HESSIAN FLY MANAGEMENT IN WHEAT

Introduction

The Hessian fly *Mayetiola destructor* (Say) (Figure 1), is considered one of the oldest and most damaging insect pests to wheat (*Triticum* spp. L.). Originally from Asia, it is believed to have been introduced in straw bedding used by Hessian troops during the Revolutionary War, hence its name. From this initial introduction in the Long Island, New York area, the fly quickly spread from farm to farm, destroying entire wheat fields (Pauly 2002). Since then, this pest can be found throughout major wheat-producing regions in both the United States and Canada. Here in Washington State, a wheat pest survey conducted in 2015 detected Hessian fly densities in Adams, Stevens, and Whitman counties at levels below economic thresholds. Even though it was detected in small numbers, producers should be able to recognize this pest, know how to sample for it, and manage it when or if outbreak numbers are detected. However, in 2017, pest numbers were detected in high numbers, resulting in economic damage around the Ritzville area.

Figure 1. Adult Hessian fly. Photo by Scott Bauer.

Hessian Fly at a Glance

Host Plants: Wheat, Volunteer Wheat, Barley, Rye, Quackgrass, and Triticale

Where to Look for Hessian Fly:

- Adults: laying eggs on wheat leaves
- Eggs: on leaves (looks like stitching, as with a thread and needle)
- Larvae and pupae: base of plants, inside stems, concealed under leaf sheaths

Pest Thresholds:

Pest thresholds are based on the number of wheat tillers infested, not the number of flies being detected. Therefore, scouting needs to start when wheat begins to tiller, (i.e., Feekes 2). Treatment measures and actions are recommended when 20% of tillers in winter wheat, or 38% of tillers in spring wheat, are infested in order to prevent this pest from reaching the economic injury level (Buntin 1999). This level is reached when crop damage is equal to the cost of control.

Pesticide Treatment:

Registered foliar treatment examples: Declare (gamma-cyhalothrin), Endigo ZC (lambda-cyhalothrin + thiamethoxam) Silencer (lambda-cyhalothrin), Mustang Maxx (zeta-cypermethrin), and pyrethrins. Seed treatments: Gaucho 600F (imidacloprid) and Cruiser 5FS (thiamethoxam).

Note: The above listed pesticide formulations are known to be highly toxic to bees and other pollinating insects. For more information about off-target impacts to beneficial insects, please note the information listed under "Bee Poisoning" within the Chemical Control section of this publication.

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Description and Lifecycle

Hessian flies belong to the Cecidomyiidae insect family and are commonly known as gall midges. They are relatively small (2 mm) in size but can be distinguished from other flies by having long legs, antennae, and reduced wing venation with seven or fewer veins reaching the wing margin. Both males and females have a brownish to black abdomen; however, the abdomen of females will take on a reddish to orange color when egg development begins. Another distinguishing characteristic of female Hessian fly is the abdomen that is tapered to a point. Males have a blunter abdomen. Males also have larger individual antennae segments (Figure 2).

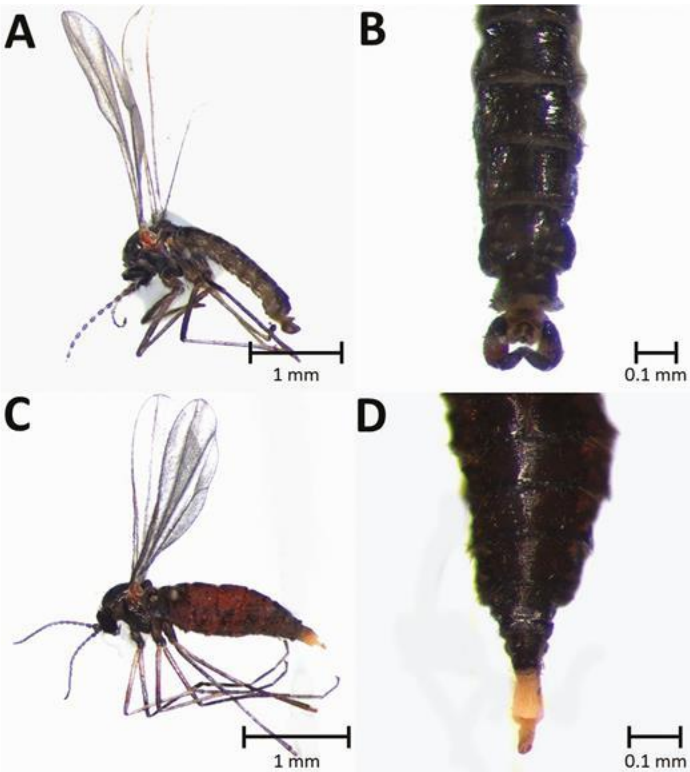

Figure 2. Adult Hessian fly. Male (A). Male genitalia (B). Female (C). Female genitalia (D). Photo by Alan Burke.

After mating and egg maturation, females seek out appropriate host plants on which to lay eggs. Eggs are deposited between the leaf veins on the upper side of individual leaves, resembling “needle and thread stitching” (Figure 3). Depending on temperature, eggs will hatch in 3–12 days. Newly hatched larvae are white, have a pair of mouth hooks, and tend to move down towards the base of the plant, feeding on stems within the plant crown. As they molt and grow in size, larvae develop a light-green stripe down the center of the back (Figure 4). Mature larvae will then pupate forming a hard, darkened case where the insect will complete its transformation into an adult. This stage is also known as the “flax seed” stage as the puparium resemble seeds of flax (Figure 5) (Schmid et al. 2018).

Figure 3. Hessian fly eggs resembling “needle stitching” on the underside of a wheat leaf. Photo by Oklahoma State University.

Figure 4. Hessian fly larva showing characteristic dorsal “green stripe.” Photo by John van der Linden.

Figure 5. Hessian fly puparium. Photo by John C. French Sr., retired. Universities: Auburn, GA, Clemson, and U of MO, Bugwood.org.

The entire lifecycle can take as little as 28 days from egg to adult, depending on climatic conditions, especially temperature. In Washington State, Hessian fly has two generations; warmer states, such as Texas, can see up to six in a year (Schmid et al. 2018).

Damage

Crop damage from Hessian fly can occur in a number of ways:

- Leaves initially may be darker in color but will eventually turn a blueish-green color as if they were drought stressed
- Plants will be stunted; winter kill can be a concern depending on the severity of the feeding damage
- Tillers may be aborted or entire plants can be killed resulting in reduced yields
- Stems may weaken and lodge if plants are attacked after stem-elongation
- Overall feeding can reduce the number of seeds per head resulting in reduced head weights and overall yield

Hessian fly damage has the potential to cause significant crop loss in many wheat growing regions of the United States. Two outbreaks in the 1980s in South Carolina and Georgia caused an average of $12 million dollars in damage. In Oklahoma, one study estimated that the overall yield loss would be 5.74 bu/acre for every tiller infested with Hessian fly larvae (Schmid et al. 2018).

Sampling and Thresholds

When it comes to sampling, male flies can be captured in pheromone-baited traps; however, the number of male flies has yet to show any correlation with damage caused by larval feeding (Schmid et al. 2018). Therefore, active sampling is required to accurately determine pest levels in the field. Prior to wheat tillering, (i.e., Feekes 2) (Figure 6), it is recommended to take a minimum of 100 side-to-side (i.e., 180-degree) sweeps at different locations throughout the field (Figure 7) using a canvas-type sweep net to see if Hessian fly adults are present. A second method of detecting whether adult flies are present is to visually inspect a sample set of plants. Randomly pick any cluster of 5 plants and visually inspect each plant for 30 seconds. This should be performed at least 10 times at random locations throughout the field. If both sampling techniques are used within the same field, it is recommended to take visual samples at a minimum of 50 feet away from the closest sweep net sample taken to ensure that one is sampling an undisturbed part of the field. A third type of sampling uses traps baited with pheromone. Currently, there are no pheromone lures that will attract adult female flies.

If adult flies are detected, then wheat tillers should be checked for larvae to determine pest levels. Pest thresholds are based on the number of wheat tillers infested. Treatment measures and actions are recommended when 20% of tillers in winter wheat, or 38% of tillers in spring wheat, are infested in order to prevent this pest from reaching the economic injury level (Buntin 1999). The economic injury level is reached when crop damage caused by the pest is equal to the cost of controlling that pest.

Survey Results for Eastern Washington

Beginning the week of May 21, 2015, the Small Grains team at Washington State University began conducting a weekly sampling of insect pest populations in wheat and barley fields throughout the dryland region of Washington State. In all, 19 locations were chosen and sampling was conducted for a period of 10 weeks. Both adults and larvae, the primary damaging stage in wheat and barley crops, were detected at 10 of the 19 sampling locations (Table 1). Densities were below economic thresholds for Hessian fly. This, however, does not mean that producers or field personnel should overlook this pest or its potential to cause significant damage in future years. For more information and a complete breakdown of the pests sampled during the 10-week project, visit the Wheat and Barley Insect Pest Surveys website (CAHNRS and WSU Extension, n.d.).

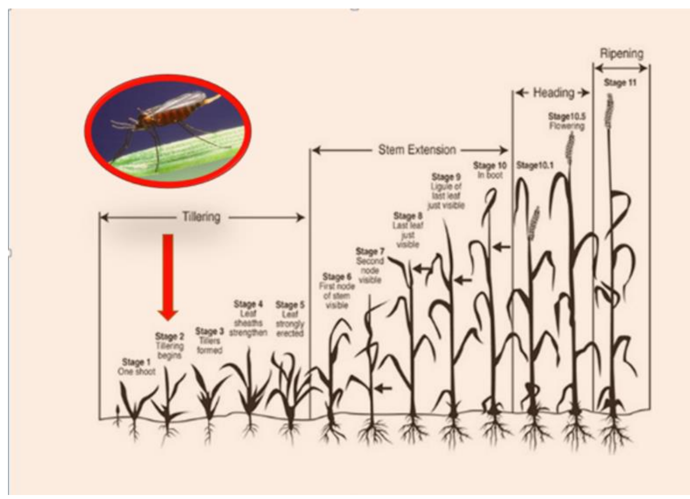

Figure 6. Stages of wheat showing when to start sampling for adult Hessian flies. Graphic by Dale K. Whaley, Washington State University Extension.

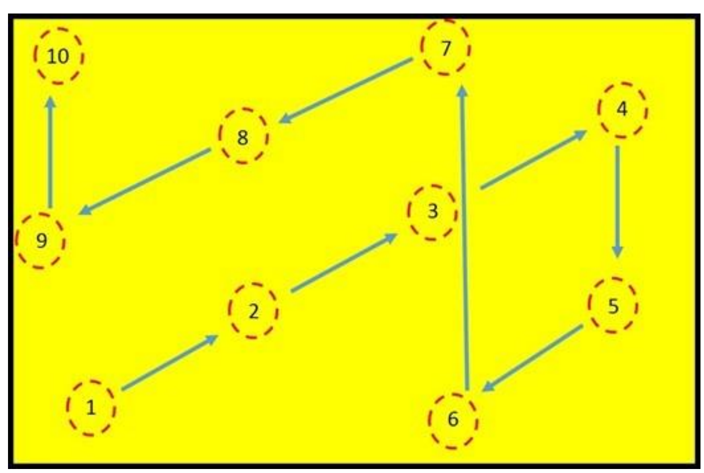

Figure 7. Random sampling example (ten sweeps at each numbered point). Graphic by Dale K. Whaley, Washington State University Extension.

Table 1. Hessian fly densities during 10 weeks of sampling across eastern Washington in 2015.

Field #	AREA NAME	5/21/2015	5/29/2015	6/5/2015	6/11/2015	6/18/2015	6/25/2018	7/2/2015	7/10/2015	7/24/2015	7/31/2015
1	Farmington	0	0	0	0	0	0	0	0	FFS	FFS
2	Plaza	0	0	0	2	2	0	0	0	FFS	FFS
3	St. John	0	0	0	0	0	0	2	0	FFS	FFS
4	Endicott	0	0	0	0	2	0	0	0	FFS	FFS
5	Colton	0	0	0	0	0	0	0	0	FFS	FFS
6	Walla Walla	0	0	0	0	0	2	0	0	FFS	FFS
7	Dayton	0	0	2	0	2	0	0	0	FFS	FFS
8	Mayview	0	0	0	0	0	0	0	0	FFS	FFS
9	Colville	N/A	0	0	0	0	0	1	0	0	0
10	Chewelah	N/A	0	0	4	0	0	0	0	0	0
11	Peone Prarie	N/A	0	0	0	0	0	0	0	0	0
12	Nine Miles Falls	N/A	0	0	0	0	0	0	0	0	FFS
13	Fairfield	N/A	0	0	0	0	0	0	0	0	0
14	Revere	N/A	2	2	2	0	0	0	0	0	0
15	Ritzville	N/A	0	0	0	0	2	0	0	0	FFS
16	Edwall	N/A	0	0	0	0	2	0	0	0	FFS
17	Mondovi	N/A	0	0	0	0	0	0	0	0	FFS
18	N. St. Andrews	N/A	0	0	0	0	0	0	0	0	FFS
19	S. St. Andrews	N/A	0	0	0	0	0	0	0	0	FFS
FFS = Finished for season											

Management

Plant Resistance

One of the most economical and effective control strategies is the utilization of resistant wheat varieties (Schmid et al. 2018). This has long been considered the standard control option in many regions of the US for this pest. A drawback to using this form of management is that continual exposure of such varieties can lead to the development of pest resistance. Therefore, rotation of wheat cultivars, much like rotating modes-of-action with pesticide use, is necessary to keep this management option viable and effective.

Delayed Planting Dates

Another management option developed in the early 1900s is to seed wheat when female Hessian fly activity (i.e., flight and egg-laying) has stopped due to cold fall temperatures. This period is known as the “fly-free date” and has been utilized in the upper Midwest and East Coast regions. Unfortunately, this strategy has shown to be less effective in states such as Georgia, Oklahoma, and Texas due to inconsistencies in temperature during both fall and winter months (Schmid et al. 2018). An alternative to using the “fly-free date” is to hold off planting wheat until later in the season, e.g., November. By doing so, this will lessen the number of eggs laid by females and thereby reduce any potential damage. However, the risk of experiencing winter-kill is higher with late-planted wheat.

Control of Volunteer Wheat

Whether in fallow, along field margins, or in alternative crops, like canola or peas (Figure 8), volunteer wheat has been shown to host Hessian fly populations (Buntin 1999). Therefore, the destruction of such plants can impact the development of future infestations. In fallow, volunteer winter wheat is typically managed through tillage. For this to succeed, residue needs to be buried at a minimum depth of 3.5–4.3 inches and must remain covered by soil (Schmid et al. 2018). Subsequent tillage operations that bring buried residue back to the surface will lessen this ability to kill Hessian fly larvae. In no-till or minimum-tillage systems, where burying residue can be a challenge, producers must rely on herbicides to effectively kill any volunteer winter wheat.

Figure 8. Volunteer winter wheat in winter peas. Photo by Dale Whaley, Washington State University Extension.

Biological Control

Two insect surveys in Washington State in 1977 and 1981 and two insect surveys in Idaho in 1998 and 1999 were conducted to determine the distribution, species composition, and parasitism rates for Hessian flies. A total of six parasitic wasp species were reared from fly puparia collected in western, central, and eastern

Washington and eight parasitic wasp species collected in northern Idaho. *Homoporous* sp. Pteromalidae was most abundant in both western and eastern Washington. In northern Idaho, *Platygaster hiemalis* Platygastridae and *Trichomalopsis americanus* Pteromalidae were the most abundant species collected (Pike et al. 1983; Bullock et al. 2004). Hessian fly populations in Washington experienced parasitism rates as high as 60–98%, indicating that these tiny beneficial wasps can be effective at reducing fly populations (Pike et al. 1983). However, parasitism rates the following year were, in some areas, significantly reduced. It is believed that various environmental factors, such as temperature, relative humidity, and the variety of wheat grown may play a factor (Bullock et al. 2004). Further research is needed to definitively discern why areas experience such large swings in parasitism rates.

Chemical Control

If 20% of tillers in winter wheat or 38% of tillers in spring wheat are infested with Hessian flies, an insecticide application is recommended in order to prevent populations from reaching the economic injury level (Schmid et al. 1918). For areas that have a history of high Hessian fly populations, or when other management techniques are not optional, for example, use of resistant varieties or delayed planting dates, a seed treatment consisting of Gaucho 600F (imidacloprid) or Cruiser 5FS (thiamethoxam) is recommended. Seed treatments typically provide a 30-day period of control and can be effective provided that only one fall generation exists. Beyond this, foliar insecticides, such as Declare (gamma-cyhalothrin), Endigo ZC (lambda-cyhalothrin + thiamethoxam) Silencer (lambda-cyhalothrin), Mustang Maxx (zeta-cypermethrin), and pyrethrins should be used to target both adults and first instar larvae. In order to optimize the effectiveness of foliar applied insecticides, it is important to target the period when adults are laying eggs, eggs are present on leaves, before larvae have reached the protection of the leaf sheath, or before they have burrowed into the stems. Foliar applications must be applied for each subsequent generation.

Use pesticides with care. Apply them only to plants, animals, or sites as listed on the label. When mixing or applying insecticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock. Refer to the online version of the Pacific Northwest Insect Management Handbook *for additional information regarding pesticide use and specific insecticide recommendations and application rates for Hessian fly (Hollingsworth 2019). The handbook is also available at Extension offices in Washington, Oregon, and Idaho.*

Bee Poisoning

The above listed insecticide formulations are known to be highly toxic to bees and other pollinators. Therefore, do not apply these products in a manner that will allow them to drift to adjacent crops or weeds, especially if they are in bloom. Avoid applications when bees or other pollinators are actively foraging by making applications during early morning or evening hours to limit possible exposure. If bee shelters are nearby, such as in canola, it may be advisable to remove them during, and for 2–3 days following, pesticide application.

Seed treatments containing imidacloprid are highly toxic to bees and other pollinators. To minimize the creation of dust (from seed coat abrasion) during planting which may drift to blooming crops or weeds and poison foraging bees and other pollinators, make sure that planting equipment is functioning properly and in accordance with manufacturer specifications. For additional information on how to prevent unnecessary pollinator poisonings from pesticide use, read the following Extension publications *Pollination and Protecting Bees and Other Pollinators* produced by Washington State University Extension and *How to Reduce Bee Poisoning from Pesticides* produced by Oregon State University Extension (Lawrence 2015; Hooven et al. 2016).

Summary

- Despite previous Hessian fly numbers occurring below economic thresholds, this pest is present across eastern Washington and has the potential to cause economic damage under certain conditions
- Learn how to successfully identify and sample for Hessian fly
- Sample these sites: volunteer wheat, barley, rye, quackgrass, and triticale
- Control volunteer wheat and other hosts
- Use Hessian fly-resistant varieties in rotation
- Delay planting dates when applicable
- Be ready to use necessary control measures when 20% of tillers in winter wheat or 38% of tillers in spring wheat are infested

References

Bullock, D.G., N.A. Bosque-Pérez, J.B. Johnson, and F.W. Merickel. 2004. Species Composition and Distribution of Hessian Fly (Diptera: Cecidomyiidae) Parasitoids in Northern Idaho. *Journal of the Kansas Entomological Society* 174–180.

Buntin, G.D. 1999. Hessian Fly (Diptera: Cecidomyiidae) Injury and Loss of Winter Wheat Grain Yield and Quality. *Journal of Economic Entomology* 92(5): 1190–1197.

CAHNRS and WSU Extension. n.d. Wheat and Barley Insect Pest Surveys.

Hollingsworth. C.S. ed. 2019. Pacific Northwest Insect Management Handbook. Oregon State University.

Hooven, L., R.R. Sagili, and E. Johansen. 2016. How to Reduce Bee Poisoning from Pesticides. *Oregon State University Extension Publication* PNW591. Oregon State University.

Lawrence, T. 2015. Pollination and Protecting Bees and Other Pollinators. *Washington State University Extension Publication* FS174E. Washington State University.

Pauly, P.J. 2002. Fighting the Hessian Fly: American and British Responses to Insect Invasion; 1776–1789. *Environmental History* 7(3): 485–507.

Pike, K.S., J.H. Hatchett, and A.L. Antonelli. 1983. Hessian Fly (Diptera: Cecidomyiidae) in Washington: Distribution, Parasites, and Intensity of Infestations on Irrigated and Nonirrigated Wheat. *Journal of the Kansas Entomological Society* 261–266.

Schmid, R.B., A. Knutson, K.L. Giles, and B.P. McCornack. 2018. Hessian Fly (Diptera: Cecidomyiidae) Biology and Management in Wheat. *Journal of Integrated Pest Management* 9(1): 14.

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