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BIOLOGY AND PEST MANAGEMENT OF THE Sunflower Beetle in North Dakota

Janet J. Knodel, Crop Protection Specialist
Laurence D. Charlet, USDA, ARS Research Entomologist
Phillip A. Glogoza, Extension Entomologist

Figure 1. Sunflower plant damaged by sunflower beetle.

The sunflower beetle, *Zygogramma exclamationis* (Fabricius), is one of the major economic insect pests of sunflower in the northern plains. It is native to North America and has moved from feeding on wild sunflowers to become the major defoliating pest of cultivated sunflower. The insect belongs to the family Chrysomelidae (leaf-feeding beetles), the group which also includes the destructive Colorado potato beetle. The sunflower beetle is found throughout the Great Plains wherever sunflower is grown. Both the adult and larval stages consume leaf tissue, which can result in yield reduction of sunflower seed (Figure 1). Although the sunflower beetle is present each year, the severity of infestation varies. During years with heavy infestations, the sunflower beetle was ranked as the worst insect pest problem by most North Dakota sunflower producers, with approximately 60 percent of the sunflower acreage being treated to manage either the adult or larval stage.

Distribution

This insect has been reported from southern Canada to northern Texas, Arizona, New Mexico, and west to Utah. High populations often necessitate control measures in cultivated sunflower grown in North and South Dakota and Minnesota. Although present in the central and south-

NDSU EXTENSION SERVICE
North Dakota State University
Fargo, North Dakota 58105
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ern plains, the sunflower beetle has not been considered a serious pest of cultivated sunflower in these regions.

Identification

Adult: The head of the adult is reddish-brown and the thorax (area between head and abdomen) is pale cream-colored with a reddish-brown patch at the base (Figure 2). Each wing cover is cream-colored and has three dark stripes that extend its length. A shorter lateral stripe ends at the middle of the wing in a small dot that resembles an exclamation point. The beetle is 1/4 to 1/2 inch (6 to 12 mm) long and 3/32 to 3/16 inch (2 to 4 mm) wide.

Eggs: Eggs are about 1/16 inch (1.5-2.0 mm) long, cigar-shaped and cream-yellow in color (Figure 3).

Larvae: Sunflower beetle larvae are yellowish-green with a brown head capsule and humpbacked in appearance. Newly hatched larvae are about 1/16 inch (1.5-1.75 mm long), and will reach a length of about an inch (8-10 mm) when fully developed (Figure 4).

Pupae: Pupae are similar in size to the adult and yellow in color.

Figure 2. Sunflower beetle adult.

Figure 3. Sunflower beetle egg.

Figure 4. Sunflower beetle larvae.

Life Cycle (Figure 5)

The sunflower beetle has one generation per year in the northern plains. Adults overwinter in the upper 2 to 4 inches (5-10 cm) of soil and emerge from the previous sunflower fields in May to early June. Beetles overwinter throughout the field and exhibit no preference for field edges or shelterbelts. Research indicates that a degree day (DD) model and calendar dates are equally accurate in predicting the onset and 50 percent emergence of the sunflower beetle population. The DD model is initiated on March 1st and is based on soil temperature at a depth of 2 inches (5 cm) and a base of 32°F (0°C). Sunflower beetles begin to emerge at a mean of 416 DD °F (232 DD °C), and 50 percent of the adult emergence occurs by 710 DD °F (395 DD °C).

Shortly after emergence the beetles begin to feed, mate and lay single eggs on stems and undersides of leaves. Adults live for about 8½ weeks and lay eggs for a 6-7 week period. Each female lays approximately 850 eggs with a range of 200-2,000 eggs. About 14 eggs per day are laid. Egg survival is about 70 percent in the laboratory but is estimated at only 50 percent in the field. Some eggs fail to hatch due to predation, egg sterility, and unfavorable weather conditions like hot, sunny weather. Eggs hatch into larvae in about one week. The larvae have four instars, which feed and are present in fields for about six weeks. When mature, larvae drop to the soil where they pupate in earthen cells. The pupal stage lasts from 10 days to two weeks. A new generation of adults (called the summer generation) emerge in late July through early September and feed for a short period on the uppermost leaves or bracts of sunflower before burrowing back into the soil to overwinter. Feeding by the summer generation adults causes minimal damage to the maturing sunflower plant. These adults do not mate or lay eggs until the following spring.

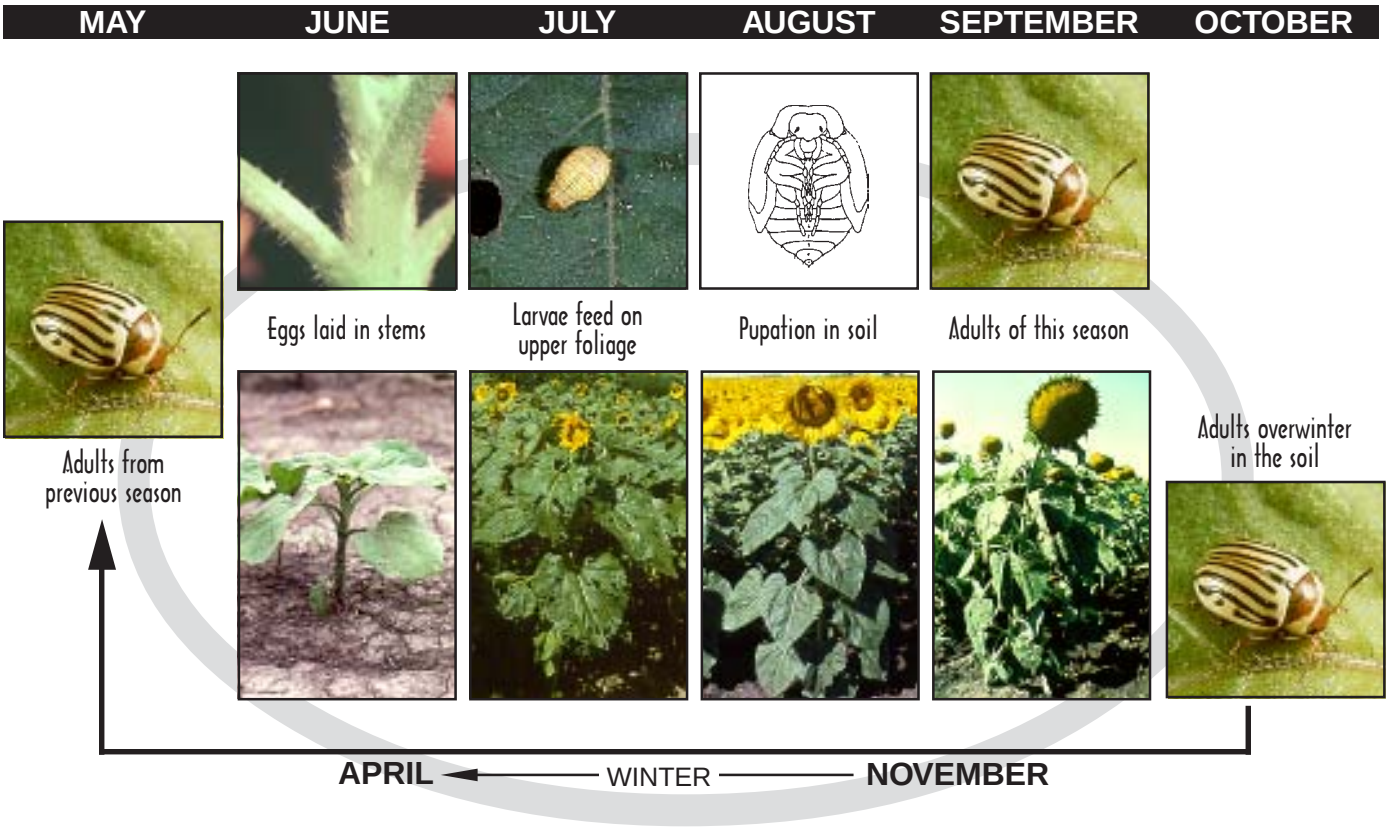

Figure 5. Life cycle of the sunflower beetle.

Hosts

Sunflower beetles are generally restricted to cultivated or wild sunflower and a few close relatives. Adults and larvae are observed on wild sunflower including *Helianthus annuus* L., *H. petiolaris* Nuttall, *H. nuttallii* Torrey and Gray, *H. pauciflorus* Nuttall, *H. maximiliani* Schrader, *H. tuberosus* L., and *H. giganteus* L. In Texas, they have also been found on woolly leaf bursage, *Franseria tomentosa* Gray.

Crop Damage

Damage due to adult feeding begins soon after beetles emerge from hibernation. They seldom feed on the cotyledons, but the first true leaves may be severely damaged or completely consumed. If beetles are abundant, fields may be severely defoliated. Adults feed predominately on leaf margins while larvae feed over the entire leaf surface. When larvae are numerous, damaged leaves take on a lacy appearance. Damage may be most noticeable in field margins. Most larval feeding occurs at night, and adults will feed during the day. During the daytime, larvae typically rest in the terminal growth area where they are easily found in leaf and flower buds. If larval feeding is severe, defoliation can reduce yield by poor seed set or fill.

The late summer generation of emerging sunflower beetle adults rarely causes economic damage to the sunflower crop. However, in some cases they have been abundant enough to cause feeding injury on late-planted sunflower.

Pest Management

In the spring, overwintering sunflower beetle adults emerge, locate, feed, mate, lay eggs, and damage emerging sunflower plants. To effectively manage sunflower beetles, producers should use an Integrated Pest Management (IPM) Program. This type of approach can maximize yields and profits and minimize losses. Sunflowers should be monitored on a regular basis to determine the level of infestation and damage. To minimize inputs, to conserve the natural enemies of the sunflower beetle, and to reduce the negative impacts of pesticides on the environment, insecticides are only recommended when beetle populations have reached the "economic threshold level."

Cultural Control

Cultural control manages insect pests by altering farming practices, is compatible with conserving natural enemies, and is environmentally friendly. Two different cultural strategies that have been studied for sunflower beetle management are:

Planting Date

For the sunflower beetle, adult and larval populations decrease as planting date is delayed. Defoliation is also lowest in the latest planting date. As a result, delayed planting was effective in preventing yield reductions caused by sunflower beetle feeding. A further benefit was that no negative impacts were observed on the parasitism rate of the tachinid fly, *Myiopharus macellus* (Rheinhard), which attacked the sunflower beetle larvae equally in all of the different planting dates. Delayed planting also has been shown to reduce losses (seed weight or oil content) caused by the sunflower stem weevil (*Cylindrocopturus adspersus* (LeConte)) and the banded sunflower moth (*Cochylis hospes* Walsingham). But, damage from the red sunflower seed weevil (*Smicronyx fulvus* LeConte) tends to be greater in later-planted fields. Thus, sunflower planting decisions need to be based on the historical pest problems for a particular area. In addition, growers should consider that sunflower fields planted late (early June) usually have lower yields than fields planted early (mid to late May).

Tillage/Cultivation

Research has demonstrated that spring or fall cultivation does not reduce the overwintering populations of sunflower beetle adults or influence the pattern of emergence from the soil during the spring and summer. However, another sunflower pest, the red sunflower seed weevil, is negatively affected by tillage, which reduces emergence of adult seed weevils.

Plant Resistance

As yet, sunflower hybrids with resistance to the sunflower beetle have not been developed. Studies with about 20 species of native sunflowers have shown the genetic basis for resistance is present in some of these species. The resistance mechanisms exhibited in these native species include both antibiosis, in which larval mortality is higher when feeding on the plants, or antixenosis (non-preference), which is evident in reduced feeding by adults and larvae. In some cases, adult longevity was reduced and females laid no

eggs. Although not killed outright, development time of beetles when feeding on some wild species was lengthened and their weights were reduced. The reduced vigor of these low-weight beetles makes them more vulnerable to attack by their natural enemies in the field.

Biological Control

The sunflower beetle has a number of natural enemies that either directly consume the various stages of the beetle or parasitize these stages with the progeny of the parasitoid destroying the beetle egg, larva or adult. Since these natural enemies are present in sunflower fields, it is important to protect them from unnecessary applications of pesticides which will kill them along with the sunflower beetles. By applying insecticides only when the pest density reaches the economic threshold, the predators and parasitoids are protected and allowed to serve as natural control agents for the sunflower beetle.

Predators

Many different insect predators feed on the different life stages of the sunflower beetle. Sunflower beetle eggs are eaten by the melyrid beetle, *Collops vittatus* Say, the thirteen spotted lady beetle, *Hippodamia tredecimpunctata tibialis* (Say), and the convergent lady beetle, *H. convergens* Guerin-Meneville. Larvae of the common green lacewing, *Chrysoperla carnea* Stephens, consume both eggs and larvae. The spined soldier bug, *Podius maculiventris* (Say), has been seen feeding on adults and larvae in North Dakota. The twospotted stink bug, *Perillus bioculatus* (Fabricius) (Figure 6), has been observed feeding on sunflower beetle larvae in Manitoba, Texas, and North Dakota. In North Dakota, a more rare, related stink bug species (*Perillus circumcinctus* Stal) is also present in sunflower fields and feeds on beetle larvae. The carabid beetle, *Lebia atriventris* Say, was reported to feed on sunflower beetle larvae in Manitoba and Texas (Figure 7). It appears to be a common inhabitant of sunflower fields in North Dakota and Minnesota. Laboratory studies have shown it to be a voracious feeder on sunflower beetle larvae. In Manitoba, damsel bugs, *Nabis* sp., were the fourth most common predator in sunflower fields and were suspected of feeding on sunflower beetle larvae. These predators are also common in North Dakota sunflower fields.

Although they are a serious pest of sunflowers in many areas of the state at certain times of the year, redwinged blackbirds also feed on sunflower beetle adults. A variety of spider species are common inhabitants of cultivated fields and undoubtedly consume adults and larvae of the sunflower beetle.

Figure 6a. Predator of sunflower beetle: adult twospotted stink bug, *Perillus bioculatus* (Fabricius).

Figure 6b. Nymphs of twospotted stink bug, *Perillus bioculatus* (Fabricius) feeding on a sunflower beetle larva.

Figure 7. Predator of sunflower beetle: adult carabid beetle, *Lebia atriventris* Say.

Parasitoids

Parasitoids attack sunflower beetle eggs, larvae, and adults. Eggs are parasitized by the pteromalid wasp, *Erixestus winnemana* Crawford, in North Dakota, Minnesota, and Manitoba. Reported parasitism rates are much lower in the U.S. (1 percent) than in Canada (17 percent). Larvae are parasitized by two species of parasitic flies of the family Tachinidae, *Myiopharus macellus* and *M. doryphorae* (Riley) in Manitoba, North Dakota and Minnesota (Figure 8). *Myiopharus doryphorae* has only been recovered from Canada and is extremely rare, constituting less than 1 percent of parasitoids reared from sunflower beetle larvae. The life history of *M. macellus* is well synchronized with the life cycle of its host, and the rate of parasitization is high in some fields in both Canada and the U.S. (up to 70 and 100 percent, respectively). The fly develops in the beetle larva, kills the larva when it moves into the soil to pupate, and emerges from the soil. Since the sunflower beetle overwinters as an adult, the fly must either overwinter in an alternate host or move into the northern plains from southern areas each year. Adult sunflower beetles are parasitized by the tachinid, *Myiopharus* sp. Approximately 0.2 to 17 percent of adults in Manitoba are attacked, but studies have shown that less than 2 percent are parasitized in North Dakota and Minnesota.

Figure 8. Parasitoid of sunflower beetle: adult tachinid fly, *Myiopharus macellus* (Rheinhard).

Chemical Control

Monitoring

Field scouting is necessary to determine whether or not a field needs to be treated. When monitoring a field, count the number of adults and/or larvae on 20 plants at five randomly selected sampling sites throughout the field for a total of 100 plants. Use a "X" pattern and select sampling sites at least 75 to 100 feet from the field margins. Determine the average number of adults and/or larvae per plant. Estimate the percent defoliation (Figure 9) during field scouting.

Economic Thresholds

Seedling:

1 to 2 adult(s) per seedling

Later plant growth stages (vegetative to reproductive):

1 to 2 adult(s) per plant
10-15 larvae per plant
OR
25 to 30 percent foliar defoliation on the top 10-15 leaves or the "active growing part"

In the seedling stage, one-two adults per seedling is the recommended economic threshold. As sunflower plants develop, they can tolerate more feeding damage. When populations reach 10 to 15 larvae per plant, approximately 25 percent defoliation on the upper eight-12 leaves occurs. When adult populations average two adults per plant, enough larvae are often produced to cause yield losses of 20 percent. Management is normally advised if defoliation reaches the 25 to 30 percent

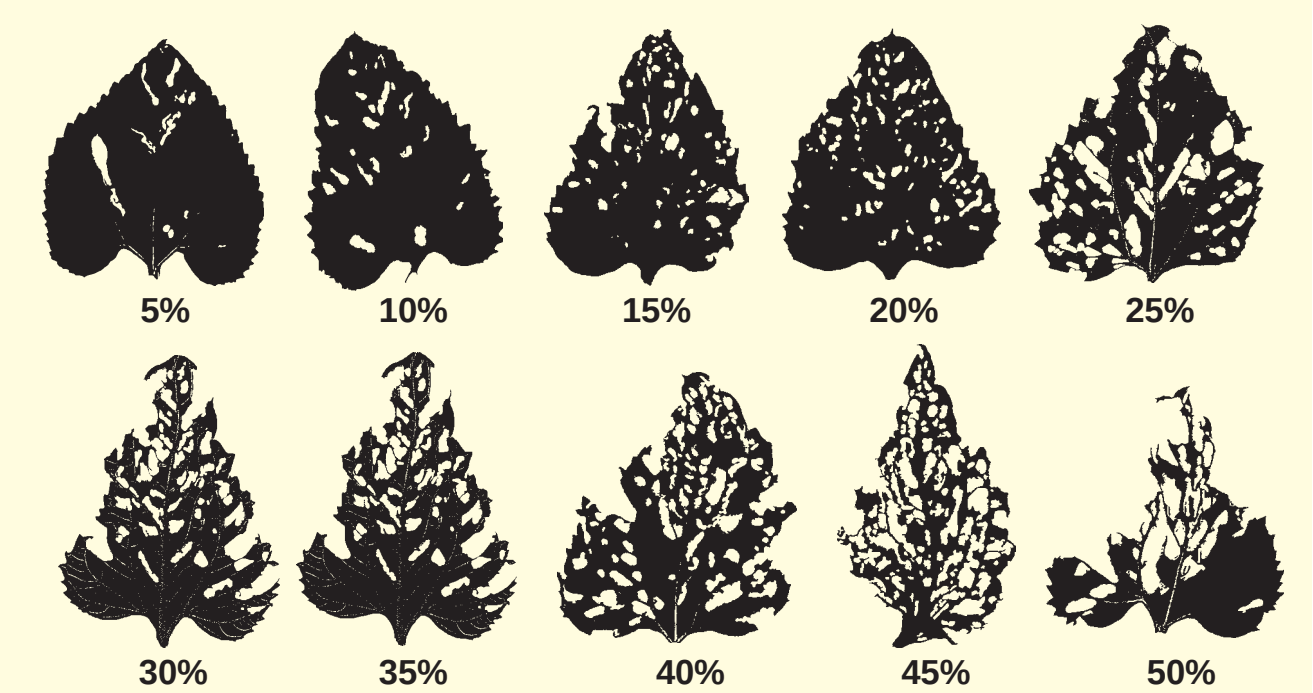

Figure 9. Various levels of percent defoliation (5-50 percent) caused by sunflower beetle feeding.

level in late vegetative and early bud stages and it appears (based on larval size of less than 1/4 inch or 6 mm) that more defoliation will occur on the actively growing part of sunflower plant. However, if defoliation is 25 percent and the majority of larvae are about 1/3 inch (8 mm) long, they will have reached maturity and stopped feeding. Then management is not be warranted.

Insecticide Recommendations

Application of an insecticide is recommended only when beetle populations have reached an economic threshold level in a field. Insecticides are effective in preventing economic loss when applied to actively feeding adults and/or larvae. Insecticides registered for sunflower beetle management in North Dakota as of 2000 are listed in the table below. Please check with the current *Field Crop Insect Management Guide* for updated insecticide registrations. It is of utmost importance that insecticide users READ, UNDERSTAND, and FOLLOW ALL LABEL DIRECTIONS.

Insecticide Recommendations

Insecticide	Dosage in lb ai/acre	Product per acre	Restrictions on use
Asana XL* *esfenvalerate* *RUP*	0.015 - 0.03 lb/acre	2.9 - 5.8 fl oz	Do not apply within 28 days of harvest. A reduced rate has been issued as a state 2 (ee) label. These lower rates are for control of SF beetle larvae ONLY. The reduced rate application has a range of 1.45 - 5.8 fl oz.
Baythroid* *cyfluthrin* *RUP*	0.025 - 0.044 lb/acre	1.6 - 2.8 fl oz	Do not apply within 30 days of harvest.
carbaryl (Sevin)	1.5 - 2 lb/acre	rate varies by formulation	Do not apply within 60 days of harvest. Do not allow livestock to graze on treated forage.
Furadan 4F* *carbofuran* *RUP*	0.125 - 0.5 lb/acre	0.25 - 1 pt	Do not re-enter treated fields within 14 days of application without wearing proper protective clothing. Do not harvest crop within 28 days of last application.
Lorsban 4E *chlorpyrifos*	0.5 - 0.75 lb/acre	1 - 1.5 pts	Do not apply within 42 days of harvest. Do not allow livestock to graze in treated areas.
Scout X-TRA* *tralomethrin* *RUP*	0.005 - 0.01 lb/acre	0.71 - 1.42 fl oz	Do not apply within 21 days of harvest.
Warrior T* *lambda cyhalothrin* *RUP*	0.015 - 0.025 lb/acre	1.92 - 3.2 fl oz	Do not apply within 45 days of harvest. A reduced rate has been issued as a state 2 (ee) label. The reduced rate application has a range of 1.28 - 2.56 fl oz.

**RUP* - Restricted use pesticide

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