AGRICULTURAL BIOLOGY
COLORADO STATE UNIVERSITY

WHEAT STEM SAWFLY BIOLOGY AND MANAGEMENT

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QUICK FACTS

- The wheat stem sawfly (WSS, *Cephus cinctus*) is an agricultural pest of cereal crops, primarily wheat, in the Great Plains from southern Alberta, Canada to Colorado, USA.
- The primary cause of damage to crops is the larva, which tunnels through the stalk of the plant and cuts it at the base, causing the plant to fall over.
- Current insecticides are ineffective against sawflies.
- Two species of Braconid wasps parasitize WSS in wheat and other grasses, but are not effective control agents in Colorado.
- Cultural controls such as tillage and trap crops can be beneficial in a pest control program for WSS.
- Solid and semi-solid stem wheat varieties are currently the most effective method available to resist damage and yield loss from WSS.

Figure 1: *Wheat stems that have been cut by the sawfly larvae | Image credit: Erika Peirce*

Figure 2: *Adult Wheat Stem Sawfly | Image credit: John Starinieri*

DESCRIPTION

- The wheat stem sawfly (WSS) is an ancestral wasp species, a stingless relative of bees, ants, and wasps, all belonging to the order Hymenoptera.
- WSS adults are 19mm long with smokey, opaque wings and yellow-and-black markings like their wasp cousins. ***(Figure 2)***
- WSS larvae are a cream-colored grub with a hardened brown head. Larvae are found exclusively within grass stems, eating their way down through the stem of the plant and leaving frass (excrement) behind them. ***(Figure 3)***

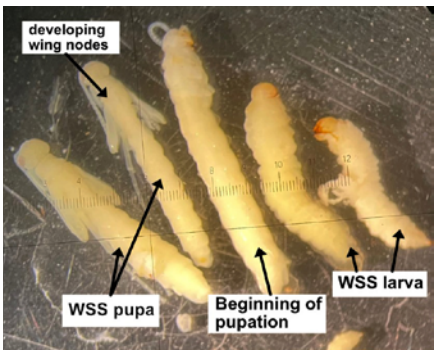

Figure 3: *Larvae/pupae WSS | Image credit: Erika Peirce*

INJURY

- WSS are pests of winter and spring wheat, triticale, and barley, and can also be found in native grasses.
- Injury to the plant becomes more noticeable when the larva reaches the bottom of the stalk and cuts a v-shaped notch into the plant, which weakens the stem and will likely cause it to fall over due to wind.
- Cut plants are hard to collect and often missed by harvesters. The inability to collect fallen heads from cut plants is the cause of most yield loss from WSS infestations.
- WSS can cause significant losses in yield, from around 15-40% of yield loss when untreated. The estimates of loss in Colorado are close to thirty million dollars annually.

RANGE AND LIFE HISTORY

- The WSS is found across the Great Plains and is found mostly in the northeastern corner of Colorado. ***(Figure 4)***
- WSS has a single generation per year, with adult sawflies emerging in late May to early June for a flight period of 3-6 weeks. Male sawflies emerge first, followed shortly by females. Sawflies depend on warmer temperatures and will become active once temperatures consistently reach over 50° F.
- Females can lay 30-50 eggs in their lifetime, only laying one egg per stem. Multiple eggs are often laid in each stem, and upon hatching the larvae will eat each other until only one remains. The remaining larva will eat its way down to the base of the stem, growing to maturity. ***(Figure 5)***
- Larvae overwinter in the stub of the plant after creating a "plug" out of frass to protect themselves. As temperatures warm, the larvae will pupate, developing into an adult which will soon emerge to begin the life cycle once more.

MANAGEMENT

SCOUTING

- To determine if the WSS is present, the easiest method is to look for adults during their flight period of late May through early June, while they are flying around the stems of grasses. ***(Figure 6)***
- WSS infestations are typically most severe on the edges of fields that are adjacent to fields that grew wheat in the previous season. Female sawflies often prefer taller plants with wider stalks when laying their eggs.
- Once the eggs have been laid within the stems, the only way to determine if an infestation is present is to cut a stem from top to bottom and determine the presence of frass or larvae.
- Late season lodging is a sure sign of a WSS infestation.

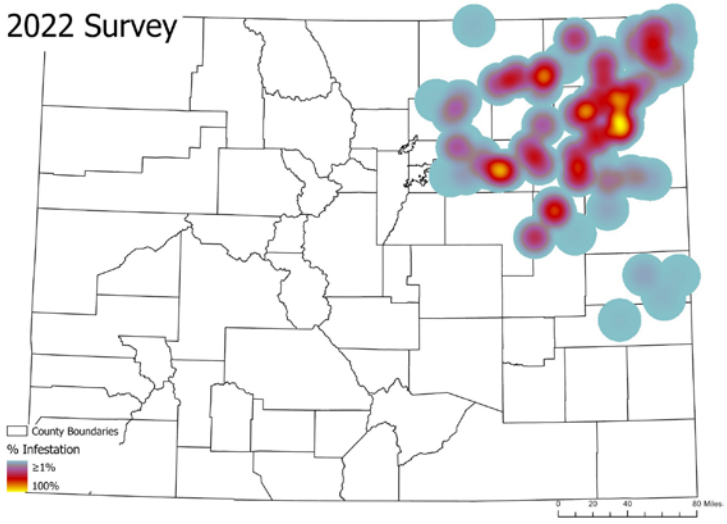

Figure 4: Range of WSS in Colorado, showing southward movement.

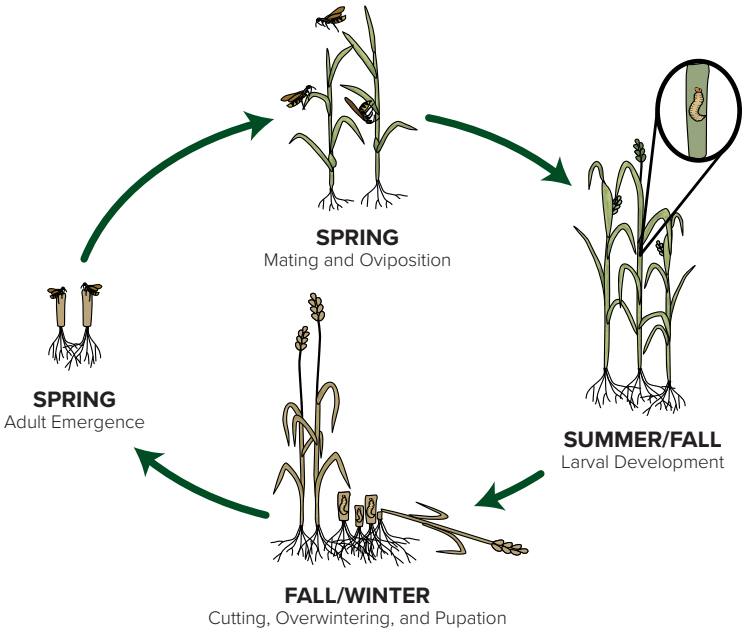

Figure 5: *WSS life cycle | Image credit: Erika Peirce*

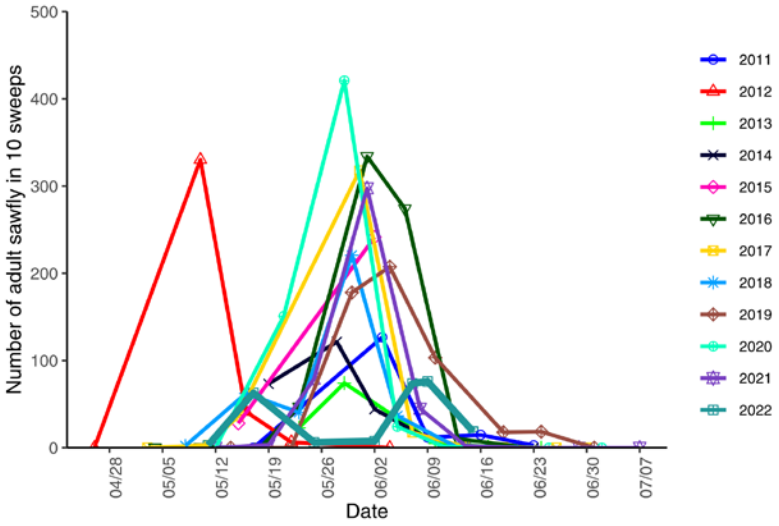

Figure 6: *WSS adult flight survey results from 2011-2022*

CHEMICAL CONTROL

- Insecticides are inefftive in controlling WSS. It is difficult to time sprays with adult flights, and systemic pesticides are ineffective in controlling eggs and larvae inside wheat stems. ***(Table 1)***

BIOLOGICAL CONTROL

- *Bracon cephi* and *B. lissogaster* are two parasitoid wasps are known to attack WSS in spring and winter wheat. Both Braconid wasps are very small (15 mm) orange-brown insects. ***(Figure 7)***
- Parasitoid wasps lay their eggs on the larva of a sawfly, and the wasp larvae will eat the sawfly larvae from the inside.
- These wasps are more commonly effective for control of WSS in the northern states and only have small established populations in non-cultivated grasses in Colorado. The populations in Colorado have yet to be found parasitizing WSS in wheat.

Figure 7: *A female Braconid wasp lays an egg inside a wheat stem | Image credit: Erika Peirce*

Table 1: *Insecticide Efficacies Against WSS*

CHEMICAL	MODE OF ACTION	VARIATIONS	EFFICACY
Warrior II	Pyrethroid	4 spray timings, multiple applications, stubble spray	Ineffective
Palisade 2.1 EC	Plant Growth Regulator (PGR)	4 spray timings, multiple applications	Ineffective
Warrior II + Palisade 2.1EC	Pyrethroid + PGR	4 spray timings, multiple applications	Ineffective
Endigo ZCX	Pyrethroid + Neonicotinoid	4 spray timings, multiple applications	Potentially effective with precise application timing
Thimet 20C	Organophosphate	3 spray timings, multiple applications/rates	Ineffective
Beauveria bassiana	Fungi	Multiple rates	Ineffective

CULTURAL CONTROL

- Shallow tillage can expose larvae in wheat stubs to elements such as extreme temperatures and dehydration.
- Due to the WSS tendency to gather at the edges of fields, trap crops planted at the edges of fields can be used to protect wheat crops. Barley, oats, and triticale can be planted at edges of fields to attract female sawflies. Larvae cannot complete their development in oats.
- Trap crops will only work for mild infestations, as large infestations will spread past the edges of fields and into the wheat beyond the trap crops.

HOST PLANT RESISTANCE

- The most effective method in WSS management currently available is the use of solid stem varieties of wheat. Solid stem varieties are bred to produce thicker stem walls that make it difficult for the adult sawfly to lay its eggs in the stem and more difficult for the larva to survive inside of the stem.
- Solid stem varieties have yield drag when compared to hollow stem varieties, but when under the pressure of sawfly infestation, solid stem varieties perform better than hollow stem.
- The Colorado State University wheat breeding program has developed multiple semi-solid wheat varieties, Fortify SF, Amplify SF, and Windom SF. Semi-solid varieties have the genes that give wheat the solid stem trait, without completely reducing the yield produced by the plant.

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REFERENCES

Beres BL, Dosdall LM, Weaver DK, Cárcamo HA, & Spaner DM. (2011). Biology and Integrated Management of Wheat Stem Sawfly nd the Need For Continuing Research. The Canadian Entomologist, 143, 105-125.

Biyiklioglu S, Alptekin B, Akpinar BA, Varella AC, Hofland ML, Weaver DK, Bothner B, Budak H. (2018) A Large-Scale Multiomics Analysis of Wheat Stem Soldiness and the Wheat Stem Sawfly Feeding Response, and the Syntenic Associations in Barley, Brachypodium, and Rice. Functional & Integrative Genomics, 18, 241-259.

Buteler M, Peterson RKD, Hofland ML, & Weaver DK. (2015) A Multiple Decrement Life Table Reveals That Host Plant Resistance and Parasitism Are Major Causes of Mortality for the Wheat Stem Sawfly. Environmental Entomology 44(6): 1571-1580.

Cockrell DM, Randolph T, Peirce E, & Peairs FB. (2021) Survey of Wheat Stem Sawfly (Hymenoptera: Cephidae) Infesting Wheat in Eastern Colorado. Journal of Economic Entomology, 114(2), 998–1004.

Fulbright J, Wanner K, Bekkerman A, & Weaver DK. (2019) Wheat Stem Sawfly Biology. Montana State University Extension.

Knodel J, Shanower T, Beauzay P. (2019) Integrated Pest Management of Wheat Stem Sawfly in North Dakota. North Dakota State University Extension Service.

McCullough CT, Hein GL, Bradshaw JD. (2020) Phenology and Dispersal of the Wheat Stem Sawfly (Hymenoptera: Cephidae) Into Winter Wheat Fields in Nebraska. Journal of Economic Entomology 113(4), 1831-1838.

Peirce ES, Rand TA, Cockrell DM, Ode PJ, & Peairs FB. (2021) Effects of Landscape Composition on Wheat Stem Sawfly (Hymenoptera: Cephidae) and Its Associated Braconid Parasitoids. Journal of Economic Entomology, 114(1), 72–81.

Piesik D, Weaver DK, Runyon JB, Buteler M, Peck GE, Morrill WL. (2008) Behavioral Responses of Wheat Stem Sawflies to Wheat Volatiles. Agricultural and Forest Entomology, 10, 245-253.

PlainsGold. (2021) PlainsGold to Market New Semi-Solid Wheat Variety. Plainsgold.com.

Portman SL, Jaronski ST, Weaver DK, & Reddy GVP. (2018) Advancing Biological Control of the Wheat Stem Sawfly: New Strategies in a 100-yr Struggle to Manage a Costly Pest in the Northern Great Plains. Annals of the Entomological Society of America, 111(3), 2018, 85–91.

Rand TA & Waters DK. (2020) Aphid Honeydew Enhances Parasitoid Longevity to the Same Extent as a High-Quality Floral Resource: Implications for Conservation Biological Control of the Wheat Stem Sawfly (Hymenoptera: Cephidae). Journal of Economic Entomology, 113(4), 2020, 2022–2025.

Runyon JB, Hurley RL, Morrill WL, & Weaver DK. (2001) Distinguishing Adults of *Bracon cephi* and *Bracon lissogaster* (Hymenoptera: Braconidae), Parasitoids of the Wheat Stem Sawfly (Hymenoptera: Cephidae). The Canadian Entomologist 133: 215 – 217.