

6. Is the sawfly introduced?

The sawfly occurred from Canada into New Mexico, and from California into Minnesota in 1890. Based on its limited dispersal ability, and the necessity to adapt to plants in this large region, sawflies could not be a recent introduction.

7. Can we import parasites for sawfly control?

Parasites from Russia were released in Montana and North Dakota in the 1940s, but did not survive. Several species of native parasites occur in Montana, and Federal regulations restrict importation of foreign parasites in cases where native species are already in place.

ACKNOWLEDGEMENTS

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WHEAT STEM SAWFLY CONTROL

A Guide for Growers



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Introduction

The wheat stem sawfly is one of the most destructive insect pests in Montana. It occurs in most of the major spring and winter wheat producing regions in the state. This guide reviews the current status of control methods and presents important information on sawfly biology.

Sawflies are very difficult to control. Successful management programs may require several types of control practices in a long-term program. Most of the practices are for alternate-year summer fallow systems. Select practices that might be compatible with your farming practices.

Selection of control practices should be based on the sawfly infestation level. Moderate level infestations are restricted to field borders. Severe infestations extend across entire strips or fields.

Moderate infestation levels should be managed with fall tillage of field borders and use of resistant varieties.

Severe infestations may require repeated, carefully timed applications of insecticide. Including resistant varieties or crops in rotation programs may be necessary.

Resistant Varieties

Selection of sawfly-resistant, solid-stemmed wheat varieties will reduce losses and suppress sawfly populations. Resistant spring wheat varieties include '*Lew*', '*Glenman*', and '*Fortuna*'. '*Rambo*' and '*Amidon*' are semi-solid varieties with some sawfly resistance. New solid-stemmed winter wheats are being developed. '*Vanguard*' is a new medium yielding winter wheat that is expected to be released in 1995.

Solid-stemmed wheat varieties are sometimes attacked by sawflies. However, there is not as much damage to infested plants, and fewer sawflies overwinter in solid-stemmed plants because they are unable to reach underground parts of the stems.

The term "solid-stem" is somewhat misleading because stems may be only partially solid, or some internodes may be more solid than others. Also, environmental factors affect stem solidness. Cloudy weather encourages rapid stem extension, and stems may not fill with pith.

Producers generally believe that solid-stemmed wheat varieties have lower yield potential and are more susceptible to stem breakage, although research data indicates stem solidness is not associated with yield. When there is heavy sawfly pressure the yield of solid stemmed varieties often is higher than the hollow-stemmed varieties. The first solid-stemmed wheat, 'Rescue', was released in 1945.

Insecticides

Sawfly wasps can be killed easily with insecticide treatment of wheat foliage, but treatments must be timed properly for good control. Treatments must be applied when wasps begin to emerge from infested stubble and before eggs are laid. The insecticide residue must be effective until all wasps have emerged. Infested stubble should be treated at the same time to help reduce wasp numbers.

Wasps appear in late May or early June, and emergence coincides with heading of wild grasses such as quack grass and smooth brome grass. When these grasses are close to heading, infested stubble should be inspected daily. Infested "stubs" should be split open to determine the sawfly developmental stage. Larvae (worms) overwinter, and change to pupae 1-2 weeks before wasps emerge. Therefore, wasps can be expected soon after pupae are found.

Sometimes all wasps emerge within a week, but the emergence period can extend for a month if the weather is cold and wet. Emerging wasps leave a hole in the plug in

the top of "stubs". Wasps can easily be detected with the use of a sweep net in the stubble and in field borders.

Some insecticides registered for use on wheat foliage include Sevin, parathion, malathion, and Furadan. Insecticide registrations frequently change, and current information is available from your local extension agent or farm products dealer.

In research trials, all of the foliar insecticides that were tested in foliage treatments killed wasps that were in fields at the time of application. Unsatisfactory control usually occurred because the insecticides were not effective long enough to kill additional wasps that moved into fields. Several insecticides were effective for only 1-2 days. In 1994, Furadan killed wasps for at least 5 days. Furadan has systemic activity, and some larvae were killed in the stems. This material can be applied twice, but cannot be applied after heads emerge. This restriction may be changed.

Tests with granular formulations of systemic insecticides including Di-Syston, Temik, Thimet, and Furadan applied at planting time in spring wheat were not effective. Always use caution when applying insecticides. Understand label restrictions such as preharvest intervals and maximum rates. Do not risk grain contamination or environmental problems.

TILLAGE

In some cases, sawflies can be killed by tilling field borders to expose infested "stubs". Sawflies overwinter in lower underground sections of stems, and are killed by low temperatures (-8°F) and desiccation if they are exposed on the soil surface. Unfortunately, dry conditions in the fall may make tillage difficult. A blade or rod weeder can be used to loosen the soil and push stubble upward, and rubber tires can be pulled behind the implement to drag stubble to the surface.

It is important to note that success of tillage depends on pushing stubble upward and onto the surface. Covering stubble with a shallow layer of soil is not effective. Emerging wasps are able to dig through several inches of crusted soil and escape.

Tillage may not be compatible with soil conservation practices. However, if infestations are limited to field borders, only the borders need to be tilled. Also, the tillage should leave stubble on the surface, and should provide some protection against soil erosion.

PLANTING DATE

Crops may avoid attack if they are not in susceptible growth stages when wasps emerge. Sawfly wasps lay eggs in stems, never in leaves, heads, or roots. Wheat is susceptible from jointing until heads begin to fill.

Late-planted spring wheat may still be in the tillering stage when wasps are present, and will avoid infestation. However, some soil moisture is not utilized early in the season if planting is delayed.

Early planting of an early-maturing variety such as *'Rocky'* may reduce sawfly infestations because the crop is not attractive to the pest when wasps emerge. However, fields that are planted in early September are more likely to be attacked by aphids, mites, and plant diseases.

More research is needed before changes in planting dates can be recommended.

MOWING WILD GRASSES

Wild grasses near wheat fields may be reservoirs for sawflies that attack wheat. Nearly all species of large hollow-stemmed grasses and weeds that commonly occur in road ditches, rangeland, and some CRP fields are potential sawfly hosts. If possible, these areas should be mowed after grass has headed. At that time, wasps have

emerged, laid eggs, and died. The eggs have hatched, and worms are feeding in the stems. Larvae cannot survive in the dried mowed grass, and also cannot move to the underground locations necessary for overwinter survival. Sawflies are not transported in hay or straw. During evaluation of research trials, thousands of ripe wheat stems or straw have been dissected without finding surviving larvae.

TRAP STRIPS

Trap strips are narrow areas between infested stubble and the standing crop. Wheat should be planted in these areas at the same time as the rest of the fields are planted. Wasps that fly from infested stubble to standing crops must move through these strips. Strips may consist of extra area planted around fields, or can be part of the normal field area that receives special management. Trap strips may be useful on farms where sawfly damage occurs only in field borders. Be aware that plants in the trap strips will utilize moisture that would be conserved for the following crop in alternate-year fallow systems. Be sure that the additional acreage does not affect allotments in ASCS programs.

Trap strips can be mowed after wasps have emerged, laid their eggs and died. Eggs and larvae will be killed, and there will be fewer wasps next year. It may be necessary to bale and remove the vegetation to prevent planting problems later.

Solid-stemmed wheat varieties can be planted in trap strips. Oats are resistant, but are not attractive, and wasps are likely to fly through the strip and lay eggs in the wheat field.

Field borders can be treated to kill wasps that are migrating from stubble to fields. To be effective, treatments must be applied as soon as wasps appear and before eggs are laid. Also, the insecticide residue must persist until the wasps are gone.

CROP ROTATION

Crop rotation may be necessary to control sawflies when infestations are severe. Resistant crops include corn, beans, peas, lentils, sunflowers, alfalfa, canola, and safflower. Unfortunately, low amounts of precipitation and short growing season limit choices for alternate crops in most regions in Montana.

Barley sometimes is damaged, and durum may be resistant. Oats never are infested. A rotation system consisting of winter wheat, solid-stemmed spring wheat, and barley is being used in the Power area with some success.

HARVESTING PRACTICES

Combining

Heavily infested fields should be harvested first and as early as possible to reduce losses from lodging. Fields can be inspected to determine infestation levels, or information on comparative damage in fields from the previous year may be used. Infested stems are "notched", and may not lodge until there is some wind, rain, or hail. Therefore, the amount of lodging increases as crops mature and continue to dry down.

Swathing

Fields can be swathed to reduce lodging losses. Swathing does not pick up sawfly larvae because they are underground, and therefore has no effect on infestation during the following year.

BIOLOGICAL CONTROL

There are no biological control practices that can be used for sawfly control. However, several species of small parasitic wasps attack sawfly larvae. Parasitized sawfly larvae are killed before stems are notched.

Under proper conditions, parasites can suppress sawfly

SAWFLY BIOLOGY

LARVAE OVERWINTER UNDERGROUND IN OLD STUBBLE AND CHANGE TO PUPAE IN MAY-JUNE



WASPS EMERGE IN LATE MAY OR EARLY JUNE. THEY FLY TO CROPS AND LAY EGGS PLANT STEMS.



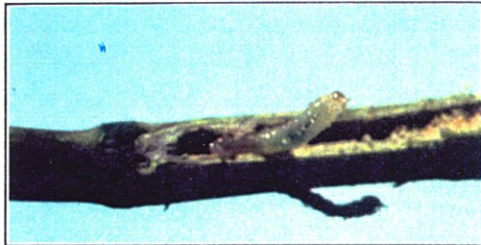
LARVAE FEED WITHIN STEMS UNTIL PLANTS BEGIN TO RIPEN. LARVAE NOTCH LOWER STEMS AND MOVE TO "STUBS".



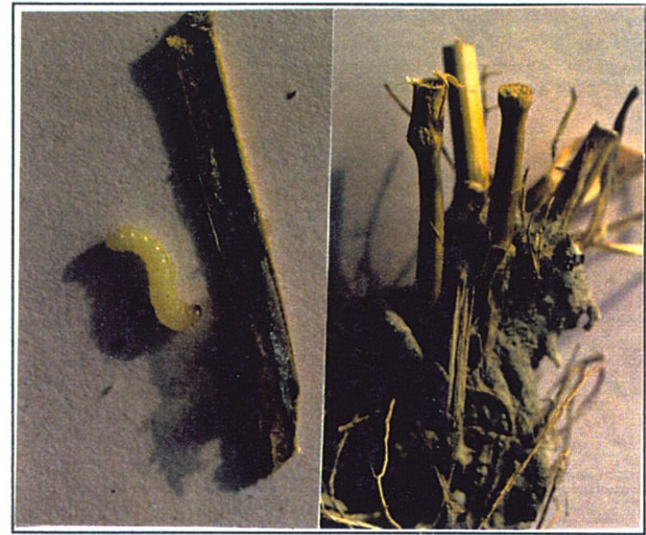
LARVAE FEED IN STEMS UNTIL PLANTS BEGIN TO RIPEN. LOWER STEMS ARE NOTCHED.



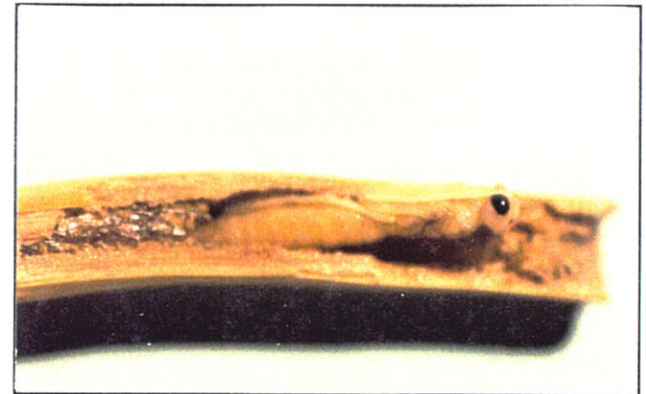
Wasps emerge in late May or early July, and lay eggs in wheat. The emergence period lasts 1-4 weeks, depending on weather and population density. Wasps live for about 7 days. They fly short distances to find suitable hosts.



Larvae feed in stems until wheat begins to ripen. Only one larva survives in stems of hollow wheat. Mature larvae "notch" stems, and weakened stems usually lodge.



Larvae overwinter underground in "stubs". They usually die from freezing or dessication if fields are tilled and stubs are exposed on the soil surface. Covering with soil is ineffective.



Larvae change to pupae in May prior to adult emergence.

SAWFLY CONTROL

SELECT SOLID-STEMMED
RESISTANT WHEAT
VARIETIES.

WATCH FOR ALTERNATIVE
CROPS THAT COULD BE
USED IN YOUR ROTATION
SYSTEM

TILL FIELDS TO PUSH
"STUBS" TO THE SURFACE
IN THE FALL.

CONSIDER SPRAYING FIELD
BORDERS WHEN WASPS
ARE EMERGING. PROPER
TIMING IS CRITICAL.

infestations. Parasites have two generations each summer. They build up enough to affect sawfly populations only after two consecutive unusually long growing seasons. During a typical growing season, sawfly larvae have moved underground and avoid attack by the second generation parasites.

The first-generation parasites may kill about 10% of sawfly larvae. However, a successful second-generation parasite population may kill 80% or more of the sawflies. The unusually long growing seasons in 1993 and 1994 resulted in a high rate of parasitism near Conrad, and the effect on sawfly populations in 1995 will be interesting.

TYPES OF LOSS

The most obvious type of damage caused by sawflies is plant lodging as a result of stem girdling or notching by larvae. Less obvious, but equally as important, is reduction of yield and grain quality.

Effects on yield

Sawfly larvae feed and complete their development inside of wheat stems. Internal stem damage occurs, especially at the nodes. When heads are filling, carbohydrates cannot move through damaged nodes to developing kernels. Accumulation of these materials appears as dark spots on stems below nodes. The dark spots are good indicators of larval infestation. This feeding does not weaken stems and cause lodging. Head weight may be reduced by up to 30%.

A comparison of hollow and solid-stemmed winter wheat lines indicated that sawflies cause less grain loss in solid-stemmed plants. Canadian research found that sawflies also reduced the protein percentage.

Lodging

The second type of sawfly damage is stem "notching". Mature larvae move to the base of plants and girdle the inside of stems. The weakened stems may break or lodge immediately, but usually remain standing until the stems dry and become brittle. It is important to note that casual observation of lodging is not always a good estimation of sawfly infestation. Accurate estimates of sawfly infestation can be made only by splitting stems to find larvae or evidence of larval feeding, or by checking for stem spotting. Use of the terms "sawfly cutting" and "lodging" are not the same. Not all "cut" stems lodge. Again, heavily infested fields may not lodge unless there is some wind, as was the case in some locations in 1994, and may appear to be clean.

Lower ends of lodged stems are cleanly cut, and contain "sawdust" when split open. Stems that lodge due to sawfly notching could be confused with hail damage or "crinkle joint", a disease. However, only sawflies cause the cleanly cut stem ends.

SAWFLY IDENTIFICATION

Sawflies have four life stages- the wasp, egg, larva, and pupa. Wasps are easily seen in wheat foliage. Eggs and larvae are found in stems. Pupae are in old overwintered "stubs".

Wasps

Sawfly wasps are about 3/8 inch long. They are shiny, yellow/black, and the wings have a golden appearance when reflecting sunlight. Wasps cannot sting, and can be handled without fear. They can be found resting on upper leaves during cool mornings, and are lower in the foliage in the afternoon. They are weak fliers, and remain close to the ground. They hang onto plants when the wind starts to blow.

Eggs

Eggs are white and about the size of the head of a pin. There is no visible scar on the outside of the stems where eggs are laid.

Larvae

Larvae are white worms with light brown heads. There are no legs, eyes, or antennae. Young larvae are tiny but they are almost 1/2 inch long when full grown. Infested stems contain chewed plant material, or "sawdust", especially near nodes. Larvae will tunnel throughout the length of the stems.

Pupa

The pupa is a transformation stage in which the larva becomes a wasp. At first the pupa is white, but it becomes black when the wasp is ready to emerge. If the pupa is closely inspected, eyes and legs can be seen.

Infested "stubs"

Infested "stubs" are the short lower sections of stems that remain standing when the upper stems break. The top of stubs matches the cleanly cut bottoms of the upper stems, and are filled with soft plugs. Often the top of the stubs are underground, and can be found only by searching through the soil. Stubs can be collected by pulling the clump of tillers from the ground. A spade may be used to loosen the soil if it is dry. Dissected stubs will show fine silken linings. Larvae can also be found, and usually are at the bottom of the stub near the crown.

BIOLOGY

Sawflies have one generation per year. A larva can damage only one stem, and populations can increase only by egg laying by wasps.

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BIOLOGY

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Sawflies overwinter as larvae in stubs. In the spring, pupae develop. Pupae are present for 1-2 weeks. Wasps have been emerging in late May or early June. Emergence may be completed in a few days or may last for a month, depending on how many are present and on weather conditions.

Emerging wasps push through the soft plug and remain in the stubble for a few hours. Then they fly near the ground until host plants are found. The furthest flight recorded is one mile.

Wasps mate in the stubble and in wheat soon after emergence. Egg laying begins 1-2 days later. Unfertilized eggs produce males and fertilized eggs become females. Female-producing eggs are more likely to be laid in large stems. Females are larger than males. The largest stems are selected for egg laying.

Wasps probe into stems and lay eggs in the hollow areas. A wasp will lay one egg per stem, then fly to another stem. However, the stem is not marked, and may receive eggs from other wasps. As a result, when there are many wasps, a single stem can receive 20 or more eggs.

Eggs hatch in about a week, and larvae begin to feed on the inside of the stem. Larvae are very cannibalistic, and eat other eggs or smaller larvae. Only one larvae will survive in hollow stems. Therefore, there has been selection for early emergence of wasps, because the first to emerge and lay eggs produce the most surviving offspring.

Population dynamics

An understanding of sawfly population dynamics is important in evaluating control practices. Compared to grasshoppers (may lay 1,000 eggs per year) or aphids (produce young throughout the growing season), sawflies have a low reproductive rate.

Each wasp lays about 30 eggs. This leads to a 10-fold population increase potential. To take this a step further, due to the 10-fold annual increase, control practices must kill at least 90% of the sawflies to prevent infestations from increasing. Also, it would appear that infestations of 10% or more could increase to 100% in the following year, and that there would be no difference in the increases resulting from a 40% infestation level and a 80% level. However, the difference between 40% and 80% is important because high populations spread further across fields.

TESTING NEW IDEAS

Growers are encouraged to test new ideas or practices for sawfly control. Some suggestions might be new tillage practices or changes in planting dates.

Field plot design

Plots should be established on the border of infested stubble, preferably downwind. Plots should be at right angles to the field border, to permit each plot equal exposure of wasps that will move in from the stubble. Plots will receive some type of experimental "treatment" consisting of tillage, pesticide treatment, wheat variety, etc.

Importance of replications and untreated checks

Sawfly infestation levels usually vary across fields. Therefore, it is important to have several plots with the same treatment to compensate for this variability. Untreated check plots are important because they permit measurement of effectiveness of the experimental treatments.

SAWFLY HISTORY

Early records of sawfly infestations are valuable in understanding the current sawfly situation and predicting future trends.

Early records

Sawflies were reared from wild grasses in California, Nevada, and Montana in 1891, and a survey indicated the pest occurred from the Canadian prairie provinces southward into New Mexico. It was widespread in wheat in North Dakota in 1909. In Kansas, the winter wheat matured too early to be infested.

Wild grass hosts

Sawflies are still found in wild grasses in some areas, and in some locations, still do not attack wheat. Most grasses with large hollow stems are suitable hosts. Wheatgrasses are preferred.

Farming practices that have encouraged sawfly populations

Changes in cultural practices have encouraged sawfly populations. Farm mechanization reduced the need for oats used for horse feed. Alternate-year summer fallow, developed in the 1800s to conserve moisture, resulted in untilled fields that were reservoirs for sawflies and other insect pests. Strip cropping, developed to reduce wind erosion, placed infested stubble reservoirs near standing crops, and provided easy access to crops for wasps. Reduced tillage, no-till, and chem-fallow practices caused minimum disturbance of infested stubble, and enhanced overwinter survival of sawfly larvae in stubs.

Adaptation to winter wheat

Winter wheat apparently avoided sawfly damage, or at least was not as heavily infested as spring wheat until the 1980s. One explanation for the current widespread

damage in winter wheat is that wasps now are appearing a month earlier than in the past, and therefore winter wheat is in a susceptible stage. Old reports indicate wasps appeared in late June-early July but now the wasps are found in May-June. High population densities and high rates of cannibalism in stems would enhance early season activity.

SOME COMMONLY ASKED QUESTIONS

1. Will stubble burning kill sawflies?

Some larvae will be killed in the stubs. However, many are underground, and not enough heat is generated to kill them.

2. How wide should trap strips be?

Trap strip width should be based on how far sawflies moved into your field last year, or on the width of equipment that is used for planting, mowing, etc.

3. Is sawfly damage getting worse?

Damage seems to be increasing each year. There also appears to be several "biotypes" of wasps. Sawflies in some areas do more damage than in other areas.

4. Does the soil type or addition of zinc affect sawflies?

We currently don't have information linking soil type and sawfly infestation. However, it is likely that anything that encourages thick healthy stands will reduce lodging. Plants are less likely to fall over if their neighbors are still standing.

5. Why are they worse on the east (or west) side of strips?

This may be due to prevailing winds when wasps are coming out of infested stubble.