have made interspecific crosses of species within the *Helianthus* genus and released commercial hybrids with traits such as high oil percentage, disease and insect resistance.

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Chapter 2: Sunflower Growth Stages

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Sunflower hybrids planted in South Dakota typically range in maturity from 80 to 100 days. Knowing current and historic weather information for a specific area of South Dakota may be important in hybrid selection. Current and historic weather data, including average growing degree-days and precipitation, is available from the SDSU Mesonet at climate.sdstate.edu.

Sunflowers require soil temperatures of 50°F to germinate. The sunflower plant will put its cotyledon leaves above ground within a few days of planting. The growing point is situated between the cotyledon leaves and gives rise to the first pair of true leaves.

Once the first true leaf reaches 1 ½ inches in length, the plant is in the V1 growth stage. V2 is when the second true leaf reaches 1 ½ inches in length (Fig. 2.1).

Figure 2.1. Sunflower plant showing two true leaves fully expanded at V2 growth stage (Photo: Ruth Beck, SDSU).

In general, the vegetative growth stages are determined by counting the number of true leaves that are present. The number of leaves a plant produces is variety dependent and can vary substantially. The vegetative growth stages will continue until the plant develops a bud at the top of the stem. The stage at which the terminal bud forms at the top of the stalk is referred to as R1 (Fig. 2.2).

Figure 2.2. R1 growth stage in sunflowers (Photo credits to Patrick Wagner.).

The R1 growth stage is the beginning of the reproductive growth stages. The terminal bud will continue to stretch and grow in size. The R2 and R3 growth stages are reached when the terminal bud elongates above the nearest leaf (Fig. 2.3). The R4 growth stage is reached when the flower begins to open and immature ray petals can be viewed when looking down on the bud.

Figure 2.3. R3 growth stage in sunflowers (Photo: Ruth Beck, SDSU).

The R5 growth stage is marked by the opening of the yellow ray petals and is the beginning of the flowering stage. Flowering or R5 in sunflowers is divided into substages. The substages are named according to the percent of disc flowers that are flowering. Therefore R5.1 would tell us that 10% of the disk flowers are flowering and R5.5 would indicate that 50% of the disk flowers are opened (Fig. 2.4).

Figure 2.4. R5.5 growth stage. Approximately 50% of the disk flowers have opened (Photo: Ruth Beck, SDSU).

Once flowering is complete and the ray flowers begin to wilt the plant has reached R6. At R7 the back of the head starts to turn pale yellow (Fig. 2.5). The back of the head is yellow, but the bracts remain green at R8. The R9 growth stage is reached when the back of the heads and the bracts are yellow to brown. At R9 the plant is determined to be at physiological maturity.

Figure 2.5. Sunflower plant at R7 growth stage. The back of the head is turning yellow (Photo: Ruth Beck, SDSU).

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Berglund, D. R. 2007. Sunflower Production. NDSU Extension Service. A-1331.

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Chapter 3: Hybrid Selection

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Hybridized sunflower plants emerged in the 1960's when researchers noted strains of wild species could be readily crossed with *H. annuus* and produce fertile progeny.

Hybrid selection by producers is an important part of sunflower production. Each producer will want to select hybrids that do well in their particular location. There are numerous characteristics for producers to consider when making hybrid selection including yield, maturity, stalk strength, height and pest resistance. Producers of oilseed hybrids will want to look for oil content if they want to market their product to crushers, while producers of confection sunflowers will select for seed size. Other characteristics may come into play, depending on grower location.

Results from sunflower performance trials should be carefully analyzed, particularly those managed by local universities or other unbiased organizations where results are based on replicated studies. Some weight should also be given to performance or strip trials performed by seed companies and producers when the information is generated close to the production area.

SDSU runs crop performance trials on sunflowers at several locations each year. Results can be downloaded at the SDSU Extension website (https://extension.sdstate.edu/tags/crop-performance-testing) or picked up at SDSU Extension Regional Centers.

Yield

Data from NASS places average sunflower yields between 1600 to 2100 lbs./acre. However, yields have been reported up to 3000 lbs./acre in some areas of SD.

Maturity

It is important for producers to select hybrids that balance yield and maturity for their geographic area. Later maturing varieties usually yield greater than earlier maturing varieties. However, yield, oil content and test weight will be impacted when a long season hybrid is damaged by frost prior to full maturity.

Oil Content

Oil content is an important trait that is typically monitored and published in variety trial results. Approximately 55% of the sunflowers produced in the U.S. go to the oil market, 25% are slated for birdseed and between 10 and 20% go into snack foods. The oilseed market pays a premium for oil type sunflowers with oil content above 40%. Discounts can occur for oil content below 40%. Markets may also pay a premium based on the type of oil a hybrid produces depending on demand. Oilseed sunflower varieties fall into three categories, traditional or linoleic types, NuSun or mid-oleic types and high oleic varieties. NuSun varieties are now the most common type of oilseed sunflower grown. NuSun varieties produce a healthier oil that contains

20% lower saturated fats than the traditional linoleic types. NuSun oil does not have to be hydrogenated which makes it excellent for use in frying and gives it a long shelf life. High oleic varieties have a higher proportion of oleic acid in the oil along with a longer shelf life.

Pest Resistance

Diseases, insects and weeds are concerns for sunflower producers. Many hybrids now have resistance to downy mildew and sunflower rust. Other hybrids show partial resistance to Phomopsis stem canker and Sclerotinia head rot. Plant breeders are selecting and breeding hybrids with disease tolerance when possible. Information regarding disease tolerance or resistance specific to different varieties is usually available upon request from seed companies. Clearfield and ExpressSun hybrid sunflowers are bred for resistance to specific herbicides. This is covered in more detail in the herbicide section of this manual.

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Mathew, F., and N. Braun. 2019. South Dakota Sunflower Variety Trial Results. South Dakota State University Extension.

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Chapter 4: Seedbed Preparation and Planting

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Planting good quality seed with high germination is an important step in successful sunflower production. Poor seed sourcing may inhibit stand uniformity and vigorous early season growth. Seed is typically sold in units based on seed count. Most seed is treated with fungicide and insecticide to protect the germinating seedlings. As mentioned previously, results from university, local or regional hybrid trials should play an important role in hybrid selection.

The first trait that growers select for when they chose a sunflower hybrid is usually yield. However, since oil content can vary dramatically between hybrids and environments, if the sunflowers are designated for the oilseed market, oil content should also be an important characteristic when selecting a hybrid. In addition to yield and oil content, maturity and test weight are important as well.

Depending on soil moisture, sunflowers are typically seeded at a depth of 1 ½ to 2 ½ inches. Sunflower's woody hull means that soil-to-seed contact is essential to ensure the seed imbibes moisture. Hence, proper functioning of seed-firming wheels and row closers is critical. Sunflowers perform well on a wide range of soil types and pH's ranging from 6.5 to 7.5. They also tolerate saline soils relatively well; particularly where adequate soil moisture and nutrition are available.

Sunflowers offer a flexible planting window with the majority of growers in South Dakota planting from late May to late June. This often makes sunflowers the last crop harvested in the fall. Sustained soil temperatures of about 50°F are required for seed germination. Previous SDSU research indicates that oil content is more sensitive than yield to later planting dates. Therefore, as planting stretches into late June, oil content may be more adversely affected than yield. Typically, oil-type sunflowers mature earlier than confection sunflowers and hence, can be planted later in the planting window.

Because of the later planting dates, tillage generally has less effect on soil temperatures with respect to seed germination. However, since much of the sunflower production exists in the more semi-arid regions of South Dakota, no-till or conservation tillage practices are the predominant tillage systems utilized in sunflower production with the purpose of maintaining soil cover and soil moisture.

Seeding Rate and Spacing

Sunflowers are quite sensitive to seed spacing. Uniform stands are critical for successful production, and to meet contract specifications for seed size for confection types. Hence, seeding rates often vary depending on the type of sunflower planted and its expected end use. Sunflowers will compensate for lower plant populations by producing larger seeds and heads, and vice versa. In order to promote large seed size, it is recommended that confection sunflowers be planted at lower populations than oil-type sunflowers. For example, producers across South Dakota generally plant confection sunflowers in a range from 14,000 to 18,000 pure live seeds (pls) (plants) per acre, with many producers on the lower end of this range in drier climates. On 30-inch row spacing, this equals 9.4 to 12.1 inches in distance between seeds.

For oilseed types, the recommended planting population generally increases from 16,000 to 22,000 pls per acre (10.6 to 7.7 inches between seeds). ConOil sunflowers, as the name suggests, are hybrids developed from both confection and oilseed parentage. Typical ConOil stands are generally at the midway point between confection and oilseeds with a range of 17,000 to 18,000 pls per acre.

Most producers plant on 30-inch row spacing for sunflowers with a row planter. In some cases, growers will plant sunflowers using an airseeder or drill on narrower spacing (e.g., 15-inch row spacing). Planting sunflowers with an airseeder will result in a less uniform stand, which, as mentioned earlier, will result in variability in head and seed size. It is recommended to increase seeding rate by 2,000 to 3,000 pls per acre when using an airseeder or drill. This will help decrease the potential for variable depth placement and inconsistent metering.

Crop Rotation

A well-designed crop rotation can help spread weather and price risks, manage weed populations, reduce plant diseases, manage workloads, and create proper environments for subsequent crops. Producers design crop rotations to meet their individual needs.

There are four crop types that can be included in crop rotations to build diversity: cool (C3) and warm season (C4) grasses, and cool and warm season broadleaf crops. Rotations that face the least weed, disease and insect issues contain at least three of the four crop types, preferably one, or more, of each type of grass and a broadleaf crop. Research also indicates that a crop rotation that includes a two-year interval between any given crop type will help to reduce pest pressure. Some crops will benefit from longer than a two-year interval between crops.

Sunflowers are a full season crop and have a deep taproot that can utilize water and nitrogen from deeper in the soil profile than many common Midwest crops. This can make sunflower a good crop choice during dry years. However, these same characteristics can limit crop options the year after sunflowers. This is especially true for crops grown early in the season (wheat vs millet) because soil moisture is still depleted from the sunflowers.

Other important considerations when determining placement of sunflowers in a crop rotation revolves around disease and other pests. The fact that sunflowers are native to North America means that there are many native disease and insect pests that can affect sunflowers. The disease section of this manual recommends managing many common sunflower diseases with crop rotation. Growing too many sunflower crops on a field within a short interval will lead to high pest pressure. Crop rotations that include only one sunflower crop every four years, at a minimum, are recommended to help mitigate pest concerns. In addition, because there is some crossover between soybean and sunflower pests, such as charcoal rot, *Diaporthe*-associated diseases, white mold and Dectes stem borer, it is not recommended to include soybean in any of the three years between sunflower crops. This recommendation would include canola, alfalfa as well as some pulse crops such as peas, dry beans and lentils due to their susceptibility to *Sclerotinia sclerotiorum* (the white mold fungus).

A common and relatively successful four-year crop rotation used in central South Dakota includes (year 1) spring cereal, (year 2) winter wheat, (year 3) corn/sorghum, (year 4) sunflowers/soybeans. This rotation does present some issues with grass pressure in the wheat crops after several cycles. It is being replaced by rotations that add a second warm-season grass.

A successful crop rotation will increase pest management options and reduce the occurrence of pest resistance. It should also optimize water use, include diversity, increase profitability and reduce risk.

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Notes

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Chapter 5: Sunflower Insect Pollinators

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Introduction

In South Dakota, sunflowers are visited by a pollinator community that is composed of species of bees, wasps, flies, butterflies, and moths. The most important pollinators visiting sunflowers are bees. On average, there are 12 major species of bees visiting sunflowers each year (Figs. 5.1-5.9). In South Dakota, the most abundant bee species visiting sunflower is *Melissodes trinodis* (Fig. 5.1). The pollinator community in central South Dakota includes several bee species that are sunflower specialists. The bee community visiting sunflowers is mainly composed of native species.

Hover flies can also pollinate sunflower (Figs. 5.10-5.13). During years with increased aphid pressure near the sunflower fields or within the fields, hover flies can become very abundant. Numerous species can be observed within a field and the adults will actively visit the sunflower head.

Although commercial varieties of sunflowers are capable of self-pollination, they still benefit from pollinator visitations. One study that included data from South Dakota determined that pollinators increase confection sunflower yields by as much as 45%. Another study conducted in South Dakota determined that pollinators improve yields of both commercial confection and oilseed varieties. These findings suggest that pollinators are important component in sunflower production.

Identification

One of the key characteristics that can be used to distinguish bees from flies is the number of wings. Bees will have two pairs of wings where flies will only have one pair. Characteristics used to distinguish one species of bee from another vary greatly but can include the presence of hair, coloration, size, and the patterns of veins on the wings. Determining the identification of bees often requires the use of a microscope to view some of these unique characteristics. However, visual observations can be used to determine the identity of some species. Because many of the native bees are not well studied or frequently discussed they do not have common names such as bumble bee or honey bee. Due to the difficulty associated with the identification of some of the smaller species we will list them as the Genus spp. This indicates that there are likely multiple species present but identification would require a specialist.

Another major pollinator group in sunflowers are hover flies. Hover flies, also called flower flies, are a diverse group of flies that often mimic bees or wasps with their appearance. These mimics will look and sound like a bee or wasp but do not bite or sting as they do not have a stinger. As mentioned previously, hover flies, like all other flies, only have one pair of wings. This is a characteristic that can be used to easily distinguish them. Other characteristics include very short antennae and proportionately larger eyes, compared to bees, that are placed close together or touching near the top of the head. The larvae are predatory, so hover flies are more common near plants where prey (e.g., aphids) are abundant.

Conservation

During flowering, sunflowers are often sprayed with insecticides to manage insect pests. Any pollinators present on the head are also negatively affected by the insecticide. Before spraying sunflower, it is important to check BeeCheck.org (sd.beecheck.org/map) to determine how close honey bee hives are to the field. The beekeepers listed for nearby hives need to be notified so that they can cover the hive and reduce the likelihood that the bees will be exposed to the applied insecticide.

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Bees

Figure 5.1. *Melissodes trinodis*.
Photo courtesy of Adam Varenhorst.

Figure 5.2. *Melissodes bimaculata*.
Photo courtesy of Johnny N. Dell, Bugwood.org.

Figure 5.3. *Melissodes agilis*.
Photo courtesy of John Baker, BugGuide.net.

Figure 5.4. *Andrena* spp.
Photo courtesy of Cheryl Moorehead, Bugwood.org.

Figure 5.5. *Lasioglossum* spp.
Photo courtesy of David Cappaert, Bugwood.org.

Figure 5.6. *Agapostemon texanus*.
Photo courtesy of Adam Varenhorst.

Bees

Figure 5.7. *Agopostemon virescens*.
Photo courtesy of Adam Varenhorst.

Figure 5.8. Honey bee *(Apis mellifera)*.
Photo courtesy of Patrick Wagner.

Figure 5.9, Bumblebee.
Photo courtesy of Adam Varenhorst.

Hoverflies

Figure 5.10. Hoverfly.
Photo courtesy of Janet Smith.

Figure 5.11. Hoverfly.
Photo courtesy of Patrick Wagner.

Figure 5.12. Hoverfly.
Photo courtesy of Adam Varenhorst.

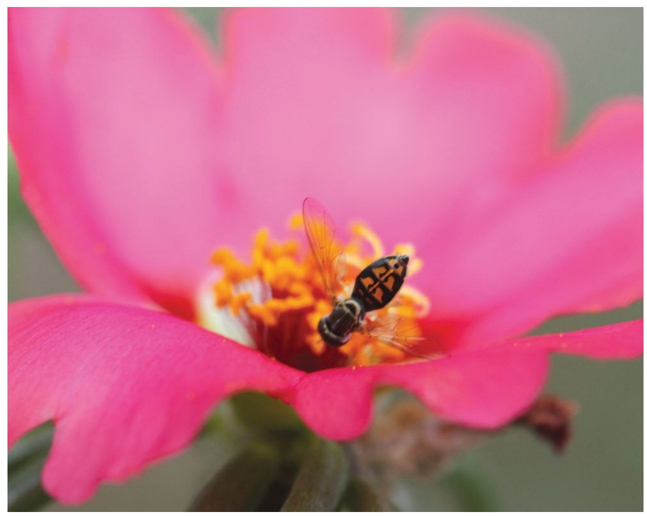

Figure 5.13. Hoverfly.
Photo courtesy of Adam Varenhorst.

Chapter 6: Water Management in Sunflower

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Sunflower are well-suited to the climate in South Dakota. Sunflower is a deep-rooted crop and can extract water from deeper in the soil profile than cool-season crops. Sunflowers are generally produced under dryland conditions but infrequently are used on irrigated land where late planting or very limited water supply favors their inclusion.

This crop has good drought tolerance due to the well-developed root systems and the ability to withstand temporary wilting. However, drought stress can limit crop productivity in certain years in South Dakota. The most critical growth stages of crop development relative to moisture stress are bud initiation, flowering and seed filling (R2 to R7 growth stages). Sunflowers are also produced in sub-humid areas, sometimes in areas with poor, sodic soils or as a warm-season alternative in fields where planting was significantly delayed. Positioning sunflower in the rotation the year following a cereal provides the opportunity for more soil moisture to accumulate in the inter-crop fallow period as compared to placing it in the rotation in the year after corn or sorghum. In all but the driest areas of South Dakota, producers find it most beneficial to plant sunflower after corn or sorghum due to sunflower's ability to extract water and nutrients from the deeper portions of the soil profile.

Irrigation Management in Sunflower

Each year South Dakota producers plant somewhere between 500,000 and 600,000 acres of sunflowers (USDA-FSA). Usually less than 1% of those acres are irrigated. Irrigation management is beneficial but not often used for sunflowers as they are considered drought tolerant. However, when soil moisture is not available from early flowering to seed filling, sunflower is not able to regulate leaf expansion and transpiration rates. As a result, the crop can be highly sensitive to drought stress and substantial yield reduction can be observed, particularly in those production areas that receive low precipitation. Yield losses vary depending on the duration and severity of the drought and can be greater than 30% during prolonged droughts. The genetics of the sunflower cultivar planted also affects drought tolerance. Wild, native sunflowers have excellent drought tolerance, and this genetic reservoir has been used to enhance many commercial varieties. Considering that sunflower is susceptible to Sclerotinia head rot (white mold), irrigation should be avoided during flowering (R-5.1 to R-5.9) growth stages.

Conservation Practices for Enhancing Water Management in Sunflower

Sunflowers were re-introduced as a crop in South Dakota (they were grown by indigenous farmers before European settlement) in the 1960's and 1970's. At this time, they were predominately grown in the cooler and more moist areas of the state. Concerns with drought and wind erosion in the year following a sunflower crop limited their utilization in drier and more fragile ecosystems. Widespread adoption of conservation tillage systems (especially no-till) facilitated the movement of sunflowers to areas along and west of the Missouri river where they are used as part of diverse, no-till rotations (Fig. 6.1). The heavy residue produced by small grain, corn, and sorghum, traps snow and protects soil moisture from evaporation. This increases available moisture for producing sunflowers and and helps to limit erosion after sunflowers.

Figure 6.1. Sunflowers are well adapted to production under no till management practices. Photo courtesy of Dakota Lakes Research Station.

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Chapter 7: Fertilizing Sunflower

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Sunflower can grow in a wide range of soil conditions. However, it grows best on well-drained medium-fine textured soils (e.g., loam, clay loam soil) with near neutral soil pH (6.5 – 7.5). Keeping soil pH near neutral will also provide better nutrient availability from the soil compared to more acidic (pH<6.0) conditions. Sunflowers remove more nutrients from the soil as yield increases. In producing 100 lbs/ac of sunflower seeds, the plant needs to take up approximately 5 lbs of N, 2.5 lbs of P_2O_5, and 3.5 lbs of K_2O (IPNI, 2012).

Starter Fertilizer

Sunflower seeds are very sensitive to fertilizer salts. When planted in 30-inch rows, do not apply fertilizer in contact with the seed. Limit seed placed N + K to 5 lbs/ac when planted in 15-inch rows, and 10 lbs/ac when using 7-inch rows. Urea-based fertilizers, UAN, DAP (18-46-0) or thiosulphate should not be placed in contact with the seed.

Nitrogen

Soil testing is the most reliable method for determining fertilizer needs. Nitrogen (N) is generally the most limiting nutrient for sunflower production. A typical approach to determining N needs in crops is to use a yield response formula and subtract credits of soil test nitrate-N amounts and credits from a previous legume crop. The following equation is currently used to determine N fertilizer rate for sunflower: Yield goal (lbs/ac) × 0.05 – soil test nitrate-N (lbs N/ac) – legume credit + 30 lbs N/ac if using no-till.

Determining a “realistic” yield goal for sunflowers is important to achieve the most accurate N fertilizer rate. To determine a realistic yield goal, follow these four steps. First, gather yield data from the past five to 10 years. Second, delete obvious high and low yields. Third, average the remaining yields. Fourth, if soil moisture conditions are near field capacity (the amount of water the soil can hold without water moving down the soil profile), then increase the average yield by 6 to 10%. If the soil moisture conditions are poor (dry), then reduce the average yield by 6 to 10%. The percentage yield increase or decrease can vary by field, zone, or grid and gives you control of what you expect to see in the coming year. In most years, it is good to increase the value by 5 to 10% because it allows for the increasing yield trend we normally see from year to year. Overall, we want to make sure the yield goal is the yield you can most likely achieve (Table 7.1).

Table 7.1. Example of determining sunflower yield goal in moist and dry conditions.

Year	Yield (lbs/ac)
1	1,760
2	1,830
3	1,840
4	1,670
5	~~1,530~~ too low
6	1,680
7	1,740
8	~~2,060~~ too high
9	1,988
10	1,770
Average	1,790

Yield goal with moist conditions
(+6%) = 1,790 + (1,790 × 0.06) = 1,897
Yield goal with dry conditions
(-6%) = 1,790 – (1,790 × 0.06) = 1,683

In using the current yield goal-based equation and yields from the 2018 and 2019 sunflower hybrid yield trials in South Dakota (987 to 2,957 lbs/ac), soil test nitrate-N + N fertilizer-N recommendations would range from 50 to 150 lbs N/ac with a mean of 95 lbs N/ac. These values would decrease depending on soil test nitrate-N level (if soil test nitrate-N is unknown, use 40 lbs N/ac) and legume credits and increase if using no-till.

Recent South Dakota fertilizer-N response studies found an economically optimal fertilizer-N rate of approximately 80 lbs N/ac was very common regardless of sunflower yield. It is important to note that sunflowers are sensitive to over application of N. Recent studies in North Dakota and South Dakota found very little yield increase (and often a decrease) with fertilizer-N application rates significantly over 100 lbs N/ac. The small increase in yield with greater N rates shown in figure 1 was not statistically significant. Typically, as more N was available to the crop, plant biomass increased, resulting in larger leaves and taller stalks. However, total seed yield did not increase. Studies from North Dakota indicated that reduced sunflower yield with higher fertilizer-N rates was likely due to increased lodging severity and disease susceptibility. Additionally, recent studies from South Dakota showed that the oil content of sunflower seeds decreased with increasing fertilizer-N rates.

Most growers are concerned about lodging of sunflowers and the reduction of oil content of oil-seed sunflowers, which has been shown to be highly correlated to fertilizer-N rate. Therefore, the soil test nitrate-N + fertilizer-N level (Total required N) is capped at 150 lbs N/ac even though there may be small yield increases above this level in some years. Therefore, the new sunflower fertilizer-N recommendation is as follows:

1. Yield Goal × 0.05 = Total required N (soil test nitrate-N + fertilizer N). If this value is above 150 lbs N/ac, then it should be reduced to 150.
2. Total required N – soil test nitrate-N (lbs N/ac) – legume credit (lbs N/ac) + 30 lbs N/ac if using no-till.
    a. For legume credits see table 7.2.
    b. Recent research in South Dakota showed that in long-term no-till fields the additional 30 lbs N/ac is no longer needed. However, research is still on going to determine what length of time or level of soil quality is required before this additional N requirement can be dropped.

Example:

- Yield goal: 1,900 lbs/ac.
- Soil test results: 15 lbs nitrate-N available in the top two ft.
- Previous crop: Soybean. Therefore a 40 lb/ac N credit will be used.
- Tillage: Recent conversion to no-till. Therefore 30 lbs N/ac will be added to the N recommendation.

Yield goal is multiplied by 0.05 to determine total required N. If this value is above 150, it is reduced to 150. Next, from the total required N value, soil test nitrate-N (15 lbs/ac) and legume credit (40 lbs/ac) are subtracted and 30 lbs N/ac is added because we recently converted to no-till. The resulting N recommendation is 70 lbs N/ac.

1. **1,900 lbs/ac yield goal × 0.05 = 95 lbs of total N required**
2. **95 lbs of total required N – 15 lbs N/ac soil test credit – 40 lbs N/ac legume credit + 30 lbs N/ac no-till debit = 70 lbs N/ac recommendation.**

Properly crediting soil nitrate-N can be difficult when producing sunflowers because active roots go down 4 to 6 feet and soil N is typically assessed from a 0 to 24 inches soil sample (Table 7.2). These deep-rooted sunflowers can also utilize N from deeper parts of the soil profile than other crops. Thus, sunflowers will often yield greater than the yield goal for a given N application rate. If possible, sunflower fields should be soil sampled to a 4-feet deep depth to assess the amount of N below 2-feet that can be accessed by the deep-rooting sunflower plants. This is especially helpful in new sunflower fields and when other deep-rooted crops, such as safflower have not been planted previously.

Table 7.2. Legume nitrogen (N) credits.

Previous Crop	Plants/ sq. ft.	Nitrogen Credit (lbs/ac)
Soybean, edible beans, peas, lentils, and other annual legumes	N/A	40
Alfalfa and legume green manure crops (sweet clover, red clover, etc.)[1] [2]	> 5	150
	3–5	100
	1–2	50
	< 1	0

[1] When no-tilling into alfalfa and legume green manure crops, use half credit.
[2] For 2nd year following alfalfa and legume green manure crops, use half credit.

Fertilizer-N Application Timing and N inhibitors

Split-N application, in theory, should be beneficial compared to a single at-planting fertilizer-N application as only a portion of the fertilizer-N provided to the sunflower would be susceptible to early season N losses. However, a study in South Dakota showed little yield difference between a single near-planting N application and when half of the total fertilizer N was applied at planting and the other half at V4 or R1 growth stage.

Urease inhibitors slow the conversion of urea to inorganic N, which protects it from environmental losses (volatilization, leaching, denitrification). Recent research found a trend towards greater seed yield and fertilizer-N uptake when using a urease inhibitor compared to a split-application or single application without an inhibitor. These results indicate when urea is used as the N source, a urease inhibitor could be an effective tool to produce sunflower in environmentally sensitive areas and reduce the need to apply fertilizer-N near planting and during the growing season.

Minimal differences have been found among N fertilizer materials when N products are properly applied. Therefore, N source decisions can be made based on availability, cost, and equipment.

Phosphorus

Phosphorus (P) removal by sunflower is generally very low and its extensive root system scavenges residual P effectively. Hence, response to P fertilization by sunflower in U.S. studies has been minimal even when following fallow. Phosphorus fertilizer application should be based on soil testing and only applied when soil test levels fall in the low to very low categories (Table 7.3). Additionally, recent studies have shown that it is likely more economically effective to focus on applying P fertilizer to the crop after sunflower. Therefore, the sunflower P fertilizer recommendation is zero.

Potassium

Potassium (K) fertilizer application should be based on soil testing and only applied when soil test levels are medium to very low. This level of soil test K normally only occurs in sandy soils. Potassium rate trials for sunflower have not been conducted in South Dakota to determine the level at which no yield increase is likely to occur. In other areas of the U.S., a soil test level of 160 parts per million is considered sufficient to maximize sunflower yield. This correlates well with data from our corn K rate studies that also has a sufficiency level of

Table 7.3. Soil test calibration levels used to determine the probability of response to fertilizer applications.

Nutrient	Soil Test	Very low	Low	Medium	High	Very high
Probability of response		80%	60-80%	40-60%	20-40%	< 20%
ppm extractable (0-6 inches)						
Phosphorus	Olsen-P	0-3	4-7	8-11	12-15	16+
Phosphorus	Bray P-1	0-5	6-10	11-15	16-20	21+
Potassium	NH_4 Acetate	0-40	41-80	81-120	121-160	161+
lbs/ac (0-2 feet)						
Sulfur	500 ppm P	0-9	10-19	20-29	30-39	40+

160 parts per million K. Few instances of K deficiency occur in South Dakota as the areas of the state where sunflower is most frequently planted have inherently high levels of K that are normally above 160 parts per million. However, when soil test levels fall below 160 parts per million a minimum of 60 lbs K/ac is recommended to optimize sunflower yield.

On most soils, banding of K near the seed is most efficient as K moves very little in soil, but it can also be broadcast and incorporated before planting. Refer to the starter fertilizer section to make sure N and K rates in starter fertilizers are not high enough to reduce seed germination. There are minimal differences in K availability among K fertilizers therefore any K fertilizer can be used without negatively affecting sunflower production.

Sulfur

Sulfur (S) fertilizer application is based on soil texture, tillage, and soil test level of the top 2 feet. Coarse textured soils are the most susceptible to S deficiency. Use table 7.4 as a guide to determine fertilizer S rate to apply to your field.

These S rates should be broadcast applied or a reduced rate of 10 to 15 lbs actual S/ac can be applied in the row or with the drill. Sulfur is a mobile nutrient and thus should be applied in the spring. Fall applications are not recommended as S can be leached below the rooting zone from winter and spring rainfall events. Sulfate forms of sulfur (ammonium sulfate 24% S, gypsum 18% S, and potassium sulfate 17% S) are the best sources for immediate effectiveness. Sulfur as a thiosulphate is also a good option but should NOT be applied with the seed as noted in the starter fertilizer section. Elemental S is not recommended as it requires 1 to 3 months in warm soil before it is completely available.

Other Nutrients

Other secondary and micronutrient deficiencies in sunflower are rare and have not been reported in sunflowers grown in South Dakota. The lack of deficiencies of these other nutrients may be due to the extensive root system of sunflowers. Deficiency symptoms of secondary and micronutrients are often only seen in sensitive crops such as corn, sorghum, edible beans, flax, and potatoes. Iron deficiency at the seedling stage of sunflowers results in interveinal chlorosis of the youngest leaves and plants are stunted. Zinc deficiency will result in stunted plants with distorted upper leaves and plants normally wilt as deficiency increases. However, deficiencies or responses to added micronutrients and secondary nutrients besides S are not likely in South Dakota. Therefore, application of these nutrients is not recommended.

Table 7.4. Sulfur recommendations for sunflower.

Soil Texture	Tillage	Sulfur Soil Test Categories (lbs/ac, 0-2 ft.)				
		Very low (0-9)	Low (10-19)	Medium (20-29)	High (30-39)	Very high (40-49)
		Sulfur Recommendations (lbs S/ac)				
Coarse	Conventional	25	25	15	15	0
	Strip-till or no-till	25	25	25	15	0
Medium/Fine	Conventional	25	15	0	0	0
	Strip-till or no-till	25	25	15	15	0

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Notes

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Chapter 8: Harvesting Sunflowers

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Harvesting

Harvesting sunflowers is a challenge. As one sunflower producer relayed "changes in temperature, humidity and plant moisture make setting the combine (to harvest sunflowers) a moving target from day to day and even from hour to hour."

Sunflowers are usually ready for harvest around 120 days after planting. This varies with climate and genetics. Therefore, although there are usually fields that are harvested in September and some as late as November, the bulk of sunflower harvest in South Dakota occurs in October.

Sunflowers are physiologically mature at growth stage R9 or when the back of the head has turned yellow and the bracts have turned yellow or brown. At this stage, seed moisture is around 35% or below.

Some growers may choose to desiccate their sunflowers in order to speed up harvest timing. The sunflowers should be at physiological maturity before application of a desiccant to avoid reduced yield and quality. There are numerous benefits to early harvest including reduced losses from lodging, shatter and bird damage. It can also allow producers the flexibility to spread harvest out and alleviate demands on time, labor and equipment. Early harvest can also help facilitate winter wheat planting if desired. For information on products labelled for desiccation on sunflowers, refer to the South Dakota Pest Management Guide for Alfalfa & Oilseeds. Application timing for desiccants is important. A video clip on desiccants by K. Howatt (NDSU) is posted on the https://www.sunflowernsa.com/growers/HarvestingStorage/Desiccant-Considerations/. Sunflower seed harvested at higher moisture will need to be dried prior to storage. Moisture level considered safe for seed storage is 9.5%.

It is possible to combine sunflowers with a row header, corn or small grain platform header fitted with pans. Traditionally the use of row crop headers has been common. However, in recent years, numerous companies have developed header options for sunflowers. Now it is also common to see combine headers designed specifically for sunflowers. Producers may also choose to use harvest attachments or special conversion kits fitted to their corn head.

With any header, it is very important to gather as many heads as possible with minimal stalk entering the combine and with as little shattering and seed loss as possible. Threshing sunflower heads results in fewer losses if the cylinder speed is only fast enough to thresh the seeds, the concaves are kept open, and seed moisture is in the low teens. Ideally, whole sunflower heads should leave the combine with only unfilled seeds in them.

Sunflower seeds are relatively light compared to other crops. Adjust the fan so there is only enough wind to keep the trash floating across the sieve. The upper sieve should be open enough to allow an average seed to pass through on end. The lower sieve should be adjusted to provide a slightly smaller opening. The final adjustments will depend on the amount of material returning through the tailings elevator and an estimation of the amount of dockage in the grain tank. Proper setting is critical, especially during harvest of larger, lighter confection type seeds. Always refer to the combine manual for initial settings.

Improper combine settings that contribute to harvest losses can be costly. Sunflowers sold at $0.16/lbs., with 5 percent harvest losses in a field yielding 2400 lbs./acre will cost producers $19.00/acre. Field losses prior to harvest and during harvest can be assessed by counting seed on the ground ahead and behind the combine. The rule of thumb is that ten seeds per square foot represents a loss of 100 lbs. per acre. Seed counts taken behind the combine will need to be adjusted to account for the reduction from the width of the header to the width at the rear of the combine. Be sure NOT to count unfilled seeds. More information on calculating harvest losses is found in the NDSU Sunflower Production Guide (www.sunflowernsa.com/growers/Production-Resource-Books/).

Sunflowers present a real fire hazard during harvest. Removing all old crop material (chaff) and starting with a very clean combine prior to harvest can reduce the risk of fire. Additionally, using compressed air (or a leaf blower) regularly to remove the dust that collects, especially around the engine compartment and exhaust, will keep the fire hazard to a minimum. Early harvest, with higher moisture plants and seeds, and late harvest, with much cooler ambient temperatures, can help mitigate the fire risks.

Drying

Harvesting sunflowers that are dry enough to put directly into storage is the best scenario. However, weather conditions and other factors will determine if this happens. Natural air, bin, batch and continuous flow dryers can all be used to dry sunflowers.

Natural air and low temperature bin drying are energy efficient methods to bring the grain moisture down to levels acceptable for storage. These methods can work well in the fall when weather is conducive. They are, however, less efficient in cool wet conditions and when the moisture content of the grain is above 15%. As with any grain crop, drying will become harder as air temperatures cool and relative humidity levels increase later in the fall.

It can be easy to over dry sunflowers as they weigh less per bushel than other grain crops such as corn. Therefore, they will dry faster because there are smaller quantities of water to be removed. Another concern that involves drying sunflowers is the high risk of fire hazard. The very fine hairs or fibers on sunflower seeds can be rubbed off during handling. These hairs, along with other plant material can be drawn through the drying fan and open burner, igniting and causing a fire. The hazard can be reduced if the fans are turned into the wind, giving them access to clean air. Daily cleaning of the dryer, air ducts, and other surrounding areas and surfaces, can also help reduce the fire hazard. In the case of a fire, producers should immediately shut off the fan to reduce the oxygen supply, douse small fires with water, and keep a fire extinguisher for oil type fires on hand. Dryers should not be left unattended when running.

The sunflower seed hull will dry faster than the meat or kernel. This can lead to lower initial moisture readings when the seed is removed from the dryer. The moisture of the seed can “rebound” a percent or two as the hull and kernel reach an equilibrium. For an accurate reading on moisture, the seed should be placed in a sealed container for 6-12 hours and then retested. This allows the moisture to equalize throughout the seeds.

Storage

Sunflower seed that has significant amounts of chaff and trash should be cleaned before drying or storage. This will improve airflow through the stored grain. Grain stored with high amounts of fines, trash or other material will be more susceptible to problems. Oil type sunflowers are considered safe for short-term storage at 10% moisture, and long-term storage at 8% moisture. Confection type sunflowers can be safely stored for less than six months at 10% moisture and for longer at 9% moisture. Sunflowers should be cooled to 40°F or below when they are put into the bin and to about 25°F during the winter. These cooler temperatures will help prevent moisture accumulation and insect and mold damage. Bins should be checked weekly for moisture accumulation, crusting or temperature changes within the pile.

The use of polybags to store sunflowers is becoming more common. Bags are a viable option to store sunflowers for the short term or even through the winter. Bag storage can be a solution if bin space is short, trucks limited and/or transport costs high. The benefit of bags is the sunflowers can be stored where they are harvested as long as the moisture of the grain is 10% or less. Successful storage of sunflowers in bags is dependent on the grain going into the bags dry and temperatures remaining cool. Bags should be placed on clean ground with good drainage and monitored regularly for wildlife damage.

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Chapter 9: Weeds in Sunflowers

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Weeds compete well with sunflowers in South Dakota. Heavy weed pressure has been noted to reduce yield by as much as 60 to 90 percent. Early season weeds like kochia *(Kochia scoparia)*, marestail *(Conyza canadensis)*, lambsquarter *(Chenopodium album)*, and red root pigweed *(Amaranthus retroflexus)* are commonly observed in sunflower fields. Other weeds like field bindweed *(Convolvulus arvensis)*, Canada thistle *(Cirsium arvense)*, wild buckwheat *(Polygonum convolvulus)*, and wild sunflower *(Helianthus annuus)* can also be difficult to control but are usually not widespread across all production acres.

Wild Sunflowers

If wild sunflowers are a problem (Fig. 9.1) they will need to be controlled and the seed bank reduced before sunflowers are planted.

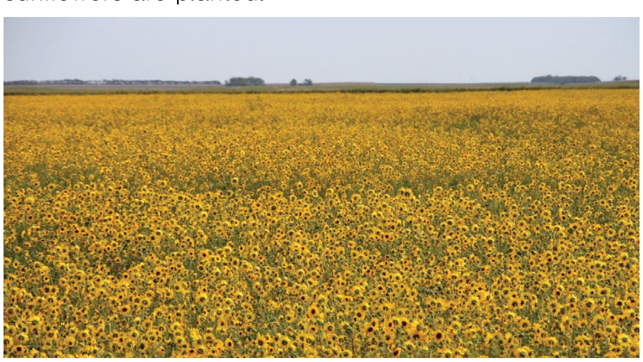

Figure 9.1. Fields with heavy infestations of wild sunflowers are not good areas to grow sunflowers as a crop due to the weed pressure from the wild sunflowers. Photo courtesy of Paul O. Johnson.

Weed Control Program

To control weeds in sunflower production, a comprehensive management plan is needed. Weeds are not just controlled with chemicals, but cultural practices also play a big role in weed management. Early season weed control in sunflowers is very important. The first month of growth is slow. This is when sunflowers do not compete as well as compared to later in the season. Weeds that are there longer than the first month can cause important yield loss if they are not removed. Chemical weed control recommendations are provided in the South Dakota Pest Management Guide for Alfalfa & Oilseeds (https://extension.sdstate.edu/south-dakota-pest-management-guides). These guides are updated yearly and list all products labeled for use in South Dakota.

Important cultural practices that can help manage weeds in sunflowers include crop rotation and time of planting. Tillage can also be considered a cultural practice that helps with weed management. However, most non-organic production of sunflower in South Dakota utilizes no-till management practices.

A chemical weed management plan should be prepared before sunflower is added into the crop rotation. The first consideration is whether the previous crop set the field up for low weed pressure? If weed problems existed during the previous growing season, these will need to be addressed the fall before planting sunflowers. Second, depending on rainfall, is a preemergent herbicide planned for the fall, early spring or close to planting? Third, are there weeds growing that require a burn down treatment at or before planting time? For the best weed control there should be no weeds actually growing when the crop begins to emerge. Sunflowers have limited post emergent chemical products available and for some weeds, there are no products available. This is why having a planned weed control program is critical. Identifying existing weed problems in a field and what products are available to control them is an important part of that program.

Rotate Herbicide Chemistries

Rotation of herbicide chemistries where possible or using more than one chemistry is important to reduce the chance of developing more resistant weeds. Presently there are eight chemistries labeled in sunflowers and they include groups 1, 2, 3, 8, 9, 14, 15, and 22.

Group 1 are ACCase inhibitors. Examples are clethodim or sethoxydim. They provide postemergence grass control.

Group 2 are ALS inhibitors. An example is tribenuron. In order to use this herbicide, use Express tolerant Sunflowers and then spray the Express post-emergent for broadleaf weed control.

Group 3 are microtubule inhibitors. Examples are pendimethalin or trifluralin. These are used early preplant in fall or spring, preplant incorporated, or preemergence. They provide both grass and broadleaf weed control.

Group 8 are lipid synthesis inhibitors. An example is EPTC. It is used preplant incorporated in the fall or spring and gives grass and broadleaf weed control. EPTC needs to be incorporated to work.

Group 9 is an EPSP inhibitor. Glyphosate is used for burn down, hooded sprayer or pre-harvest weed control. It controls all weeds except those that have developed resistance to glyphosate.

Group 14 are cell membrane disrupters (PPO inhibitor). Examples are sulfentrazone or flumioxazin. Group 14 herbicides mainly control broadleaf weeds. They are used in the fall or as an early preplant. Some products are also labeled for preemergent and harvest aid use.

Group 15 herbicides are seedling shoot inhibitors. Examples are metolachlor or pyroxasulfone. These are used from early preplant to preemergence, and some are also labeled for early post emergence application. However emerged weeds are not controlled. They are used for both broadleaf and grass control.

Group 22 are cell membrane disrupters (PSI inhibitor). An example is paraquat. Paraquat is used as a burndown or a harvest aid. It kills all weeds and will also kill the sunflowers as a way to speed up harvest in the fall.

Figure 9.2. Kochia can be a difficult weed to control in sunflowers. Heavy infestations will reduce yield. Photo courtesy of Paul O. Johnson

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Chapter 10: Diseases of Sunflower

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Phoma Black Stem *(Phoma macdonaldii)*

Phoma black stem is widespread disease throughout sunflower fields in South Dakota. Yield losses are considered rare but can occur in high disease pressure and are more common if the fungal pathogen is transmitted into the stem by sunflower stem weevils *(Apion occidentale)*.

Biology: The causal fungus, *P. macdonaldii*, survives on infested crop residue. Phoma black stem can be observed at any time on the sunflower plants during the growing season when environmental conditions are favorable, such as rainfall, humid conditions, and moderate temperatures (60 to 75°F).

Symptoms: Disease symptoms include chlorosis and necrosis in leaf veins and/or petiole and jet-black colored lesions on the stem of the plant, specifically at the base of the petiole. The lesions on the stem have definite borders and appear shiny (Fig. 10.1). Lesions are generally superficial and do not severely damage the pith or cause lodging (Fig. 10.2).

Figure 10.1. Phoma black stem lesions on the stem of the sunflower plant (Photo: Samuel Markell, NDSU).

Figure 10.2. Phoma black stem lesions do not cause wilting or lodging of sunflower plants (Photo: Samuel Markell, NDSU).

Management: Phoma black stem can be managed by crop rotation and avoiding planting near a field with crop residue from previously cropped to sunflowers. Foliar fungicides may be applied and can be efficacious but may not be economically viable.

Phomopsis Stem Canker (*Diaporthe helianthi, D. gulyae,* species of *Diaporthe*)

Phomopsis stem canker is an economically important stem disease of sunflower in South Dakota. However, the disease prevalence varies among years and locations. Yield losses greater than 40% have been observed in severely affected fields.

Biology: The causal fungus (or fungi) overwinters on infested crop residues. Phomopsis stem canker is favored by wet weather, high humidity (~90%) and moderate temperatures (68 to 77°F).

Symptoms: Disease symptoms include brown-colored lesions on the leaves (Fig. 10.3), which spread into the petiole and stem. The lesions on the stem begin as a small, brown-colored spot that can become large and tan-to-light brown colored (Fig. 10.4) over time. These stem lesions are often and commonly six inches or more in length, and larger than lesions caused by Phoma black stem. Phomopsis stem canker can cause extensive degradation of the pith, becoming soft and mushy enabling the stems to be easily crushed by light to moderate thumb pressure. Infected plants will then lodge easily, resulting in severe loss at harvest.

Figure 10.3. Phomopsis stem canker lesion observed on the leaf (Photo: Febina Mathew, SDSU).

Figure10.4. Phomopsis stem canker lesion observed on the stem (Photo: Febina Mathew, SDSU).

Management: Phomopsis stem canker can be managed by rotating with non-hosts (e.g., wheat, corn), eliminating crop residue, controlling volunteer and wild sunflowers (that are hosts) and avoid planting near fields that were affected in the previous season. Commercial hybrids with partial resistance are available. Application of foliar fungicides at R1 growth stage (when miniature floral head is formed on the plant) may help mitigate Phomopsis stem canker, but the efficacy may also be affected by prevailing weather conditions and disease pressure.

Sunflower Rust *(Puccinia helianthi)*

Rust is an important foliar disease of sunflower in South Dakota, but the disease severity varies among fields, based on time of infection and disease progress influenced by environmental conditions. Yield losses up to approximately 80% have been reported from rust in the neighboring state of North Dakota.

Biology: The rust fungus is very specific to sunflower and can overwinter (as teliospores) on residues of wild, volunteer or commercial sunflower even during the harshest South Dakota winter. When rust overwinters, the first visible signs and symptoms of rust can occur in vegetative growth stages as small (¼ inch or less) circular orange bumps (pycnia; Fig. 10.5) on the top sides of leaves. On the underside of the leaf will be a small cluster of orange cups (Aecia; Fig. 10.6). These structures are relatively uncommon and rarely observed. Rust most frequently appears in reproductive growth stages, and when small cinnamon-brown pustules (uredia) appear on leaves (Fig. 10.7).

Figure 10.5. Circular, orange-colored bumps (pycnia) produced by the sunflower rust pathogen on the leaf (Photo: Samuel Markell, NDSU).

Figure 10.6. Orange colored cups (aecia) produced by the sunflower rust pathogen on the leaf (Photo: Samuel Markell, NDSU).

Figure 10.7. Cinnamon-brown colored pustules (uredia) produced by the sunflower rust pathogen on the leaf (Photo: Samuel Markell, NDSU).

Symptoms: Pustules may be surrounded by a yellow halo and will be filled with cinnamon-brown spores that easily rub off leaving a dusty streak of urediniospores. Spores can be dispersed by wind for miles. Rust is favored by long periods of leaf wetness (fog, dew) and air temperatures between 55 and 85°F.

Management: The disease is best managed by using integrated management practices, which include removal of overwintering hosts (such as wild and volunteer sunflowers), avoiding planting sunflower adjacent to a field with infested crop residue, selecting commercial hybrids with rust resistance, removing infested residue (by plowing, disking, etc.), and applying a foliar fungicide if needed. While considering foliar fungicide applications, it is critical to scout sunflower fields for rust. A foliar fungicide is likely beneficial if 1% rust severity is observed on the four uppermost-fully-expanded leaves at or before bloom (growth stage R5). Fungicides applied at R6 or after are not likely to be beneficial. In cases where rust has overwintered, observed in vegetative growth stages, and conducive conditions for disease development persist, an earlier application may be beneficial.

Sclerotinia Wilt/Basal stalk rot, Sclerotinia Mid-Stem Rot and Sclerotinia Head Rot *(Sclerotinia sclerotiorum)*

The causal fungal pathogen, *S. sclerotiorum*, causes three different diseases on sunflower - Sclerotinia wilt/Basal stalk rot, Sclerotinia mid-stem rot and Sclerotinia head rot. The fungus has a large host range (~350 plant species), known to cause "white mold" in all broadleaf crops and weed species. Among the three diseases, Sclerotinia head rot is most prevalent in the Northern Great Plains. Sclerotinia wilt/Basal stalk rot and Sclerotinia mid-stem rot may be common in Northern Great Plains, but these are generally more common in the Central High Plains and Southern Great Plains. Yield losses between 10 and 70% have been documented.

Biology: The fungus survives as irregularly shaped black structures (sclerotia) in the soil and plant residues, that resemble rat droppings. Sclerotia can persist for several years in the soil. For Sclerotinia wilt/Basal stalk rot, sclerotia can germinate to produce mycelium, which infects the lateral roots of the plants. For Sclerotinia mid-stem rot and Sclerotinia head rot, sclerotia can germinate to form small structures resembling mushrooms (apothecia) that produce and release spores (ascopores). The ascospores can move by rain splash and for several miles by wind. These spores, upon availability of free moisture, infect the senescing plant tissue and flower petals, initiating new infections and disease.

Symptoms:

Sclerotinia wilt/Basal stalk rot. Disease symptoms include a tan to light brown colored lesion, often at the soil line, which may girdle the stem over time. Dense, white-colored growth of the fungus may be observed on the stem lesion (Fig. 10.8). The affected plants can wilt and/or lodge as they enter reproductive growth stages of crop development. Additionally, these affected plants may occur singly or in clusters within rows.

Figure 10.8. Tan-colored lesions of Sclerotinia wilt/Basal stalk rot at the base of the sunflower plant (Photo: Samuel Markell, NDSU).

Sclerotinia mid-stem rot. The causal fungus produces a tan-colored, water-soaked lesion on the stem of the plants, primarily around the petiole. These lesions will enlarge over time and will eventually girdle and shred the stem (Fig. 10.9). Sclerotia can be visible within or on the exterior of the sunflower, however, they are observed towards the end of the growing season.

Figure 10.9. Shredding of stem of sunflower plants from Sclerotinia mid-stem rot (Photo: Samuel Markell, NDSU).

Sclerotinia head rot. Disease symptoms are observed as a soft, brown-colored lesion on the back of the sunflower head. The lesion will spread to cover a portion or the entire head, and at times, white growth of the fungus may appear on the face of the head. As the disease continues to develop, the head may completely shred and fall apart, resembling a white straw broom that can be seen from a distance (Fig. 10.10). Several sclerotia may be produced within the sunflower head with varying shape and size.

Figure. 10.10. Sclerotinia head rot on a sunflower plant (Photo: Samuel Markell, NDSU).

Management: Managing Sclerotinia wilt, Sclerotinia mid-stem rot and Sclerotinia head rot can be a challenge. Current options include rotating sunflower with non-hosts (e.g., wheat and corn), managing broadleaf weeds and crop volunteers that are hosts of *S. sclerotiorum*, and avoiding practices (excess nitrogen or high seeding rate) that can increase crop canopy density. Commercial hybrids with partial resistance are available that be planted in fields with history of white mold. At the time of this publication, foliar fungicides are not recommended as limited efficacy has been demonstrated. Microbial products may be available for biological control of *S. sclerotiorum*, but their efficacy data is currently lacking.

Other diseases of less importance in South Dakota

Bacterial leaf spot *(Pseudomonas syringae pv. helianthi)*

Bacterial leaf spot is now commonly recognized occurring in sunflower production throughout temperate growing regions worldwide but is seldom considered to be an economically significant problem. Symptoms of bacterial leaf spot are variable, depending upon cultivar and accompanying environmental conditions. Leaf lesions begin as small necrotic spots of varying size and shape. Initially the spots are water-soaked and angular later becoming necrotic. The lesions may also be surrounded by a yellow (chlorotic) halo (Fig. 10.11), which also can coalesce to form large chlorotic areas on affected leaves. As disease progresses, the leaf spots coalesce, dry up and die. As the disease is often found occurring primarily on leaves in the lower part of the canopy, it seldom causes yield reductions. Like many bacterial pathogens, it is spread by splashing rains and high winds, and can also infect plants naturally through open stomata on leaves and through wounds created by hail, sandblasting, or other forms of mechanical damage. No control measures are warranted or recommended due to the normally low degree of damage to affected plants.

Figure 10.11. Bacterial leaf spot on sunflower leaf (Photo: Robert Harveson, UNL).

Charcoal Rot *(Macrophomina phaseolina)*

Charcoal rot can cause yield loss of sunflower under hot and dry environments. In South Dakota, the disease is less common than other stem diseases, such as Phomopsis stem canker and Phoma black stem. Charcoal rot can develop during the reproductive growth stages of crop development and is favored by high temperature (>90°F) and low soil moisture. Disease symptoms include a gray-colored lesion on the stem at the soil line (Fig. 10.12), and possibly premature senescing or lodging. The interior of the stem may be filled with dusty, black-colored microsclerotia (Fig. 10.13). Charcoal rot can be managed by rotating sunflower with non-hosts (e.g., wheat) and by avoiding drought stress through irrigation.

Figure 10.12. Charcoal rot of sunflower at the base of the stem (Photo: Robert Harveson, UNL).

Figure 10.13. Microsclerotia produced by the charcoal rot fungus inside the stem (Photo: Robert Harveson, UNL).

Downy Mildew *(Plasmopara halstedii)*

Downy mildew is infrequently observed in South Dakota. Yield loss from downy mildew depends on the disease incidence (number of diseased plants) and distribution of the affected plants. Root-initiated systemic infections occur early in the season when seeds are germinating, and plants are emerging. Infected plants are severely stunted (Fig. 10.14) and exhibit conspicuous chlorosis and yellowing between veins that may be confused with virus symptoms (Fig. 10.15). These types of infections are favored by cool and waterlogged soil conditions. The causal pathogen is a soilborne, fungal-like oomycete and can survive in soil for long periods of time and is specific to sunflower. Downy mildew can be managed by selecting hybrids with resistance to *P. halstedii* and fungicide seed treatments.

Figure 10.14. Sunflower plants stunted from downy mildew (Photo: Robert Harveson, UNL).

Figure 10.15. Downy mildew symptoms observed on the stunted sunflower plant (Photo: Robert Harveson, UNL).

Rhizopus Head Rot (species of *Rhizopus*)

Rhizopus head rot is a sporadic, but potentially destructive disease when it does occur. Under optimal environmental conditions, such as a hailstorm followed by warm humid temperatures. Yield losses of 100 percent have been reported from this disease. Symptoms first appear on the backs of heads as a result of some type of wound, followed by a watery, soft rot that later dries and turns dark brown (Fig. 10.16). As disease progresses, heads may dry prematurely, and tissues may shrivel and become shredded (Fig. 10.17). These symptoms could then be easily confused with other diseases like Sclerotinia head rot. Rhizopus head rot is distinguished from the other diseases by the presence of grayish, mycelial strands growing within infected heads (Fig. 10.18). The disease can be caused by several species in the genus *Rhizopus*, but primarily *R. oryzae* (syn. *R. arrhizus*). The fungal spores are ubiquitously found occurring naturally in soils and as a common airborne contaminant. Very few definitive management recommendations can be made for this disease, and no known disease-resistant hybrids are available. The primary management techniques would be limited to avoiding any form of mechanical damage to heads by controlling insect and bird feeding after flowering.

Figure 10.16. Beginning symptoms of Rhizopus head rot observed on the sunflower head (Photo: Robert Harveson, UNL).

Figure 10.17. Advanced symptoms of Rhizopus head rot observed on the sunflower head (Photo: Robert Harveson, UNL).

Figure 10.18. Gray-colored fungal strands observed on the sunflower head affected by Rhizopus head rot (Photo: Robert Harveson, UNL).

Verticillium Wilt *(Verticillium dahliae)*

Verticillium wilt occurs sporadically in South Dakota. The causal fungus survives in soil as microsclerotia, which upon germination infect sunflower roots. On the lower leaves, interveinal yellowing (chlorosis) spots develop, which may merge and grow larger. Over time the yellow spots become brown and necrotic and are surrounded by yellow halos given the leaves a mottled appearance (Fig. 10.19). Symptoms also progress up to new leaves as the pathogen moves upward in the stem's vascular system. Infected stems will show a reddish-brown discoloration of vascular elements (Fig. 10.20). Black streaky patches may be observed on the lower stems in severe infections. These black areas consist of thousands of the microsclerotia and can easily be rubbed off with a fingernail (Fig. 10.21). Yield loss occurs when plants are affected by Verticillium wilt during their reproductive growth stages. Verticillium wilt can be managed by rotating sunflower with non-hosts (e.g., wheat and corn) and avoiding fields with a disease history.

Figure 10.19. Yellow and brown spots observed on the leaves affected by Verticillium wilt (Photo: Robert Harveson, UNL).

Figure 10.20. Internal discoloration of the stem affected by Verticillium wilt (Photo: Robert Harveson, UNL).

Figure 10.21. Brown-colored microsclerotia observed on the sunflower stem affected by Verticillium wilt (Photo: Robert Harveson, UNL).

Additional Information

Sunflowers can be impacted by other diseases in South Dakota. Additional information can be found at Sunflower Disease Diagnostic Series (https://www.ag.ndsu.edu/publications/crops/sunflower-disease-diagnostic-series/pp1727.pdf).

Fungicide recommendations are provided in the South Dakota Pest Management Guide for Alfalfa & Oilseeds (https://extension.sdstate.edu/south-dakota-pest-management-guides). These pest management guides are updated every year and has the list of fungicides labeled for use on sunflower in South Dakota.

Selected Reference

Kandel, H., Buetow, R., and Endres, G. (eds.) 2020. Sunflower production. A-1995. North Dakota State Extension Service, North Dakota State University, Fargo, ND, USA.

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Chapter 11: Sunflower Insect Pests

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Defoliators

During the growing season, more than one defoliating insect pest may be present within a sunflower field. Although most of these pests cause negligible injury to the plant, scouting should still be conducted to ensure that defoliation does not result in yield loss. Table 11.1 highlights the amount of defoliation that can occur on sunflower and the expected yield losses based on growth stage of the plant.

Cutworms

Introduction

In South Dakota, there are four species of cutworms that may negatively affect sunflower stands shortly after emergence. These species include the dingy cutworm *(Feltia jaculifera)*, darksided cutworm *(Euxoa messoria)*, redbacked cutworm *(Euxoa ochrogaster)*, and pale western cutworm *(Agrotis orthogonia)*. Cutworm caterpillars of these species can feed on both root tissue as well as foliage, which normally doesn't result in economic injury. However, their ability to cut off young seedlings can cause economic damage through significant stand reductions. Scouting for cutworm caterpillar activity in sunflower should begin at emergence and continue through V4 to V6. Earlier planted sunflower is at a greater risk for cutworm defoliation and stand losses.

Identification

Cutworm moths all can be distinguished from one another by examining the markings on their forewings. In general, these moths are a drab brown-gray color with brown-gray hindwings. The cutworm caterpillars are all similar but can be distinguished by the colorations or markings that are present on their bodies.

Dingy cutworms have dark brown forewings with lighter brown bean-shaped markings next to a light triangle marking (Figure 11.1). The dingy cutworm caterpillars are dull brown to cream mottled coloration (Figure 11.2). Broad diagonal gray markings on each abdominal body segment are "V" shaped. The dingy cutworm head capsule is light brown with dark brown markings. The last-instar caterpillars are 1 to 1 ¼ inches in length.

Figure 11.1. Dingy cutworm moth. Photo courtesy of Hanna Royals, Screening Aids, USDA APHIS PPQ, Bugwood.org.

Table 11.1. Estimated yield loss due to defoliation based on sunflower growth stage.

Growth Stage	Percent Defoliation									
	10	20	30	40	50	60	70	80	90	100
	Expected yield loss (percent)									
V4 to V5	0	1	2	2	4	4	5	9	14	21
V9 to V11	0	2	3	4	5	5	7	11	17	24
R1	2	4	6	6	7	9	16	24	34	47
R3	2	8	15	19	24	32	44	59	78	99
R5	1	3	7	10	16	25	37	49	67	90
R7	0	1	3	7	10	13	16	18	20	22
R8	0	1	2	3	5	7	8	9	10	11
Table adapted from North Dakota State University Extension Bulletin 25.										

Figure 11.2. Dingy cutworm caterpillar. Photo courtesy of Canadian National Collection, The Canadian National Collection (CNC) of Insects, Arachnids and Nematodes, Bugwood.org.

Redbacked cutworm moths have reddish brown forewings with mottled gray bean-shaped and circular markings that are closed on one end (Figure 11.3). The redbacked cutworm caterpillars are dull gray to brown in color with two dull red stripes running the length of their bodies (Figure 11.4). The caterpillars are approximately 1 ¼ inches when fully matured.

Figure 11.3. Redbacked cutworm moth. Photo courtesy of James Bailey, Bugguide.net.

Figure 11.4. Redbacked cutworm caterpillar. Photo courtesy of John Gavloski

Darksided cutworm moths (Reaper dart) have light-colored forewings with darker markings (Figure 11.5). The darksided cutworm caterpillars have gray to brown body with a narrow dark gray stripe on each side (Figure 11.6). The mature caterpillars are approximately 1 ½ inches in length.

Figure 11.5. Darksided cutworm moth (Reaper Dart). Photo courtesy of Carl Barrentine, Bugguide.net.

Figure 11.6. Darksided cutworm caterpillar. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Pale western cutworm moths are gray to tan with a light-colored circle on the forewings (Figure 11.7). The pale western cutworm caterpillars are pale yellow to gray in color with a distinct white line that runs down the middle of their back (Figure 11.8). The caterpillars head capsule is light brown with two vertical black lines that form an inverted V.

Figure 11.7. Pale western cutworm moth. Photo courtesy of John Capinera, University of Florida, Bugwood.org.

Figure 11.8. Pale western cutworm caterpillar. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Biology and Life Cycle

The cutworms observed in South Dakota sunflowers can be separated based on their activities in the field. The two categories are early season and late season. The dingy cutworm is an early season cutworm, whereas the redbacked cutworm, darksided cutworm and pale western cutworm are late season cutworms. Both the early and late season cutworms only produce a single generation per season.

Dingy cutworms and other early season cutworms overwinter as second or third instar caterpillars. When the weather begins to warm up in the spring, they start feeding on available plants and potentially crop seedlings. The dingy cutworm caterpillars will continue feeding until mid-June when they will pupate. The dingy cutworm moths emerge in August and are active until mid-October. Peak moth activity normally occurs in September. Female moths lay eggs onto plants in the Asteraceae family (e.g., sunflower, safflower, goldenrod, ragweed). When the caterpillars hatch, they begin feeding on the flower faces, which may include commercially grown sunflower. The dingy cutworm caterpillars drop off the plant when they reach the second or third instar and will overwinter in the soil.

The redbacked cutworm, darksided cutworm, pale western cutworm and other late season cutworms overwinter as eggs. The oviposition timing will vary depending on the species, but, in general, eggs are laid in late summer through fall. The eggs overwinter in the soil and young cutworm caterpillars hatch in the spring when the temperatures increase. The late season caterpillars feed from May to the end of June. The late season moths emerge in late summer and will deposit eggs into the soil of fields.

Injury

For dingy, redbacked and darksided cutworms, young caterpillars will leave small notches or holes in the leaves. In some cases, the caterpillars will not feed completely through the leaf, but will instead remove layers of the leaf tissue which results in transparent sections or windows of injury on the leaves. The dingy cutworm caterpillars feed primarily on leaf tissue but can also cut off plants at or just below the soil surface. Later stage redbacked and darksided cutworms will cut the plants from one inch below the soil surface to two inches above the soil surface. The pale western cutworm caterpillars are subterranean and will feed on the plants below the soil surface.

Scouting

Cutworm caterpillars are nocturnal feeders so they will hide under plant residue or under the soil surface during the day. Therefore, scouting efforts during the day should be focused on finding defoliated plants or cut plants. When wilted, broken or obviously cut plants are observed, dig 1 to 6 inches deep around the cut plant and search for the presence of the caterpillars. Occasionally, cutworm caterpillars may be observed feeding even in daylight hours.

Management

Foliar insecticide management of cutworms in sunflower is recommended when the action threshold of 1 caterpillar per square foot is observed or when 25 to 30% of scouted plants are cut. Because cutworms are nocturnal feeders, apply insecticides late in the day or in the early evening to ensure adequate coverage. Foliar insecticides will provide only minimal management of palewestern caterpillars because they do not feed on aboveground tissues. Insecticide seed treatments may reduce cutworm feeding when limited populations are present. However, when large populations are present, stand reductions may still be observed.

Palestriped Flea Beetle

Introduction

The palestriped flea beetle *(Systena blanda)* is a common insect pest of sunflower fields throughout South Dakota. The adult palestriped flea beetles cause early season defoliation. When left unmanaged, early season defoliation can cause plant death and subsequent stand reductions. Late season sunflower can tolerate injury caused by flea beetle adults. If large populations of palestriped flea beetles are present in a sunflower stand, several management options are available.

Identification

The palestriped flea beetle is around 1/8 of an inch in length and are shiny black to brown in color with a broad, white stripe running down each elytron (hardened forewing) (Figure 11.9). They can also jump, like a flea, because of their enlarged hind legs. The larval stage is a small, white and slender. The larvae are easily distinguishable from other beetle species.

Figure 11.9. Palestriped flea beetle adult. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Biology and Life Cycle

Palestriped flea beetles overwinter as larvae in the soil and emerge in the spring. Adult palestriped flea beetles will start to emerge in June and are active for much of summer. Along with sunflower, other host plants of the palestripped flea beetle include bindweed, pigweed, and alfalfa.

Injury

The larval stage of the pale striped flea beetle can cause minor injury to sunflowers root systems but is rarely significant enough to warrant management. Large numbers of flea beetle adults, however, will kill or stunt sunflower seedlings by chewing on their cotyledons and young leaves. Injury from adult flea beetles will appear as small pits or irregular holes in the leaf (Figures 11.10 and 11.11).

Figure 11.10. Palestriped flea beetle leaf damage. Photo courtesy of Patrick Wagner.

Figure 11.11. Palestriped flea beetle hole damage. Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org.

Scouting

To scout for palestriped flea beetles, it is recommended to check newly emerged sunflowers every week until the sunflower stand reaches the V4 growth stage. Flea beetles overwinter on nearby weed host plants and field residue of previous susceptible crops. Due to this overwintering activity, flea beetle populations may be sporadic throughout a sunflower stand.

Management

Foliar insecticide application is recommended when the economic threshold is reached. For palestriped flea beetles, the economic threshold is when 20% of sunflower stand in a field has visible injury from flea beetle feeding. Other management techniques include using insecticide seed treatments, managing the residue within the field, removing weed host plants in field margins, and rotating crops. In South Dakota, the use of insecticide seed treatments has greatly reduced early season pressure from palestriped flea beetles.

Thistle Caterpillar

Introduction

The thistle caterpillar *(Vanessa cardui)* is an occasional pest of sunflowers, especially when populations are present in sunflower fields during the vegetative stages. Damage from the thistle caterpillar is often minor and usually does not warrant management action.

Identification

Thistle caterpillars can vary in color between black, yellow or gray. However, all larvae will have long, black, white, or yellow spines on their body and four pairs of abdominal prolegs (Figures 11.12 and 11.13). The caterpillars are 1 ¼ to 1 ½ inches in length. Thistle caterpillars can also be identified by their presence in leaves that are curled and secured using webbing.

Figure 11.12. Thistle caterpillar larva. Photo courtesy of Lyle Buss, University of Florida, Bugwood.org.

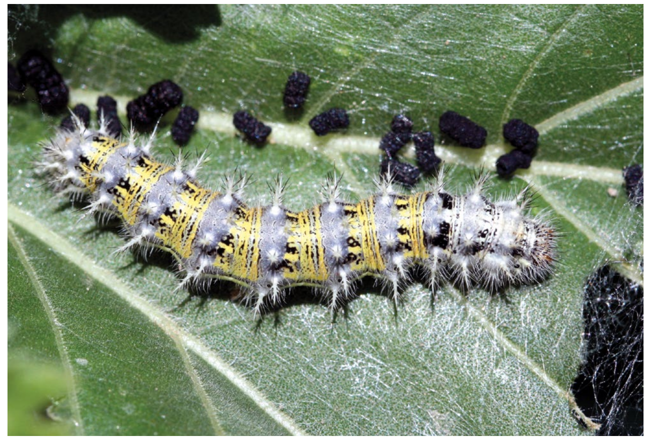

Figure 11.13. Thistle caterpillar larva. Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org.

The adult form of the thistle caterpillar is the painted lady butterfly. Painted lady butterflies have orange and brown coloration on their wings with dark spots on the edges of the wings. The edges of the forewings are darker than the edges of the hindwings. They also have black, orange, and white markings on the inside of their forewings. The wingspan of a thistle caterpillar adult ranges from 2 to 2 ¾ inches (Figure 11.14).

Figure 11.14. Adult thistle caterpillar. Photo courtesy of Adam Varenhorst.

Biology and Life Cycle

The thistle caterpillar is a migratory species and overwinters in the southern US. The painted lady butterflies travel north in the spring and summer. Adults will lay eggs on Canada thistle, sunflower, soybean, and other hosts. Typically, thistle caterpillars will feed on early season sunflower in late June to early July and will have one to two generations per growing season.

Injury

Thistle caterpillar injury will appear as irregular holes and skeletonization on a leaf accompanied by webbing and fecal material. In most cases, the injury of the thistle caterpillar will not warrant management and should be considered along with other sunflower defoliators (Figure 11.15).

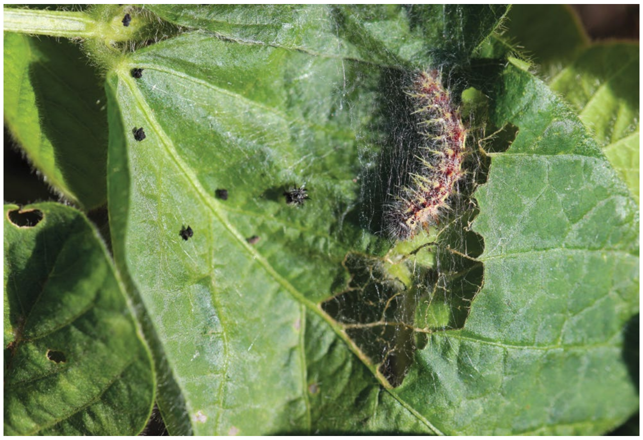

Figure 11.15. Thistle caterpillar larval damage to leaf. Photo courtesy of Adam Varenhorst.

Scouting

The easiest way to scout for thistle caterpillars in early season sunflower stands is to look for leaves that have been bound by silken webs or for irregular holes in leaves. Within these bound leaves will be fecal material and usually a thistle caterpillar. Scout by looking in an X pattern and examine 20 plants per sampling site for defoliation. Estimate the percent of defoliation present on the sampled plants. If the 20 sampled plants have an average of 25% defoliation and the thistle caterpillars are 1 ¼ inches long or less, management is recommended. However, if caterpillars are larger than 1 ¼ inches, most feeding injury has already occurred, and management is not recommended.

Management

Since the thistle caterpillar is a defoliating pest, it should be considered for management along with other sunflower defoliators. If the sunflower stand reaches the economic threshold of 25% defoliation, insecticide application may be necessary. Rarely does the thistle caterpillar, by itself, cause economic damage.

Silvery Checkerspot Caterpillar

Introduction

The silvery checkerspot caterpillar *(Chlosyne nycteis)* is an occasional pest of sunflower in South Dakota. This pest can cause rapid defoliation on sunflowers and will typically appear in June or July. Defoliation from the silvery checkerspot caterpillar is usually not enough to warrant management action and should be considered along with other sunflower defoliators.

Identification

Silvery checkerspot caterpillars are mostly black and may have several small white spots present. They have one broad yellow to orange stripe on the back and two thinner stripes along their sides. They have multiple branched spines present on their body, giving them a prickly appearance. The size of checkerspot caterpillars depends on their age, but they may grow up to 1 ½ inches in length (Figures 11.16 and 11.17).

Figure 11.16. Silvery checkerspot larvae. Photo courtesy of Patrick Wagner.

Figure 11.17. Silvery checkerspot larvae with damaged soybean leaf. Photo courtesy of Patrick Wagner.

Silvery checkerspot butterflies are pale orange with black boarders and markings. Like their name implies, they have a pattern of silvery patches and spots on the underside of the wings. The hindwings also have a large white crescent at the margin. The wingspan of silvery checkerspot butterflies range from 1 ½ to 2 inches (Figure 11.18).

Figure 11.18. Adult silvery checkerspot larvae. Photo courtesy of Karan A. Rawlins, University of Georgia, Bugwood.org.

Biology and Life Cycle

The silvery checkerspot butterfly is native to South Dakota. There are one to two generations per year which occur between May and September. Female butterflies lay eggs in large clusters on their host plants, which include members of the daisy family (Asteraceae), especially sunflower. The caterpillars feed in groups after hatching and can cause rapid defoliation.

Injury

Silvery checkerspot caterpillars will skeletonize plants and produce concentrated areas of frass (waste) (Figures 11.19 and 11.20). Heavy defoliation can appear suddenly and may reduce yields if it occurs when plants are very young or during the early reproductive stages. Similar to the thistle caterpillar, management is not always necessary and should be considered along with other sunflower defoliators.

Figure 11.19. Silvery checkerspot caterpillars on a damaged sunflower. Photo courtesy of Patrick Wagner.

Figure 11.20. Silvery checkerspot caterpillars and associated leaf damage. Photo courtesy of Patrick Wagner.

Scouting

Check 10 random sunflower plants in an area and repeat the process in five different locations within a field. For each of the selected plants, evaluate the amount of defoliation that is present on the sunflower. The threshold for sunflower defoliation is approximately 25% and if most of the caterpillars are less than 1 ¼ inches long. If they are longer than 1 ¼ inches, management is unnecessary. When caterpillars are larger than 1 ¼ inches they are nearly fully grown and most of the feeding injury will have already occurred.

Management

If a sunflower stand reaches the defoliation threshold, insecticide application may be necessary. Depending on the size of an infestation, silvery checkerspot caterpillars may be managed using spot spraying in areas where defoliation is more severe (e.g., field edges).

Grasshoppers

Introduction

There are several species of grasshoppers that may feed on sunflowers in South Dakota. The three species that are most likely to be observed feeding on sunflower include the differential grasshopper *(Melanoplus differtialis)*, twostriped grasshopper *(Melanoplus bivittatus)* and the redlegged grasshopper *(Melanoplus femurrubrum)*. Typically, these grasshopper species are not present in large enough populations to cause substantial defoliation. However, sporadic grasshopper population outbreaks can result in rapid defoliation of sunflowers. Due to their size, the active movement and feeding habits of grasshoppers are easily observed in fields and on sunflower plants.

Identification

All species of grasshoppers have a similar morphology with hind legs that are used for jumping. However, the three species that were mentioned vary based on size, coloration and patterns that are present on the body.

The differential grasshopper adults have a large body that varies from 1 ⅛ to 1 ½ inches long. Their bodies are olive to light green and yellow in coloration. Although rare, some differential grasshoppers may have a black (melanistic) coloration. An important characteristic for identification is the black chevron markings that are present on the hind femurs of the adults (Figure 11.21).

Figure 11.21. Differential grasshopper adult. Photo courtesy of Adam Varenhorst.

The twostriped grasshoppers are also large with bodies that vary in size from 1 to 1 ½ inches long. They vary in color from brown to dark green. They have two light yellow stripes that run from the head to the tips of the wings. The stripes converge on the wings (Figure 11.22).

Figure 11.22. Twostriped grasshopper adult. Photo courtesy of Adam Varenhorst.

Redlegged grasshoppers are the smallest of the three commonly observed species with bodies that vary in size from ⅔ to 1 inch in length. The adults have a black and yellow-body coloration with red hind tibia. Occasionally, the hind tibia may be blue. Rare individuals may have a yellow and blue colored body (Figure 11.23).

Figure 11.23. Redlegged grasshopper adult. Photo courtesy of Adam Varenhorst.

Biology and Life Cycle

Although there is some variation by species, most grasshoppers will have a similar life cycle. Grasshoppers hatch and emerge in the spring or early summer. The timing of hatching will vary based on grasshopper species. Some grasshoppers hatch early in the spring while some will hatch much later. After emergence, the grasshopper nymphs will feed on the foliage of both wild and cultivated plants. The number of nymphal instars (stages) varies based on species. Most species will have 4 to 6 instars before they reach the adult stage. Adult grasshoppers will continue feeding on any available foliage or plant tissue until the first hard frost of the year. Grasshopper populations are favored by warm, dry weather conditions. These conditions improve the survival of the nymphal grasshoppers. Furthermore, warm falls with a late hard frost will extend the egg laying period for the adults. Typically, grasshopper populations will move to crops from adjacent road ditches, grassy areas or maturing small grains. In the late summer and fall, female grasshoppers lay eggs into the soil in field margins, pastures, or ditches.

Injury

As defoliating insects, the main injury caused by grasshoppers is the removal of foliage from the plants

(Figure 11.24). However, populations that arrive later in the season may also feed on the developing sunflower head, resulting in direct damage and yield reductions. The amount of defoliation and head feeding that may occur is dependent on the grasshopper populations that are being observed. Large populations can cause rapid defoliation within a field.

Figure 11.24. Grasshopper defoliation on sunflower plants. Photo courtesy of Aaron Hargens.

Scouting

The road ditches around a field can be scouted for grasshoppers using a sweep net. Surrounding road ditches are where scouting should start prior to grasshoppers being observed within the field. The best scouting method within sunflower fields is visual observation. This is due to the large size of grasshoppers and the potential damage caused by sweep netting to the sunflower plants. To determine the population size within a field, walk into the field and estimate the number of grasshoppers in one square yard. Repeat this process several times to determine the field average. An average of 30 to 45 grasshopper nymphs or 8 to 14 adults per square yard warrants an insecticide application for management. If extensive feeding on the developing sunflower heads is observed, management should occur as soon as possible to minimize yield loss. If extensive defoliation is observed but few grasshoppers are present, treatment is not recommended as the grasshopper populations have likely moved to a new area.

Management

If grasshopper populations exceed the recommended thresholds, a foliar-applied insecticide will be necessary to reduce their numbers. There are several products labeled for the management of grasshoppers in sunflower. If adult populations are present, it is recommended to use the highest labeled rate for the insecticide product. Adult grasshoppers are resilient and lower rates may result in inadequate population reductions.

Sunflower Beetle

Introduction

The sunflower beetle *(Zygogramma exclamationis)* is a defoliator insect of sunflower. It feeds exclusively on sunflower and is often confused with the Colorado potato beetle *(Leptinotarsa decemlineata)*. Both the larval and adult stages of the sunflower beetle can cause economic injury throughout the growing season.

Identification

Both the larval and adult stages of the sunflower beetle can cause economic injury to sunflower. Larvae range from white, yellow or green in color, and have a light brown head capsule. The larvae are similar in size to the adult life stage. Adults are around ⅓ of an inch in length and have unique coloration. The head is brown while the pronotum (segment directly behind the head) is also brown but with white margins towards the front. Each elytron (hardened forewing) is white with three lateral brown-black lines and one shorter brown-black line followed by a brown-black dot. One lateral brown line runs down the center of the elytra (Figure 11.25).

Figure 11.25. Sunflower beetle larva and two adults. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Biology and Life Cycle

The sunflower beetle overwinters as an adult. These adults emerge in late May and can live for up to eight weeks. After mating, each female can lay from 200 to 2,000 eggs. Larvae that hatch from these eggs will then feed on the underside of leaves during the night and hide within sunflower bracts and buds during the day.

Larvae will feed for two weeks before entering the soil to pupate. Because adult females lay eggs throughout the growing season, first generation larvae will be present for around six weeks in June through July. Second generation adults that emerge from pupation will feed for a short time on sunflower heads and upper leaves before re-entering the soil to overwinter.

Injury
Defoliation from the sunflower beetle is caused by both the larvae and adults. The feeding injury generally appears as irregular shaped holes. The entire leaf may be removed in early season sunflower and lace-like holes will appear in later season sunflower (Figure 11.26).

Figure 11.26. Sunflower beetle damage. Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org.

Scouting
Using the standard X pattern for scouting sunflower beetles is recommended. Five different sites should be scouted throughout the sunflower stand, and adults and larvae should be counted on 20 plants per site. Since the sunflower beetle is a defoliator, look for defoliation percentage as well. The economic thresholds for sunflower are 25% defoliation or an average of 1 to 2 adults or 10 to 15 larvae per plant during V2 to V6 growth stages. Beyond V6, sunflower plants are usually mature enough to tolerate sunflower beetle injury.

Management
There are many management tactics available for the sunflower beetle. The easiest tactic is relying on and promoting natural enemies and parasites of the sunflower beetle. Multiple predators like the melyrid beetle *(Collops vittatus)*, convergent ladybird beetle *(Hippodamia convergens)*, and green lacewing *(Chrysoperla carnea)* will eat sunflower beetle eggs and larvae. The pteromalid wasp *(Erixestus winnemana)* is a parasite of sunflower beetle eggs and multiple species of tachinid flies will parasitize sunflower beetle larvae. In some cases, natural enemies and parasites can reduce sunflower beetle populations by 70 to 100%.

If natural enemies and parasites are not present or aren't effectively reducing sunflower beetle populations, applying insecticides at the economic threshold is recommended. Also, if sunflower beetle populations are high within a sunflower stand, using insecticidal seed treatments the next growing season can reduce early season pressure.

Head Feeders

Red Sunflower Seed Weevil

The red sunflower seed weevil *(Smicronyx fulvus)* is a native pest of sunflower in the United States and is partially responsible for the historical decline in sunflower production acreage in Illinois and Missouri. It has been an annual economic pest of sunflowers in South Dakota since 1978. During severe infestations, approximately 50% of the total sunflower plants may have up to 80% of the achenes per head infested with red sunflower seed weevil larvae. Unlike many insect pests, large populations of the red sunflower seed weevil have been observed on an annual basis. When scouting sunflower after the onset of flowering, it is likely that red sunflower seed weevils will be observed on the flowering head. In South Dakota, field failure reports of pyrethroid applications for red sunflower seed weevil management have been received by SDSU Entomologists since 2017.

Identification

The adults of the red sunflower seed weevil are approximately 1/10 of an inch long and are a reddish-orange color. They have a black elongated snout with small bent antennae originating from the snout (Figure 11.27). The larvae of the red sunflower seed weevil are legless and cream-colored with a light brown head capsule (Figure 11.28). They often curl into a C-shape if disturbed. However, the larvae are seldom observed because they feed on developing seeds and are concealed by the achenes.

Figure 11.27. Red sunflower seed weevil adult. Photo courtesy of Adam Varenhorst.

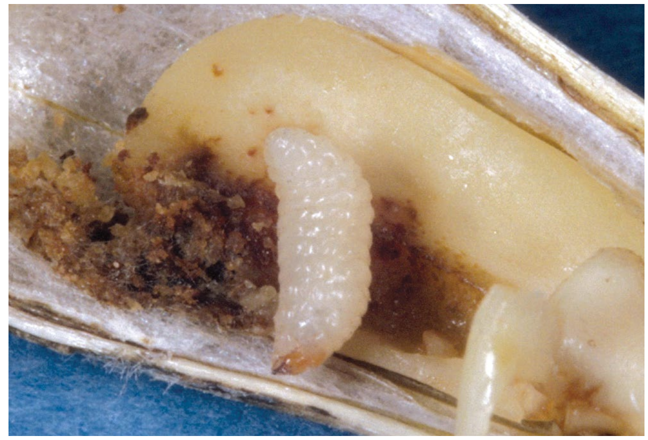

Figure 11.28. Red sunflower seed weevil larva. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Biology and Life Cycle

There is a single generation of red sunflower seed weevils each year. There are five larval instars that develop within the achenes. During late August and early September, the fifth-instar larvae exit the achenes and drop to the soil. The larvae will then burrow 2 to 6 inches into the soil to overwinter. The larvae remain in the soil until pupation occurs in June or July of the following year. The adults emerge from the soil and are active from late June to early September. Both male and female red sunflower seed weevils are attracted to both wild sunflower and commercial sunflower. Prior to flowering (R5), the adult red sunflower seed weevils feed on the stems, petioles or bracts. After the onset of flowering, the adults feed on pollen. Female red sunflower seed weevils require several days of pollen feeding before they are able to lay eggs. The female red sunflower seed weevils lay eggs during flowering. Typically, a female will lay only one egg per achene. When flowering is complete (R6) the adult red sunflower seed weevils are no longer attracted to the plants and their populations will decrease rapidly. Red sunflower seed weevil infestations are the highest in the outer achene rows. The larva will feed on the developing seed from July to September and then chew an exit hole to drop to the soil.

Damage

The adult red sunflower seed weevil feeding may leave noticeable marks on the bracts, but the adults do not cause economic levels of injury. The larvae of the red sunflower seed weevils will only partially feed on the developing seed. This feeding reduces the seed weight and oil content of the seeds. If infested sunflowers are harvested before the larvae drop from the infested seeds, they may cause heating and moisture issues during storage.

Scouting

Scouting for red sunflower seed weevils should begin when more than 50% of the plants within a field between the stages of showing yellow ray petals (R5.0) to 30% of the head shedding pollen (R5.3). Scouting should continue until the majority of the plants within a field have reached 70% pollen shed (R5.7). Once the field has reached R5.7, it is unlikely that additional infestation by red sunflower seed weevils will occur. This is due to a reduction in oviposition and the fact that the achenes become hardened which also reduces oviposition rates.

To scout for red sunflower seed weevils, choose five sampling sites that are at least 75 feet from the field edge, with at least one site on each side of the field. At each sampling site, count the total number of adults present on five randomly selected plants (regardless of plant growth stage) for a total of 25 plants per field. To ensure that all of the adults are counted, spray each of the selected heads with an insect repellent containing DEET and wait for the red sunflower seed weevils to move to the surface of the head. Calculate the field average and compare it to the recommended threshold of 4 to 6 adults per plant.

Management

When populations of the red sunflower seed weevil exceed 4 to 6 adults per plant, it is recommended to treat the field with a foliar insecticide. Treatment should occur between R5.0 and a field average of 40% pollen shed (R5.4). Making treatment decisions between R5.0 and R5.3 provides a time window in case of inclement weather or scheduling difficulties. However, treating a population too early may result in field re-infestation and require additional treatment. Treatment should not occur at or after R5.7 as most of the oviposition would have occurred before this time. Fields should be re-scouted 48 hours after insecticide application to determine if red sunflower seed weevil populations have been reduced. Early planting dates can also reduce the levels of red sunflower seed weevil infestation.

Gray Sunflower Seed Weevil

Introduction

The gray sunflower seed weevil *(Smicronyx sordidus)* is less frequently observed than the red sunflower seed weevil in South Dakota. However, it is possible to have both species present on a single sunflower head. Unlike the red sunflower seed weevil, the gray sunflower seed weevil populations do not normally reach levels that require management.

Identification

The adults of the gray sunflower seed weevil can be up to 1/5 of an inch long and are noticeably larger than the red sunflower seed weevil. In addition, they are light gray in color and have a black elongated snout with small bent antennae originating from the snout (Figure 11.29). The larvae of the gray sunflower seed weevil are also legless and cream colored with a light brown head. When disturbed, the larvae curl up into a C-shape. Differentiation of the gray and red sunflower seed weevil larvae is very difficult.

Figure 11.29. Gray sunflower seed weevil adult. Photo courtesy of Adam Varenhorst.

Biology and Life Cycle

There is a single generation of gray sunflower seed weevils each year. Gray sunflower seed weevils emerge 5 to 10 days earlier than the red sunflower seed weevils. The adult gray sunflower seed weevils are observed in sunflower fields during the bud stages (R1 to R3). Gray sunflower seed weevil eggs are laid onto the reproductive buds that are within unopened florets. The populations of gray sunflower seed weevil adults decline at the onset of flowering. After hatching, the larvae migrate to the achene and begin feeding on the base of the seed. The presence of a larva results in the achene becoming enlarged and protruding from the head in comparison to nearby achenes. This enlargement is referred to as a gall and is likely a source of nutrients for the developing larva. Gray sunflower seed weevils have higher infestation rates of the middle achene rows. The last instar larvae emerge from the seeds and drop to the soil where they overwinter 1 to 4 inches below the surface.

Damage

The larvae of the gray sunflower seed weevil consume the entire developing seed. The adults feed on developing flower buds beneath the bracts and on leaves. This feeding is considered minor.

Scouting

Scouting for gray sunflower seed weevils should begin at R1. Scouting should continue until the majority of the field has reached R4.

Management

There are no set management thresholds for gray sunflower seed weevils. The populations of gray sunflower seed weevils are typically lower than those of the red sunflower seed weevils. Occasionally the thresholds for red sunflower seed weevils are used to manage gray sunflower seed weevils. However, insecticide application for gray sunflower seed weevil management must occur prior to bloom or when 10 to 15% of the field has reached the R4 growth stage.

Banded Sunflower Moth

Introduction

The banded sunflower moth *(Cochylis hospes)* is a common sunflower seed pest throughout the growing season. The larval stage is the most damaging due to its feeding on sunflower bracts, florets, and seeds.

Identification

The most injurious life stage of the banded sunflower moth is its larval stage. The larvae differ in appearance as they progress through their five instars. Young larvae are off-white and will progress towards pinkish to red and then a blue-green color in the later instars (Figure 11.30). The head capsule of younger caterpillars is a dark brown to black color. More mature caterpillars have a light brown head capsule. Adult banded sunflower moths have a dark band across their yellowish-tan forewings. Typically, their wingspan is ½ of an inch (Figure 11.31).

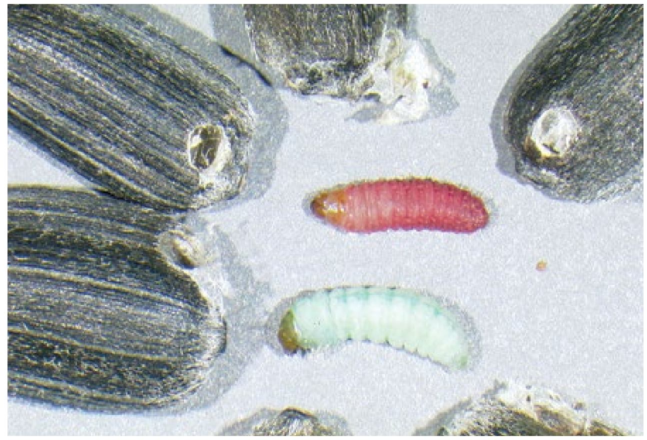

Figure 11.30. Banded sunflower larvae inside sunflower seed. Photo courtesy of North Dakota State University Extension.

Figure 11.31. Banded sunflower moth adult. Photo courtesy of Mark Dreiling, Bugwood.org.

Biology and Life Cycle

The banded sunflower moth's life cycle begins in mid-July when adults emerge from overwintering sites. These adults will then lay eggs on the outside of sunflower bracts and will continue doing so through mid-August. The eggs hatch five to eight days after being deposited on the bracts. The caterpillars are present in sunflower heads from mid-July to mid-September. They will feed until they reach the end of the last larval instar and will then drop to the soil to overwinter.

Damage

Damage from the banded sunflower moth is caused entirely by the larval stage. Newly emerged larvae will initially feed on bracts before moving into open florets. This early feeding reduces the total number of seeds present on the head. As the larvae mature, they will tunnel through the base of a floret and into the seed, consuming all of the contents (Figure 11.30). Each larva can consume the entire kernel of six to seven seeds before dropping to the soil.

Scouting

From mid-July through mid-September, look for small patches of silken webbing on the face of sunflower heads. This webbing can indicate the presence of banded sunflower moth larvae. Scouting can also be done for the egg and adult life stages primarily during the R2 to R3 growth stages of sunflower. To scout for eggs, look over eight random sites consisting of five sunflower plants and count six outer bracts of a bud per plant (Figure 11.32). Using a magnifying lens is recommended. Calculate and compare the average amount of eggs per plant to the economic threshold of two to three eggs per six bracts. Treatment is recommended if above the economic threshold. When scouting for adults, one adult per 100 plants warrants insecticidal treatment.

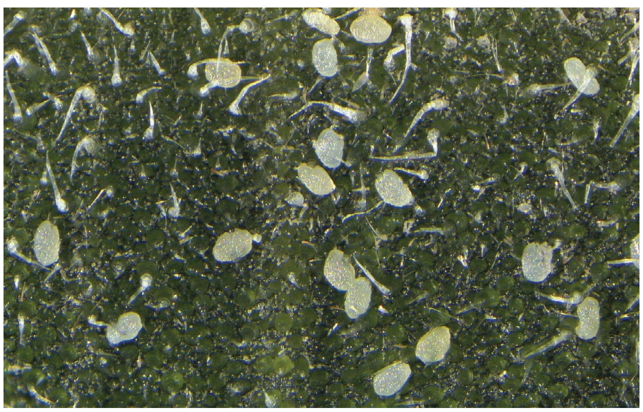

Figure 11.32. Banded sunflower moth eggs on a sunflower bract. Photo courtesy of K. Mundal, North Dakota State University Extension Service.

Management

Insecticide treatment to the sunflower heads is recommended when either the banded sunflower moth egg or adult thresholds are reached. Spraying in the earlier morning or late afternoon is recommended in order to avoid harming pollinators.

Sunflower Moth

Introduction

The sunflower moth *(Homoeosoma electellum)* is a common pest of sunflower that is present at the time of flowering. Sunflower moths are a migratory pest that overwinter in the southern United States and move north during the growing season. Adult moths can be observed on sunflower heads in the early flowering stages. The caterpillars cause injury to the plants by feeding on the pollen and seeds.

Identification

Caterpillars of the sunflower moth are black with light-colored stripes running the length of their bodies and have a distinctive orange head. As the caterpillars mature, they can become light brown with white stripes. The caterpillars vary in size based on their developmental stage but will reach approximately ¾ of an inch during their final instar (Figure 11.33). Adult sunflower moths are mottled gray. The wingspan of the sunflower moth ranges from ½ to 1 inch. The wings are tucked tightly to the body while at rest (Figure 11.34).

Figure 11.33. Sunflower moth caterpillar. Photo courtesy of Adam Varenhorst.

Figure 11.34. Sunflower moth adult. Photo courtesy of Mark Dreiling, Bugwood.org.

Biology and Life Cycle

Each year, sunflower moths migrate from the southern United States into South Dakota. The adult moths are attracted to blooming sunflowers and the females will lay their eggs on the sunflower heads, based on the presence of pollen (Figure 11.35). Female sunflower moths can lay up to 400 eggs near the base of florets. The caterpillars will hatch and feed on the sunflower head until they complete their development.

Figure 11.35. Sunflower moth on a sunflower head. Photo courtesy of Phil Sloderbeck, Kansas State University, Bugwood.org.

Damage

Caterpillars feed on the pollen, move on to the corollas, and eventually feed on the developing achenes (Figure 11.36). The caterpillars will tunnel into the sunflower head tissue which can lead to secondary infections of Rhizopus head rot. Rhizopus head rot is a fungus that is the main source of yield loss associated with the sunflower moth. However, each caterpillar also causes direct damage by feeding on 3 to 12 seeds within the head. The caterpillars spin silken webs that bind the drying florets and other debris, giving infested sunflower heads a "trashy" appearance. The webbing will typically cover the majority of the head.

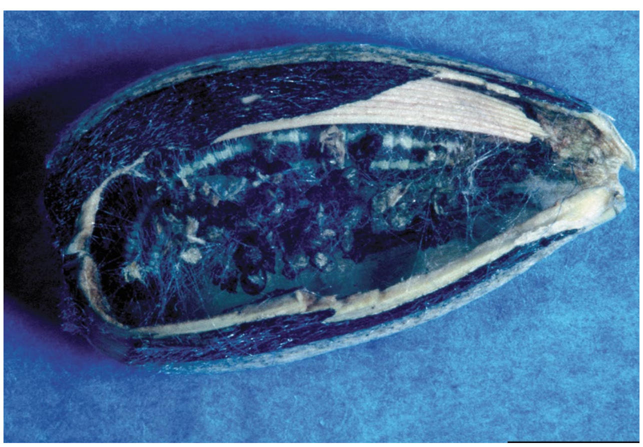

Figure 11.36. Damage to sunflower achene and seed caused by sunflower moth larva. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Scouting

Scouting for sunflower moth should begin at the R4 growth stage. Moths are most active in early morning or evening. The best way to scout for sunflower moths is to use a flashlight and examine fields 1 hour after sunset, when moth activity peaks. Count the number of moths on the heads of 20 sunflowers from five random locations throughout the field. The threshold for sunflower moth is 1 to 2 moths per five sunflower heads.

Management

Insecticides can be applied to sunflower heads once the adult sunflower moths reach threshold levels. If applying an insecticide, it is best to spray in the evening when moth activity is greatest. Spraying at this time will also reduce the impact on pollinators as these beneficial insects are less active during the evening hours. Later planting dates can be effective at reducing the likelihood of sunflower moths reaching economic threshold.

Sunflower Bud Moth

Introduction

Sunflower bud moth *(Suleima helianthana)* is a minor pest of sunflower in South Dakota. The caterpillars are the damaging stage and burrow into unopened heads. This feeding injury can result in deformed heads but has not yet been associated with economic loss.

Identification

Sunflower bud moth caterpillars have a smooth cream-colored body with a dark head capsule. They can range in size from approximately ¼ to ½ of an inch long at their final instar (Figure 11.37). Adult sunflower bud moths are gray in color with two dark traverse markings across the back of the forewings. Their wingspan is approximately 2/3 of an inch (Figure 11.38).

Figure 11.37. Sunflower bud moth larva. Photo courtesy of Adam Varenhorst

Figure 11.38. Sunflower bud moth adult. Photo courtesy of Mark Dreiling, Bugwood.org.

Biology and Life Cycle

There can be up to two generations of sunflower bud moth each year during the growing season. The female moths will lay eggs on various parts of the sunflower plants. Upon hatching, caterpillars will tunnel into the plant and leave behind frass around the entrance hole. Caterpillars will pupate inside the plant and emerge as new adults.

Injury

Feeding injury from sunflower bud moth caterpillars mostly occurs in the stalk but can also occur in the developing head (Figure 11.39). Deformed heads can occur when the caterpillars tunnel through unopened buds and disrupt head development.

Figure 11.39. Sunflower bud moth larva next to damaged achene. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Scouting

As this pest is not considered to be of economic significance, there are no established thresholds or scouting recommendations.

Management

Only a small proportion of plants in a field are affected by sunflower bud moth, so their impact is very minimal. Insecticide applications are not recommended for this pest because they have limited efficacy due to the caterpillars feeding within the plants.

Headclipping Weevil

Introduction

The headclipping weevil *(Haplorhynchites aeneus)* is an occasional pest of sunflower in South Dakota. Headclipping weevils typically appear in July and August during the reproductive stages of sunflower. They feed on the peduncle and leaf petioles which causes girdling. Injury from headclipping weevils can be easily identified by the “clipped” heads or leaves left hanging from infested plants. However, headclipping weevils typically only impact a small proportion of plants within a field and rarely require management.

Identification

Adult headclipping weevils measure approximately ⅓ of an inch long. The body is uniformly black in color and has a slight bronze luster which is characteristic of the species. Like other weevils, they have an elongated snout with antennae originating near the base of the snout (Figure 11.40).

Figure 11.40. Headclipping weevil adult. Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org.

Biology and Life Cycle

Adults begin emerging in July and remain active for 2 to 3 weeks. The weevils feed on pollen and nectar, and the females lay their eggs in the sunflower heads. Adults feeding on the peduncle will cause girdling and the heads will hang or fall to the ground. The larvae feed and develop within the detached heads where they eventually overwinter.

Damage

Headclipping weevils are most abundant around the field edges, making the border rows at highest risk of infestation. The main feeding injury associated with this pest involves the girdling at the peduncle which causes head clipping (Figure 11.41).

Figure 11.41. Damage caused by the headclipping weevil. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Scouting

Scout for headclipping weevils by checking several plants in different areas of a field (e.g., X pattern) and counting the adult weevils. The recommended thresholds for headclipping weevils are one adult for every two plants scouted or when the number of clipped heads exceeds 5% of the entire field.

Management

An insecticide may be applied to sunflower heads if the number of headclipping weevils or the percentage of clipped heads reaches threshold levels. However, this pest rarely causes economic injury.

Sunflower Midge

Introduction

The sunflower midge (*Contarinia schulzi* Gagné) has a wide distribution ranging from the northern Great Plains to Texas. Its populations are most abundant in North Dakota, South Dakota and Minnesota. Damage from the sunflower midge results in abnormal head shapes and sizes, which is caused entirely by its larval growth stage.

Identification

Both the adult and larval life stages are quite small and are not the best way to determine if sunflower midge is in a sunflower stand. The damage caused by the larval stage is the best indication. The tan colored, adult sunflower midge is approximately 7/100 of an inch in length with transparent wings. The adult wingspan is approximately 2/10 of an inch. The cream to yellowish orange larvae are 1/8 of an inch in length and are found primarily in the sunflower head.

Biology and Life Cycle

The sunflower midge overwinters as adults in the soil and emerges from June to July. Newly emerged adults only live for a few days, long enough to lay eggs on sunflower bracts. Larvae from these eggs will feed on the edge of the head before moving into the center of the sunflower head and causing the most economic injury to a sunflower. Once mature, these larvae will drop into the soil to overwinter or, if the life cycle started early enough, emerge for a second generation in August.

Injury

Injury caused by severe infestations of sunflower midge will appear as undeveloped heads or heads that are gnarled and twisted. Damage is usually sporadic and near field margins.

Scouting

There are no scouting methods developed for the sunflower midge. However, looking for damaged sunflower heads near field margins is a good way to determine if sunflower midge populations are present.

Management

There are no economic thresholds or chemical controls for the sunflower midge, however, crop rotations and varied planting dates can mitigate or reduce sunflower midge populations. Consult your local agronomist as some sunflower hybrids have been shown to tolerate sunflower midge better than others.

Sunflower Receptacle Maggot

Introduction

The sunflower receptacle maggot *(Gymnocarena diffusa)* is a minor pest of sunflowers in South Dakota. It earns its name by causing damage to the sunflower receptacle during its larval life stage.

Identification

Larvae of the receptacle maggot are yellowish white in color. Mature larvae are around 5/16 of an inch in length and are found within the sunflower head (Figure 11.42). The adult flies of the receptacle maggots are the same length as the larvae, 5⁄16 of an inch, and have a wingspan of ¾ of an inch. The wings have a mottled brown pattern, the body is bright yellow, and the eyes are a bright, metallic green (Figure 11.43).

Figure 11.42. Sunflower receptacle maggot larva. Photo courtesy of Adam Varenhorst.

Figure 11.43. Sunflower receptacle maggot adult. Photo courtesy of Keith Roragen, BugGuide.net.

Biology and Life Cycle

The pupal stage of the receptacle maggot overwinters in the soil. In June and early July, adult flies emerge from the soil and lay eggs on sunflower bracts. Larvae hatched from these eggs will move into the sunflower head, feed on the receptacles, and will eventually drop to the soil to pupate. Most larvae will have dropped to the soil by late August and early September.

Injury

Injury to sunflower by the sunflower receptacle maggot is caused entirely by its larval stage. The mature larvae cut a small emergence hole on the underside of the receptacle when they are ready to drop to the soil for pupation.

Scouting

No scouting methods have been developed for the sunflower receptacle maggot. In general, monitor for adult presence in June and early July and look for exit holes in the sunflower receptacle throughout August and early September.

Management

Damage caused by the sunflower receptacle maggot has not been found to cause significant yield loss in sunflower. Therefore, chemical management is not considered necessary to manage this pest. Crop rotations can generally keep sunflower receptacle maggot populations in check.

Sunflower Seed Maggot

Introduction

The sunflower seed maggot *(Neotephritis finalis)*, commonly known as picture winged fly, is a minor sunflower pest in South Dakota that usually does not require management. Picture winged fly adults can be seen throughout the summer as there are two generations per year in South Dakota. The larval life stages cause damage to sunflower buds, resulting in deformed sunflower heads and a reduction in the number of developing seeds on deformed heads.

Identification

Larvae of the sunflower seed maggot are white and ⅕ of an inch in length when mature. Pupae are oblong in shape and range from yellowish-tan at first to reddish-brown when mature. The pupal life stage can be found in the sunflower receptacle during the first-generation lifecycle and in the soil to overwinter during the second generation.

The light brown adults of the sunflower seed maggot are ¼ of an inch in length. The wings are clear with mottled, brown-black markings that form a distinct "X" pattern. Their heads are light, yellowish-brown with green-red metallic eyes. The end of the abdomen is a dark, reddish-brown (Figure 11.44).

Figure 11.44. Sunflower seed maggot adult. Photo courtesy of Adam Varenhorst.

Biology and Life Cycle

The sunflower seed maggot has two generations per growing season. First generation adults emerge in late June while second generation adults emerge in mid-August. First generation adults lay eggs on the bracts and corolla of sunflower buds. Larvae from these eggs burrow into the sunflower heads, feeding on the florets and ovaries. Once these larvae are mature, they'll tunnel into the sunflower receptacle to pupate. Second generation adults will then emerge, lay eggs, and the hatched larvae will feed on developing seeds through August. The second-generation larvae then drop to the soil when mature to overwinter.

Damage

Damage caused by the sunflower seed maggot is different between its two generations. First generation larvae can feed on up to 10 to 12 ovaries and florets, resulting in undeveloped or lost seeds and deformed sunflower heads. The second-generation larvae feed directly on developing seeds.

Scouting

Scouting methods have not been developed for the sunflower seed maggot. However, adults can generally be looked for in late June and mid-August. Larvae and pupae can be found by looking for deformed sunflower heads and digging into the receptacle.

Management

Chemical management is not recommended for the sunflower seed maggot as adults are highly mobile and the larvae are too deep within the sunflower receptacle to be affected by insecticide treatment. However, planting sunflower later may help in avoiding peak emergence of the first-generation adults. Natural enemies (*Pteromalus* spp.) may also keep sunflower seed maggot populations below economic concern.

Sap Feeders

Aphids

Introduction

There are several species of aphids that may be observed on sunflowers in South Dakota. The most observed aphids are the sunflower aphid *(Aphis asclepiadis)* (Figure 11.45), cotton aphid *(Aphis gossypii)* (Figure 11.46), potato aphid *(Macrosiphum euphorbiae)* (Figure 11.47) and the green peach aphid *(Myzus periscae)* (Figure 11.48). In general, aphids are not considered a major pest of sunflowers in South Dakota as populations rarely reach levels that cause yield loss. However, under ideal conditions there is the potential for aphids to be a problem.

Figure 11.45. Sunflower aphid colony. Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org.

Figure 11.46. Cotton aphid. Photo courtesy of Jim Baker, North Carolina State University, Bugwood.org.

Figure 11.47. Potato aphid. Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org.

Figure 11.48. Green peach aphid. Photo courtesy of Jim Baker, North Carolina State University, Bugwood.org.

Identification

All of the aphid species will be small in size but will vary in color. They have soft bodies and will have two cornicles near the end of their abdomens that are often called "tailpipes" (Figures 11.45-11.48). A colony of aphids on a sunflower plant will consist of all life stages including both winged and wingless adults. On sunflower, these aphids will be reproducing asexually, which can lead to rapid population growth.

Biology and Life Cycle

The exact life cycles and alternative hosts will vary by aphid species. In general, aphid populations reproduce asexually during the summer months. This results in clonal populations comprised of only female aphids that give live birth. The reproduction strategy coupled with short generation times allows aphid populations to increase rapidly. However, these populations are often limited by predators that feed on the aphids.

Injury
Aphids feed on sunflowers using piercing-sucking mouthparts that remove phloem. Small populations of aphids may have little to no observable impact on sunflower health. However, larger populations may cause noticeable plant stress that is observed as yellowing or wilting of the sunflowers.

Scouting
While scouting fields, examine the underside of the sunflower leaves for aphid populations. As there are no set thresholds for aphids in sunflower, individual judgement on the sunflower health and estimates of the aphid populations will be necessary to make management decisions.

Management
Aphids are not considered an economic pest of sunflower and for this reason no management recommendations exist. However, if very large populations of aphids are present in a sunflower field, a foliar applied insecticide labeled for aphids and sunflower could be used to effectively reduce the populations.

Lygus Bugs

Introduction
Lygus bugs are commonly found on sunflowers in South Dakota. However, they are primarily considered to be a pest of confection sunflowers due to the very low threshold. As Lygus bugs feed, they inject digestive enzymes into the plant tissue so that they can easily extract nutrients. This feeding activity leads to scarring on the developing seeds. While it may not impact yields, Lygus bugs can significantly reduce the quality of confection sunflower seeds.

Identification
Adult Lygus bugs are approximately ¼ of an inch in length and pale green to reddish brown in color. There is a yellow triangle on the back and the tips of their wings bend downward at the end of the abdomen (Figure 11.49). Nymphs vary in size depending on their developmental stage. Instead of having fully developed wings, they have wing pads on the back that grow as the nymphs mature. Nymphs are initially pale green in color but develop markings in the later stages, including five characteristic black spots on the back (Figure 11.50).

Figure 11.49. Adult lygus bug. Photo courtesy of Whitney Cranshaw, Colorado State University, Bugwood.org.

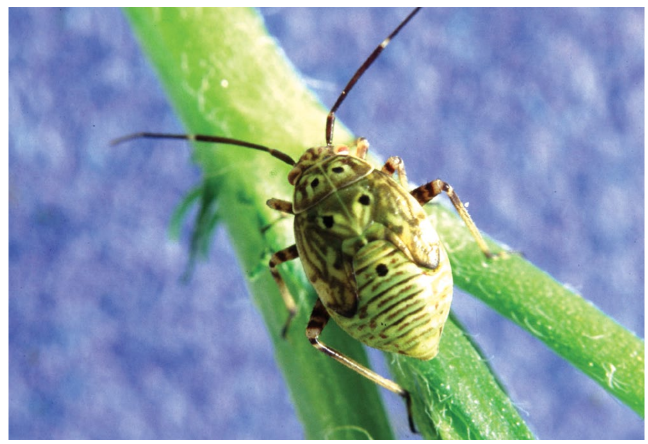

Figure 11.50. Lygus bug nymph. Photo courtesy of Scott Bauer, USDA Agricultural Research Service, Bugwood.org.

Biology and Life Cycle
Lygus bugs overwinter as adults and can have several generations throughout the growing season. Both nymphs and adults feed on sunflowers and will often move in from neighboring alfalfa fields after they have been harvested.

Damage
Kernel brown spot is the main injury concern with Lygus bugs. This occurs when the Lygus bugs inject digestive enzymes into the plant while feeding. The value of confection sunflowers can be severely impacted because the feeding activity causes a visible brown spot on the kernels and gives the seeds a bitter taste. Lygus bugs are capable of damaging over 30 seeds per adult.

Scouting
Monitor sunflower fields for Lygus bugs during flowering as this when the plants are susceptible to damage.

Count the number of adults on several plants at different locations within the field. Due to the low tolerance in confection sunflowers, the threshold is about one adult per ten plants.

Management

Insecticides can be used if Lygus bugs reach threshold levels in a confection sunflower field. This application can be planned when treating for other insect pests (e.g., red sunflower seed weevil, banded sunflower moth) that may be present on sunflowers at the same time. In some cases, a second insecticide application may be necessary to extend the protection of confection sunflower during the flowering stages.

Stem Borers

Dectes Stem Borer

Introduction

Dectes stem borer *(Dectes texanus)* infestations are common in South Dakota sunflower fields. However, this pest is not always readily observed as the larvae are present inside of the sunflower stem. Although this is a common pest, many infested fields will have little to no yield loss unless the larvae are able to girdle the stem and cause lodging. During dry years in South Dakota, we have observed the larvae girdling the stems earlier in the season. The risk of lodging from Dectes stem borer is also greater during dry years as the stem diameters are often reduced. Although the Dectes stem borer is a native insect pest, wild sunflowers are rarely infested. This is due to resistance present in the wild sunflower associated with a tougher epidermis and the production of resin when the females attempt to lay eggs. However, the increased resin production has been bred out of commercial sunflower varieties to reduce issues that it caused during harvesting. Alternative hosts of Dectes stem borer include ragweed *(Ambrosia spp.)*, cocklebur *(Xanthium strumarium)* and soybean *(Glycine max)*.

Identification

The Dectes stem borer adults are approximately ⅜ of an inch long and light gray in color. They will have antennae with alternating light gray and black segments. The antennae will also be much longer than the length of the body (Figure 11.51). Adult Dectes stem borer that emerge from soybean will be considerably smaller in size as soybean is not a high-quality host for their development.

Figure 11.51. Dectes stem borer adult. Photo courtesy of Adam Varenhorst.

Dectes stem borer larvae are ½ to ⅝ of an inch long and legless. They are white to cream colored and have an orange-brown head capsule (Figure 11.52). Due to their body segmentation the larvae are often described as being accordion-shaped. The larvae are present inside of the sunflower stems and their presence in the stem is often indicated by discoloration and the presence of a sawdust-like excrement (Figure 11.53).

Figure 11.52. Dectes stem borer larva. Photo courtesy of Patrick Wagner.

Figure 11.53. Dectes stem borer larva feeding in a sunflower stem. Photo courtesy of Adam Varenhorst.

Biology and Life Cycle

The Dectes stem borer adults emerge from infested plant material beginning in May with peak emergence in mid-June. This extended period of emergence makes it very difficult to manage this pest through reductions of the adult populations. The adults live for approximately 6 to 8 weeks but often don't disperse far from where they emerged. The females chew holes in the underside of the leaf petioles and then deposit eggs into the holes. When the larvae hatch, they bore through the petiole and into the central pith of the plant. The larvae will fight and cannibalize each other until only one larva remains in the plant. In the fall, the larva will descend to the base of the plant and girdle the stem. The larva then forms a chamber below the girdled point and will plug it to provide an overwintering site.

Injury

The stalk boring of the Dectes stem borer larvae has limited to no impact on sunflower yield. However, the girdling behavior can reduce yields by preventing the sunflower head from being harvested. The girdling behavior appears to be triggered by stalk desiccation, which explains why during dry years lodging often occurs earlier in the season when compared to years with adequate moisture. The larvae can only feed approximately ½ of an inch outward from the center of the stalk. For this reason, stalks with a diameter that is greater than 1 inch are less susceptible to lodging caused by Dectes stem borer.

Scouting

Although adults can be scouted for in fields, the best method of scouting is dissecting sunflower stems and determining if a Dectes stem borer larva is present. The presence of a larva can be determined by looking for discolored pith and evidence of a feeding tunnel. Following the tunnel will lead to the larva. Scouting for Dectes stem borer larvae will provide insight into the potential for nearby infestations during the following year. For infested fields, seed moisture should be monitored closely, and the fields should be harvested as early as possible to prevent yield losses due to lodging.

Management

Dectes stem borer adults have an extended emergence period, so it is not economical to manage them to reduce infestations. Similarly, there are no thresholds or remedial insecticide management recommendations for the Dectes stem borer. Delayed planting also doesn't appear to reduce infestations. The best approach is to reduce planting populations to ensure that stem diameters are large enough to prevent girdling.

Sunflower Stem Weevil

Introduction

The sunflower stem weevil *(Cylindrocopturus adspersus)* is a minor to severe sunflower pest throughout most of the Northern Plains. Damage caused by this pest may result in lodged sunflower and can be amplified by a dry growing season. Along with direct damage caused by the sunflower stem weevil, this pest is also a vector of Phoma black stem and charcoal rot.

Identification

Sunflower stem weevil larvae appear as many of the other sunflower pests, white to yellow body with a dark brown head capsule. However, unlike many sunflower pests, the larvae will be found in the vascular tissue of the sunflower stem (Figure 11.54). The sunflower stem weevil adults are grayish brown in color with irregular white spots covering the body and black eyes. Adults will be ⅛ to $\frac{3}{16}$ of an inch in length and have a long, beak-like mouthpart tucked under the head (Figure 11.55).

Figure 11.54. Sunflower stem weevil larva. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Figure 11.55. Sunflower stem weevil adult. Photo courtesy of Frank Peairs, Colorado State University, Bugwood.org.

Biology and Life Cycle

Sunflower stem weevils overwinter within chambers at the base of the previous year of sunflower stems. From mid to late June, adults emerge from these overwintering chambers and feed on the leaves of the current year of sunflower. Females will then lay eggs within the lower stems of sunflowers. Females will chew a small hole into the stem, deposit one egg, and cover the hole with frass. Larvae will then feed in the pith area of the stem until fully grown. In August, these larvae descend into the base of the sunflower stem to construct the overwintering chamber.

Injury

Direct injury caused by the sunflower stem weevil is done mostly by its larval life stage. Larvae feed on the vascular tissue of the sunflower stem which usually does not cause economic damage. However, this feeding weakens the stem and can result in lodging. Lodging caused by the stem weevil can become severe and will be worse during times of drought. Adult stem weevils do feed on sunflowers but never enough to cause economic damage. However, adult stem weevils are vectors of Phoma black stem and charcoal rot.

Scouting

Begin scouting for the sunflower stem weevil at adult emergence in mid to late June and continue until mid-July. Using the standard X pattern for scouting is recommended. Adults should be counted on 20 plants per X site. Five different sites should be scouted throughout the sunflower stand. If counts average one adult per three sunflower plants, management is recommended.

Management

If the economic threshold is reached, chemical management is recommended and is usually effective. However, other management tactics can be used to mitigate sunflower stem weevil populations. Planting sunflower from early to late June may help in avoiding the sunflower stem weevil adult emergence. However, lower yields should be expected due to the sunflower having less time to mature before harvest. Planting sunflower at lower populations may also help if sunflower stem weevils are known to have caused issues in previous years. The reason being that sunflowers will have more space and produce larger stems that are more resistant to lodging. Sunflower hybrids are also available that exhibit tolerance to the sunflower stem weevil.

Sunflower Maggot

Introduction

Although the sunflower maggot *(Strauzia longipennis)* is a widespread pest and can be found in most sunflower fields, it is not considered a major pest of sunflowers. This is attributed to the fact that the larvae of the sunflower maggot feed in the stalks of sunflowers and not on the heads or seeds. This feeding activity by the larvae has little to no impact on the development of the sunflower. For this reason, management strategies have not been developed for this pest.

Identification

The sunflower maggot adults are flies that are approximately ¼ to 5/16 of an inch long. The flies have a yellow head and legs, and their bodies are light orange (Figure 11.56). The wings are clear with dark yellow to black bands on them. Near the wing tip, the bands form a reversed "F" shape. The flies also have iridescent eyes that range in color from green to orange.

Figure 11.56. Sunflower maggot adult. Photo courtesy of Florida Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Bugwood.org.

The larvae of the sunflower maggot are white to cream in color. They do not have a head or legs. During the last larval stage, they are approximately ¼ to 1/3 of an inch long.

Biology and Life Cycle

There is only one generation of sunflower maggots each year. The adults begin emerging at the end of May and continue until mid-June. The sunflower maggot adults are attracted to sunflower and can be observed visiting sunflowers until the end of July. The female flies lay eggs near the growing point of the stalk. When the eggs hatch, the larvae burrow into the stalk and begin tunneling in the pith of the stem. The larvae exit the stalks in August and move into the soil near the exited sunflower stalk. Sunflower maggots overwinter as larvae and pupate during the following spring.

Injury

The larvae tunnel in the pith of the stalks but this activity is not associated with observed yield loss. The pith is important for stalk support but does not play a role in nutrient or water movement in the plant. When sunflower maggot infestations reach 8 to 10 larvae per plant, some breakage may be observed. Although in some fields, 100% of the plants may be infested, but the larvae are normally not present in high population densities. It is possible for the sunflower maggot tunnels to serve as an entry point for plant diseases.

Scouting

The sunflower maggot is not associated with economic losses, so no scouting protocol has been developed. Infestations are more common near road ditches or grass waterways. If lodging or stalk breakage is observed, examine the pith to determine if sunflower maggot larvae are present.

Management

No management recommendations exist for sunflower maggot. Insecticide applications are not recommended for this insect.

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Chapter 12: Controlling Birds

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Charles Edinger, Sunflower producer

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Sunflower is vulnerable to damage by several bird species. The greatest losses occur from migrating flocks of red-winged blackbirds, yellow-headed blackbirds, and common grackles. Fields located near cattail marshes are especially susceptible to bird damage. Blackbirds often roost in the cattail marshes at night and feed in nearby sunflower, small grain, or corn fields during the day. Before these crops mature and become vulnerable to damage, the blackbirds feed on insects and weed seeds. Once the birds become used to feeding in a particular area, it becomes more difficult to get them to move.

Blackbird control measures consist of cultural practices used in combination with frightening methods to move birds out of the areas where sunflower fields are located (Fig. 12.1 and Fig. 12.2). Do not plant sunflowers near cattail marshes or woodlots. Producers can leave blank rows or strips every 2 to 300 feet in large fields to provide access for scaring birds from the center of the field or alternatively, later in the season trails can be made in strategic locations with a four wheeler. Planting at the same time as neighbors will reduce damage that often occurs to early- or late-ripening fields.

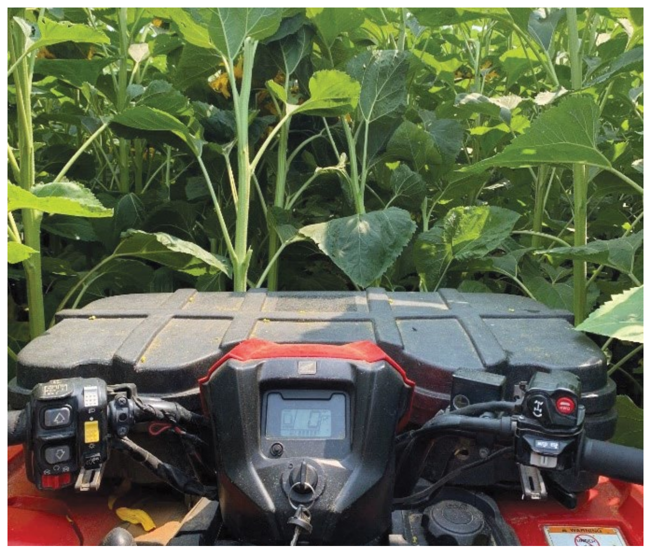

Figure 12.1. A four wheeler pushing down sunflowers to make trails for bird monitoring (Photo courtesy of Charlie Edinger)

Figure 12.2. A trail in sunflowers made by four wheeler, to monitor birds. (Photo courtesy of Charlie Edinger)

Some hybrids possess morphological traits that make them more bird resistant. These traits include concave heads, horizontally-oriented heads, and long head-to-stem distance. Hybrids possessing these traits must be planted in north-south rows to avoid overlapping of plants at maturity, which would offset some of their seed-protecting characteristics. In addition, the use of shorter varieties can make it easier for producers to locate birds and target control measures where birds are feeding.

Weed seeds are an attractive food source for blackbirds. Good weed control will help prevent blackbirds from establishing a feeding pattern in weedy fields before the sunflower crop matures. Consider planting lure or trap crops on diverted acres in areas of high bird risk to keep birds out of susceptible crops. Harvesting sunflower as early as possible will reduce exposure to bird damage. Desiccants may be used after sunflowers reach physiological maturity to speed dry down and allow for earlier harvest.

Cattail marshes can be managed with an aquatic herbicide (Rodeo) to remove cattails used as roosting sites for blackbirds. Generally, the herbicide must be applied the year before sunflowers are planted in the vicinity of the marsh to allow time for the cattails to decompose.

Begin harassment of blackbird flocks as soon as birds are seen in the area, regardless of their diet. Deterring infestations of local birds early in the season, can help to reduce infestations of migrating birds that occur later in the season. Early bird infestations can be more damaging to the crop, as more seeds are required to satisfy their appetite. If producers are persistent with shotguns or rifles when the birds first begin to visit the fields, the use of cannons with daily monitoring will be much more effective the remainder of the season.

Automatic exploders or bird-scaring cannons detonate a gas to produce a loud explosion. Place these devices on a stand above the crop, and operate from just before sunrise until the birds head for their roosting sites at night. Move the exploder every few days, because the birds may become accustomed to the noise if the device is operated in the same place day after day. Another option is to set the propane cannons to run during the night where the birds roost. This can annoy the birds (difficult to sleep) and may cause the birds to move elsewhere. One exploder can generally protect 10-20 acres of sunflowers.

Use of a .22 rifle can often give good results in frightening blackbirds from sunflower fields. Use this method only with extreme care in areas where it is legal and safe. Fire the rifle from a high position into the midst of settling birds, and then fire several more rounds into the lifting flock. One rifle can protect about 100 acres. Some producers may prefer using a 12 gauge shotgun, as it will have more volume that a .22. In addition one shell has potential to impact more birds if they are in a group. As mentioned earlier, persistence early in the season can help reduce bird damage throughout the remainder of the season.

Electronic frightening devices are available that broadcast distress calls of blackbirds. They can be effective, but use is limited because of their high cost and limited broadcast range.

Pyrotechnic products are effective at frightening birds but can pose both personal and fire hazards. These products include firecrackers, flares, whistlers, and cracker-shells. Wear safety glasses and hearing protection when using any of these products. Do not use during dry periods when fire risk is high.

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Chapter 13: Other Pests and Damage

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July 2021

(NDSU Extension granted South Dakota State University permission to use information from the Sunflower Production Guide in a similar publication for print and/or online.)

Rabbits

Rabbits will start foraging soon after seedling emergence, especially near the edges of fields. They will tend to concentrate on one row and apparently eat their fill, then leave until the next feeding period. Continued feeding by rabbits has been observed until the plants are 8 to 10 inches tall. Rabbit feeding on such large plants may be confused with deer. However, deer can be detected by their tracks.

Deer

Deer begin foraging on sunflower plants when the plants reach 8 to 10 inches and continue through harvest. They feed in areas near cover, such as wooded areas. All leaves of young plants will be consumed below the growing point. Heads will be foraged until near maturity and seeds until harvest. Often deer will knock down the stalk to facilitate foraging.

Gophers and Mice

Gopher and mouse damage usually is seen just after planting. It generally occurs next to overgrazed pastures, grassland recently converted to cropland and fields next to abandoned areas. The seed will be dug up, split open with the kernel consumed and the hull left on the soil. Several seeds in a row will be eaten. Seedlings are eaten occasionally when they are 2 to 3 inches tall. If the growing point is consumed, the seedling gradually dies.

Lightning

Lightning damage sometimes is mistaken for a disease. It is distinguished from disease damage by the sudden death of the plants in the affected area and the fact that both sunflower and weeds (not grass, however) are killed. Near the edge of the area, plants are wilted but not dead, and the stalks may have a brown to blackened pith. The area may be as large as 50 to 100 feet in diameter. The affected area usually is circular and does not increase in size after the first two weeks.

Flooding

Soils should have good drainage for sunflower production, but the crop doesn't differ greatly from most other crops. In flooded sunflower, research found that ethylene increased in the stems and roots below the water. Later, chlorophyll breakdown and leaf epinasty resulted. Sunflower plants flooded longer than three days may not recover. Cool, cloudy days during the flooding period reduce the damage, whereas hot and sunny days may hasten the death of plants.

Heat Canker

Warm temperatures and sunny days can result in heat canker injury to young sunflower seedlings growing in black or dark, moist soils. Hot temperatures at the soil line cause cell death in the young stem and the plants will show bands of yellowing and constricting. In severe cases, the constricted area completely girdles the stem at the soil line and the plant topples over. The sunflower seedling will not recover since the growing point is above this site.

Frost Damage

Sunflower seedlings in the cotyledon stage (VE) can withstand temperatures down to 26 F when just emerging from the soil. Sunflower in the V-1, V-2 and V-3 stages become less tolerant to frost as they grow and develop. The terminal bud can be frost damaged in seedlings with two, four and six true leaves. This early frost damage and killing of the terminal bud can result in excessive branching as the sunflower grows and develops.

Sunflower is most susceptible at the bud (R-4) and pollination stages (R-5.0 to R-5.9) of development. Temperatures of 30°F or less can cause damage to the anthers and stigmas of the pollinating disk flowers. (See Fig. 13.1 for frost-damaged sunflower head).

Figure 13.1. Frost damage in the center third of sunflower head. (Photo: Duane Berglund, NDSU).

Sunflower has a composite flower. Several rows of showy yellow ray flowers encircle the head and commonly are called the "petals," although each is an individual flower. The center portion of the head, and by far the greater part, is composed of inconspicuous individual flowers, one for each seed that may develop. These disk flowers mature in circles from the outside of the flower head to the center, so that at various stages, the disk flowers ready for pollination appear as a yellow circular band in the brownish or dark center of the head. These disk flowers are sensitive to frost.

The result of the frost damage in the flowering period is circular bands of undeveloped seed that would vary with individual flower heads from a band around the outside edge to an area in the center. Unopened buds are less susceptible to frost than the opened flower heads. Growers can determine the extent of injury by cutting the surface of the flower head.

Once pollination is completed and 10 to 14 days after petal drying occurs, the sunflower plants can withstand frost temperatures as low as 25°F and have only minor damage. If hard frosts do occur, many times only the seed in the center of the head (the last to pollinate) will be affected.

When sunflower heads start to turn yellow on the backside and the bracts are drying and turning brown, most risk of frost damage is very minimal.

In non-oilseed sunflower, frost damage can cause quality problems by causing a dark brown to blackened nutmeat to result during the roasting process. For the birdseed market, light-weight sunflower seed and brown seeds are the result of frost damage and will be discounted. For oilseed sunflower, reduced test weight per bushel and lower oil percent may result from a frosted immature sunflower crop.

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Chapter 14: Feeding Value of Sunflower Products in Beef Cattle Diets

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(NDSU Extension granted South Dakota State University permission to use information from the Sunflower Production Guide in a similar publication for print and/or online.)

Sunflower Meal

Nutrients in sunflower meal can vary depending on several factors. The amount and composition of meal is affected by oil content of the seed, extent of hull removal and efficiency of oil extraction. The proportion of hull removed before processing differs among crushing plants. In some cases, a portion of the hulls may be added back to the meal after crushing. The amount of hull or fiber in the meal is the major source of variation in nutrients (Table 14.1).

Pre-press solvent extraction of whole seeds with no dehulling produces meal with a crude protein content of 25 to 28%, partial dehulling yields 34 to 38% crude protein content and completely dehulled sunflower meal commonly yielding 40+% crude protein. Sunflower meal is marketed and shipped as meal or pellets. Protein required by rumen microbes can be provided in the form of rumen-degradable protein from sunflower meal. Heat treatment or toasting of meal from the solvent extraction process may increase the proportion of undegradable protein. Sunflower meal is more ruminally degradable (74% of crude protein) than either soybean meal (66%) or canola meal (68%; Table 6).

Table 14.1. Nutrient content of solvent-extracted sunflower meal based on amount of hulls retained.

Item	No Hulls Removed	Partially Dehulled	Dehulled
Dry Matter, %	90.0	90.0	90.0
	Percent, Dry Matter Basis		
Crude Protein	28.0	34.0	41.0
Fat	1.5	0.8	0.5
Crude Fiber	24.0	21.0	14.0
Ash	6.2	5.9	5.9
Calcium	0.36	0.35	0.34
Phosphorus	0.97	0.95	1.30
Potassium	1.07	1.07	1.07
Magnesium	0.80	0.79	0.79

Hesley (ed), National Sunflower Association, 1994.

Table 14.2. Protein and energy fractions for sunflower meal, soybean meal and canola meal.

Item	Sunflower Meal	Soybean Meal	Canola Meal
	Dry Matter Basis, %		
Crude Protein	26.0	49.9	40.9
	Crude Protein, %		
Rumen Degradable	74.0	66.0	68.0
Rumen Undegradable	26.0	34.0	22.0
	Dry Matter Basis, %		
Crude fiber	12.7	7.0	13.3
Neutral Detergent Fiber	40.0	14.9	27.2
Acid Detergent Fiber	30.0	10.0	17.0
Net Energy, Maintenance, Mcal/lb	0.67	0.93	0.73
Net Energy, Gain, Mcal/lb	0.40	0.64	0.45
Total Digestible Nutrients	65	84	69

Adapted from NRC, 1996.

Sunflower meal has a lower energy value than either canola or soybean meal (Table 14.2). Energy varies substantially with fiber level and residual oil content. Higher levels of hulls included in the final meal product lower the energy content and reduce bulk density. The mechanical process of oil extraction leaves more residual oil in the meal, often 5 to 6 % or more, depending on the efficiency of the extraction process. Elevated oil content in mechanically extracted meals provides greater energy density. Pre-press solvent extraction reduces residual oil to 1 ½% or less.

Sunflower Meal in Beef Cattle Diets

Sunflower meal can be used as the sole source of supplemental protein in beef rations. In trials comparing sunflower meal with other protein sources, equal animal performance commonly is observed based on isonitrogenous diets from different sources.

Cows consuming low-quality forages, such as winter range, crop aftermath or other low-quality forages, can utilize supplemental degradable protein to increase total intake, forage digestibility and performance. Protein can be supplemented with a number of feeds, coproducts or oilseed meals. Least costly sources are critical to profitability, and sunflower meal often is very competitively priced per unit protein. Sunflower meal has been used widely in beef cow supplementation programs but few research trials document comparative animal performance.

Sunflower Silage

Sunflower silage can make a suitable feed for beef cows; however, high moisture levels can be a challenge since sunflowers typically don't dry down well. Consequently, dry feed must be added to the silage pile to reduce the moisture level to a point where seepage is not a major problem.

Table 14.3 gives the estimated nutrient content of sunflower silage produced from either low-oil or high-oil varieties of sunflower. Depending on what other feeds are mixed in the silage pile, nutrient contents may change.

Blending corn and sunflower silages together can help alleviate the moisture problem. Producers also may consider waiting seven to 10 days following a killing frost to facilitate dry down. Blending dry forage into the silage pile also can reduce moisture content. To minimize seepage problems, the moisture level should be 65% or less.

Whole Sunflower Seeds

When economical, whole sunflower seeds can be used as a source of energy and protein in beef cattle diets (Table 14.3). Fat levels can be quite high in whole seeds; consequently, amounts fed should be restricted based on fat content of the seed. Typically, no more than 4% supplemental fat should be added to cow diets to reduce the potential for any detrimental effects on fiber digestion. This will result in inclusion levels of approximately 10% of the diet.

Table 14.3. Nutrient content of sunflower products.

Product	DM, %	TDN, %	%Mcal /lb	NEm, Mcal/lb	NEg, CP, %	ADF, %	Ca, %	P, %
Sunflower Hulls*	90.0	40.0	0.41	0.00	5.0	63.0	0.00	0.114
Sunflower Screenings*	87.0	64.0	0.66	0.39	11.1	29.0	0.72	0.42
Sunflower Seed, Confectionary*	94.9	83.0	0.93	0.63	17.9	39.0	0.18	0.56
Sunflower Seeds, Oil Type*	94.9	121.0	1.42	1.03	17.9	39.0	0.18	0.56
Sunflower Silage, Low-oil Variety**	30.0	61.0	0.61	0.69	11.1	42.0	0.8	0.3
Sunflower Silage, High-oil Variety**	30.0	66.0	0.35	0.42	12.5	39.0	1.50	0.3

*Adapted from Lardy and Anderson, 2003.
**Adapted from Park et al., 1997.

Sunflower Residue

Sunflower residue is useful for aftermath grazing by beef cows. Nutritional value of the head is greater than the stalk. Supplementation may be required if the volume of residue is limited and nutrient quality decreases rapidly after head material is consumed.

Sunflower Screenings

Sunflower screenings from both confection and oil seed plants are often available at competitive prices. Nutrient content varies widely with the amount of meats, which are high in fat and protein, and hull, which is low in nutrient content and digestibility. Screenings are best used in modest growing or maintenance diets when animal performance is not critical. The presence of sclerotia bodies does not appear to be a problem for palatability, nutrient content or animal performance.

Sunflower Hulls

Sunflower hulls are low in protein and energy and should be used only as a bedding source.

Summary

That sunflower meal is a useful protein source for growing and finishing cattle is apparent from the limited research. Similarly, beef cows can be provided supplemental protein effectively with sunflower meal. Sunflower meal may be especially useful in diets where degradable protein is required, such as lower-quality forage or high corn finishing rations. The increased bulk of this relatively high-fiber meal may affect logistics, but ruminants are positioned to be more tolerant of high fiber levels than other species. Other sunflower products can be used effectively in ruminant diets, given appropriate performance expectations.

Selected Reference

Kandel, H., Buetow, R., and Endres, G. (eds.) 2020. Sunflower production. A-1995. North Dakota State Extension Service, North Dakota State University, Fargo, ND, USA.

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