Gall Midge in Soybeans

CROP BULLETIN

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SUMMARY

- Soybean gall midge is a new insect pest of soybeans first found in Nebraska in 2011 that has now spread into parts of several other states.
- Gall midge injury in soybean is a result of larval feeding, which occurs near the base of the plant. Prolonged feeding can cause the stem to break, resulting in plant death.
- Injury is generally most severe at field edges, which suggests that populations are moving in from adjacent fields planted to soybeans the previous season.
- Yield loss reports have ranged from a 1-2 bu/acre to nearly total yield loss depending on how early injury occurs and the severity of the infestation in certain areas of a field.
- In 2019, populations of a second gall midge species that feeds specifically on white mold-infected plant tissue were found in soybeans in Minnesota.
- Management recommendations for soybean gall midge are still in the process of being developed. Research on soybean variety susceptibility and foliar insecticide and seed treatment efficacy is currently underway.

GALL MIDGE – A NEW PEST OF SOYBEAN

Soybean gall midge is a relatively new insect pest of soybean. Gall midge was first observed in soybeans in Nebraska in 2011. Initially, it appeared to be a relatively minor pest of soybeans, mostly confined to field margins and feeding on soybean plants that were already damaged or diseased. However, instances of greater infestation levels and damage to soybeans were observed beginning in 2018, with populations extending further into field interiors and feeding on otherwise healthy plants.

Very little was known up to this point about the biology of soybean gall midge, including exactly what species it was. Initial investigations identified gall midge observed in soybeans as belonging to the genus *Resseliella*, which included 15 species known to exist in the U.S., none of which were known to infest soybeans. Genetic and morphological analyses subsequently confirmed soybean gall midge to be a previously undescribed *Resseliella* species, now named *Resseliella maxima* (Gagne et al., 2019).

Figure 1. Gall midge larvae feeding in soybean stems. Iowa, August 3, 2018. Photo: Jessie Alt, Corteva Agriscience Research Scientist.

Soybean gall midge has now been confirmed in seven states and has proven capable of causing significant crop damage and reductions in yield. There is still much to be learned about the biology and lifecycle of this pest, as well as effective management practices. The situation was further complicated in 2019 with the discovery of a second gall midge species affecting soybeans in parts of Minnesota.

FIELD OBSERVATIONS IN SOYBEANS

Gall midge damage in soybeans was first reported in Nebraska in 2011 in isolated cases mostly associated with damaged or diseased stems. Sporadic infestations were observed in subsequent years, but damage generally was not severe enough to impact yield. While remaining a relatively minor concern for soybean production, gall midge populations began to spread, with feeding in soybeans first reported in South Dakota in 2015 and western Iowa in 2016.

Agronomists and scientists at the University of Nebraska, Iowa State University, and South Dakota State University all noted increased infestation in 2018, with infestations occurring earlier in the season and causing higher levels of damage to soybeans. Numerous infestations were observed in 2018 by agronomists on otherwise healthy soybean plants, indicating that damaged or diseased tissue is not a necessary prerequisite for gall midge infestation. Economic levels of damage were observed again in 2019. The spread of soybean gall midge has continued, with populations reported in Missouri in 2019, North Dakota in 2022, Kansas in 2023, and expansion of affected areas in Nebraska, Iowa, and South Dakota (Figure 2).

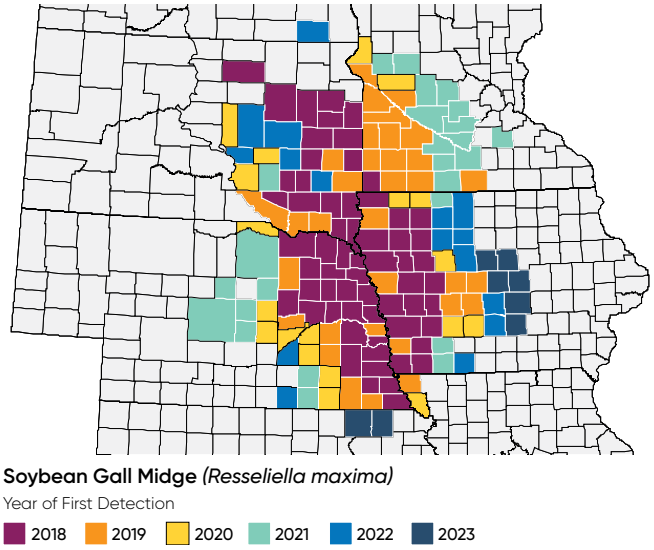

Figure 2. Counties with documented infestations of soybean gall midge and year of first detection.

(Source: www.soybeangallmidge.org)

CHARACTERISTICS AND PLANT INJURY

Larvae are very small and start out white, turning bright red or orange as they mature (Figure 3). Adult midges are small (2-3 mm in length) and have long antennae and hairy wings (Figure 4). Gall midge injury in soybean is a result of larval feeding, which occurs near the base of the plant. Multiple larvae can infest a plant. Larvae feed inside the stem, causing swelling and abnormal growth (galls). Infested portions of the stem will appear swollen and brown (Figure 5 and 6). Discolorations of the stem often begin near the soil surface and can extend up to the unifoliate node. Prolonged feeding can cause the stem to break off, resulting in plant death.

Figure 3. Gall midge larvae feeding in a soybean stem at the soil surface, South Dakota, August 8, 2018. Photo: Curt Hoffbeck, Field Agronomist.

Figure 4. Gall midge adults.

Figure 5. Galls on a soybean stem due to gall midge infestation (left). Stem girdling from prolonged feeding (right). Photos: Jessie Alt, Corteva Agriscience Research Scientist.

Figure 6. Galls on a soybean stem near the soil surface due to gall midge infestation, Nebraska, August 8, 2018. Photo: Jessie Alt, Corteva Agriscience Research Scientist.

GALL MIDGE SPECIES

Hessian fly (*Mayetiola destructor*), an agricultural pest in the *Cecidomyiidae* family. Photo courtesy of Scott Bauer, USDA-ARS.

- The term midge is used to refer to a broad group of small fly species, encompassing several taxonomic families. Gall midge refers to species of flies in the family Cecidomyiidae.
- Gall midges are characterized by larvae that feed inside plant tissue, resulting in abnormal plant growth (galls).
- More than 6,000 species of gall midge have been described worldwide, although the total number of species in existence is believed to be much larger. More than 1,100 species have been described in North America.
- The gall midge family includes numerous species that are economically important pests of agricultural crops, including Hessian fly (*Mayetiola destructor*), wheat blossom midge (*Sitodiplosis mosellana*), and sunflower midge (*Contarinia schulzi*).
- Some species of gall midge are known to feed primarily on decaying organic matter, fungi, and molds; therefore, they tend to be attracted to damaged or diseased areas on plants.

INJURY PATTERNS IN SOYBEANS

Infestation can occur during vegetative and reproductive stages. Injury is generally most severe at field edges (Figure 7 and 8). Injury on field margins suggests fly movement from previous crop residue to new crop. Research has shown that overwintering generation adult emergence comes almost entirely from fields infested the previous year, with very low rates of emergence observed in fencerows and other non-crop areas (McMechan et al., 2021a). Injury has been observed next to CRP, pastures, and tree lines in some cases. In severe cases, infestation can extend into the interior of the field.

Figure 7. Dead soybean plants due to gall midge injury along the edge of a soybean field. South Dakota, August 8, 2018; Photo: Curt Hoffbeck, Field Agronomist.

Depending on the severity of gall midge infestation, some soybean plants may wilt, die, or simply show signs of poor pod development and small seed size, especially in the upper 1/3 of the canopy on "healthy-appearing" green plants. Yield loss varies depending on how early injury occurs and the severity of the infestation in certain areas of a field. Yield losses in soybean gall midge infested fields can be up to 100% within 100 ft from the field edge, with losses of 17-31% further into the field (McMechan et al., 2021c).

Figure 8. Dead soybean plants due to gall midge injury near the edge of a soybean field. Approximately 95% of plants in this area were dead. Iowa, August 3, 2018; Photo: Jessie Alt, Corteva Agriscience Research Scientist.

SOYBEAN GALL MIDGE LIFECYCLE

Soybean gall midge undergoes complete metamorphosis, with egg, larva, pupa, and adult stages. Gall midge larvae overwinter in larval cocoons in the soil, similar to wheat midge (*Sitodiplosis mosellana*) (Figure 9). The majority of larvae overwinter in the top 1.5 inches of soil. This is relatively shallow compared to species such as northern and western corn rootworm that overwinter as eggs at depths of 4 to 6 inches. Overwintering larvae would have very little protection at such shallow depths from extreme cold temperatures and freeze-thaw cycles. The extent to which winter temperatures and snow cover can influence gall midge populations the following season is not yet known.

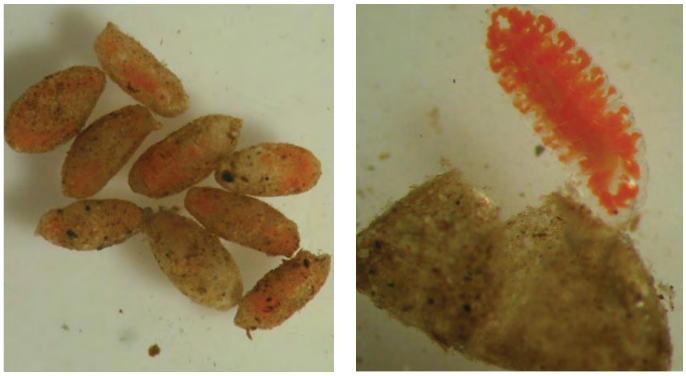

Figure 9. Soybean gall midge larval cocoons found in soil samples taken in a field with high soybean gall midge pressure (left). A soybean gall midge larva extracted from a larval cocoon (right). Photos courtesy of Kirk Anderson and Marion Harris, Dept. of Entomology North Dakota State University.

Timing of adult emergence from the soil varies by geography with first adult emergence observed in mid-June in Nebraska and early July in Minnesota (Knodel, 2019). Adults have a long emergence window – overwintering generation adult emergence extended over a 17-day period in a Corteva Agriscience study in 2019 and as long as 37 days in a 2021 study (Figure 10). Adults live three to five days and do not feed on soybean plants (Calles-Torrez et al., 2020).

Females lay eggs in cracks and fissures in soybean stems. Females do not pierce the stem tissue when laying eggs. Larval infestation of soybean plants has not been observed prior of the V2-V3 growth stage. At this stage of soybean growth, the stem diameter expands creating small fissures allowing the overwintering generation adults to deposit eggs into the stem (McMechan et al., 2021c). Prior to V3, the soybean stems do not have these fissures.

Newly hatched larvae feed under the epidermis of the stem and go through three instars. Larvae drop off the plant to the soil, where they form larval cocoons and pupate (Calles-Torrez et al., 2020). Adults then emerge and repeat the cycle. Adults are not strong fliers, so are limited in their mobility. The effect of wind in dispersing adults over longer distances is under investigation.

Based on observations so far, soybean gall midge appears to go through two or three overlapping generations per season. The substantial overlap between generations makes it difficult to detect discrete generations within the growing season, and larvae can be present in an infested field continually over the majority of the growing season. The timing of adult emergence cessation in the fall appears to be relatively consistent from year to year (McMechan et al., 2021a).

Research on soybean gall midge lifecycle has been challenging due to the fact that entomologists have not yet been able to sustain a colony in a laboratory environment. What is known about the insect's lifecycle so far comes entirely from field observations. Consequently, many aspects of the soybean gall midge lifecycle have been difficult to ascertain or remain unknown. Basic facts such has generation time, number of eggs laid by females, favorable conditions for development, and characteristics that drive host plant selection are all important for formulating a management plan but remain poorly understood.

Two other host species for soybean gall midge have been identified – alfalfa and sweet clover. There is no apparent need for management in these alternate hosts. Populations observed in alfalfa have been relatively low (McMechan et al., 2021a).

Figure 10. Trap set up following soybean planting to measure soybean gall midge adult emergence from the soil in 2019.

A SECOND GALL MIDGE SPECIES IN SOYBEAN

In 2019, populations of a second gall midge species were observed in soybeans in Minnesota. These populations were identified as belonging to a different species in the gall midge family (Cecidomyiidae), *Karshomyia caulicola*, known to exist in North America and northern Europe (Koch et al., 2019). Observations of *Karshomyia caulicola* have been in fields infected with white mold and, within the context of soybean management, it is now being referred to as white mold gall midge (WGM). *Karshomyia caulicola* is known to be a fungus feeder on other plant species and appears to only feed on white mold fungus in soybeans and not on the soybean plants. There is no evidence so far of white mold gall midge causing or spreading white mold infection.

Populations of white mold gall midge have been found in soybeans fields in Minnesota, Wisconsin, and North Dakota. White mold gall midge appears to be widespread in the North Central region of the U.S. (Calles-Torrez et al., 2020).

Larvae of white mold gall midge are very similar in appearance to those of soybean gall midge. The most effective way to distinguish between the two species is based on the timing and location of larval feeding. White mold gall midge feeding is specifically associated with the presence of white mold infection, so it has only been observed later in the season after flowering when infected tissue is present. White mold gall midge feeding can occur anywhere in the field where there are infected plants and anywhere on the plant where there is infected tissue.

MANAGEMENT CONSIDERATIONS

Management practices for gall midge are currently under investigation; however, nothing has worked very well so far. Preliminary investigations into foliar insecticide treatments have shown some promise for suppressing gall midge populations when applied at the time of pre- or early post-emergence herbicide applications to control egg-laying adults. However, these types of insecticide applications still need more thorough evaluation, and careful consideration is needed to avoid insect resistance issues with midge or other insects, and potential harm to beneficial insects.

The long emergence window of soybean gall midge adults poses a significant challenge for timing and effectiveness of insecticide application. Foliar treatments later in the season when larval feeding in the stems is already underway are not likely to be effective since the larvae are protected from exposure to the insecticide. More insecticide treatment timings, active ingredients, and rates need to be fully evaluated to determine what options are effective.

In general, the best opportunity for managing soybean gall midge is to limit overwintering generation's ability to infest soybean plants. Tillage of previously infested fields has been investigated as a way to potentially reduce adult emergence by disturbing the larval cocoons in the soil. Spring tillage has shown some effectiveness in reducing emergence rates and also appears to shift emergence earlier, possibly due to the quicker warming of the soil (McMechan et al., 2021b). Ridging soil around the stems of soybean plants has also been investigated as a way to impede egg laying in stem fissures. This technique has shown some effectiveness but is not likely to be a practical management tactic for many growers. Planting fields with a history of soybean gall midge last may provide some benefit, as early-planted soybeans tend to attract more overwintering generation adults.

Research on differences in soybean variety susceptibility to gall midge damage is ongoing. Host plant resistance is used to manage midges in other crops, so may offer some promise in soybeans. The goal is to identify a characteristic that makes soybean less attractive or more resistant to egg-laying midges (Sever, 2021).

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