

Essential Question: How does natural selection in weeds create a problem for Washington wheat farms?

Background



Figure 1: Italian ryegrass, a herbicide-resistant weed from OSU Extension, extension.okstate.edu/fact-sheets/herbicide-programs-for-italian-ryegrass-control-in-winter-wheat.html



Figure 2: Round up, a name-brand version of glyphosate herbicide from Mozart, Mike. Roundup, Flickr. 30 April 2016, flickr.com/photos/jeepeersmedia/26133876014

Vocabulary

**herbicide:** chemicals used to kill unwanted plants.

**resistance:** is not affected, or can withstand something; weeds that are resistant to herbicides will not die when sprayed.

**biotypes:** a scientific term for a group that has the same, or nearly the same set of genes.

**mode of action:** refers to how the herbicide kills the weed.

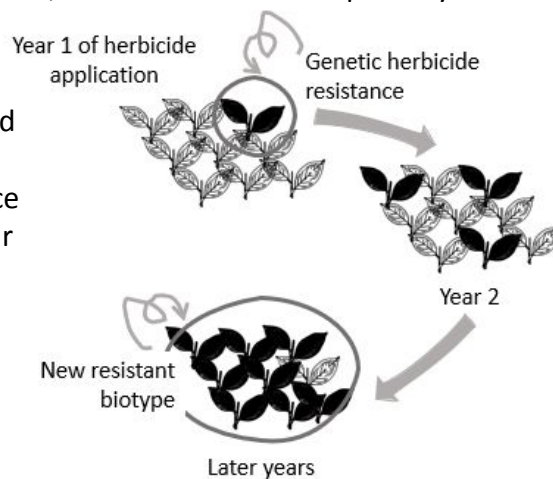
**effective:** successful in doing what it was intended to do.

**susceptible:** able to be harmed by something; weed is likely to be killed by the herbicide.

Herbicides are chemicals that are sprayed on weeds to kill them or control their growth. Different herbicides use different **modes of action**, each of which kill the plant by attacking a different plant life process.

**Herbicide resistance** is the ability of a plant to survive an application of a herbicide that would normally kill the plant. Individual weeds in a population may have natural, genetic resistance to the herbicide, and can pass that trait to their offspring.

Herbicides put selection pressure on weeds that can change the population over time. For example, if there is one out of a million plants that has the genetic trait of resistance, that plant will survive the herbicide application and pass the trait on to its offspring. In following years, more plants in the population will be naturally resistant until a new **biotype** develops where the entire population has developed herbicide resistance.



Read your article at least two times. Follow the instructions below for each time you read.

1. MARK THE TEXT

Underline claims the author makes. A claim is the idea (or ideas) the author will show you or try to convince you of.

2. CONNECT AND RESPOND

Use these symbols to mark sentences or paragraphs in the article. Explain your connections or responses in the **margin**. Include at least two of the following:

Circle the vocabulary words listed in the box above if you find them in the text.

→ Something you have a connection to (Do you know something else about the point the author is making? Did you learn this information in another place?)

† Something you agree with

× Something you disagree with or have a counterclaim for

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**In the Weeds** *Wheat Life* July 2021 by Trista Crossley

- 1 Drew Lyon, who holds the Endowed Chair in Small Grains Extension and Research, Weed Science, kicked off the 2021 Wheat College, tackling the thorny subject of herbicide resistance.
- 2 Herbicide resistance develops over time as a process like natural selection weeds out the plants that are susceptible to a chemical, leaving mostly resistant plants to reproduce. If the genetic variation (which occurs naturally) that provides resistance is passed to a plant's offspring, eventually, the resistant plants outnumber the susceptible plants, and the chemical stops being effective.
- 3 Resistance can develop within just a few short years, even when the percentage of resistant weeds in a population is just .0001 percent at the beginning.
- 4 In order for natural selection to take place, three things have to happen. There has to be a struggle for existence, there has to be variation in the population, and that variation has to be inheritable. The amount of time it takes for resistance to occur depends on a number of factors, including cultural practices; the frequency of herbicide use; the herbicide mode of action; the biology of the weed species; and the frequency of resistant biotypes among weed species.
- 5 "Eventually, weed populations will develop resistance to an herbicide given enough time and enough use," Lyon said, adding that herbicide resistance has been around as long as we've had synthetic organic herbicides, but the pace of herbicide resistance is quickening. "We've relied more on herbicides in the last 20 or 30 years than we did before. We used to use more methods of weed control back in the 1950s, 60s and 70s."
- 6 Chemicals rely on modes of action to be effective. A mode of action is the way a chemical controls a susceptible plant, with different chemicals using different modes of action.
- 7 It used to be that when one chemical stopped being effective, all a grower had to do was switch to a chemical with a different mode of action. But Lyon said we are developing more weeds that are resistant to more than one mode of action, and growers are running out of the ability to control some weeds, such as Italian ryegrass in Eastern Washington.
- 8 "It's a scary situation when you start developing weeds that are resistant to multiple modes of action," he said.
- 9 The current state of herbicide development is grim. There are no herbicides with new modes of action in advanced development trials, save for one herbicide in development by the FMC herbicide company.

**Cultural practices** are choices farmers can make to reduce weeds such as choosing to plant varieties of wheat that will outcompete weeds and rotating their wheat with other crops on the field

Roundup is a brand name of glyphosate, a herbicide. Roundup Ready crops like corn and soybeans are genetically resistant to glyphosate and don't die when the entire field is sprayed with the herbicide. Wheat grown in Washington state is not genetically modified to be Roundup Ready.

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The last new mode of action was introduced more than 30 years ago. The number of weeds with herbicide resistance continues to increase within the U.S. and globally, and the number of weeds with herbicide resistance to more than one herbicide continues to increase. Part of the problem, Lyon said, is that the introduction of Roundup Ready crops in 1996 sucked all of the profitability out of the herbicide market in the U.S.

“Basically, companies make money by selling herbicides to the corn and soybean market, and if they can't make a profit in the corn and soybean market, they don't make a profit in the U.S.,” he explained.

“When Roundup Ready soybeans came out, everything was cheap, easy and effective, and people no longer bought other herbicide products. Only the big players still had discovery programs [to develop new herbicide modes of action], and they didn't really see herbicides as a place to make money. That might be starting to change now that we have glyphosate-resistant weeds, but we'll never be back to the heyday. We have to work with what we have today. If we lose the effective products we have today, there's not much coming down the road to save us.”

In other words, don't keep doing the same thing over and over again to control weeds. Some things farmers can do are raise a new crop, change the timing and/or type of herbicide application or introduce a different tillage system to remove weeds by turning over the soil.

“The lesson is, we need to try to get more mechanisms of action working,” he said. “It would have been nice to do that before we developed resistance to some of these things, but now it's almost imperative that we don't rely on a single mechanism of action to control these troublesome weeds.”

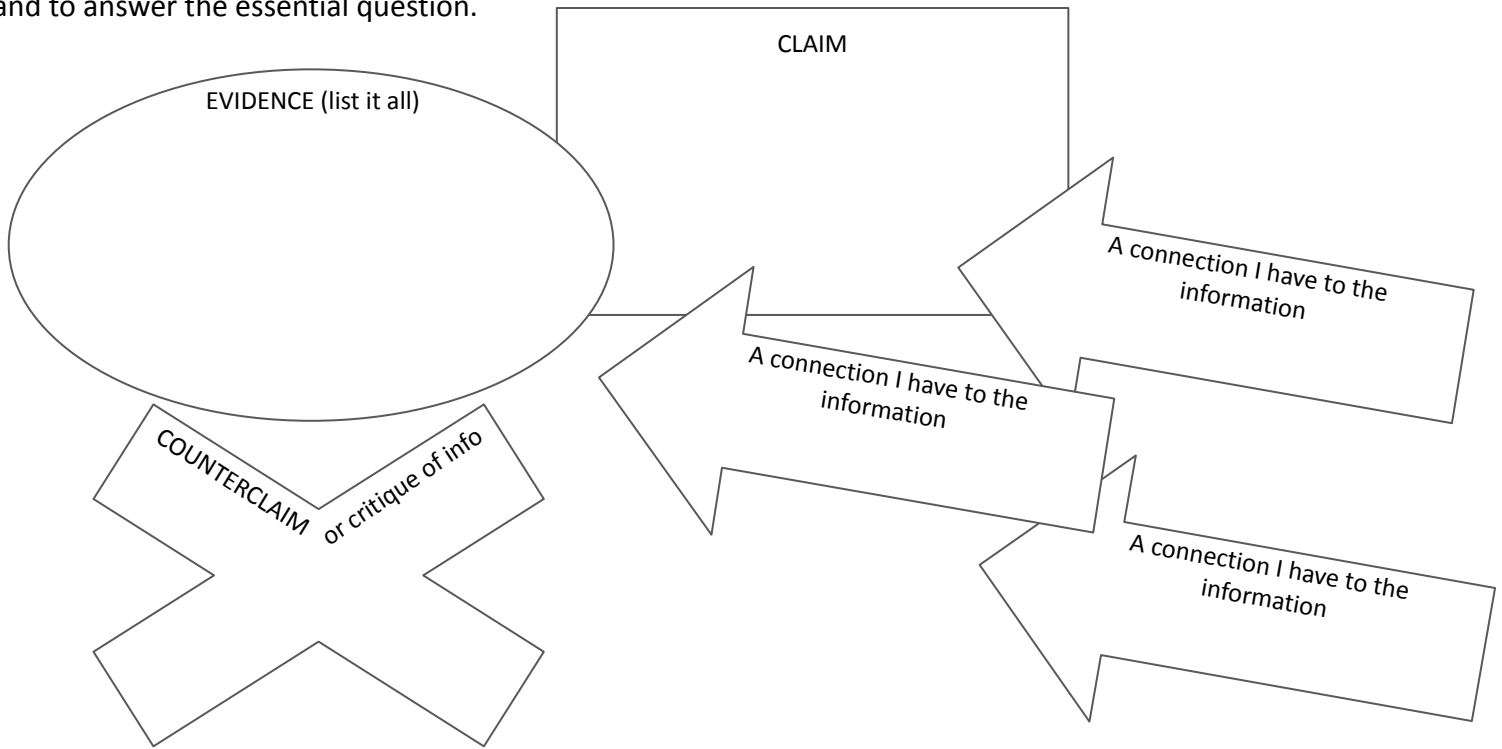
Adapted from Crossley, Trista. "In the Weeds: 2021 Wheat College focused on resistance, stripe rust, Hessian fly." *Wheat Life*, July 2021, [wheatlife.org/t\\_0721\\_2021\\_wheat\\_college.html](http://wheatlife.org/t_0721_2021_wheat_college.html).

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**Summary:** Review the essential question and your annotations. Answer at least two of the following questions in the space below. What claim(s) does the author make about the essential question? Do you agree with the claims? Are they well supported by evidence from the article? What connections did you make that help you evaluate the author's claim?

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**Discussion** Use your annotations on your article and fill in the shapes to help you prepare for the discussion and to answer the essential question.



During the discussion, use the sentence frames below to get you started.

**Near the beginning**

Give (and analyze) claims and evidence

My article says...but I think...

My article says...and I think...

**In the middle**

Evaluate information and look for connections and/or counterclaims

From what I know...because...

A counterclaim would be that...

Does anyone have more information about...

**Near the end**

Answer the essential question

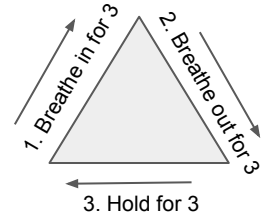
When you said....I thought....

Does the group agree that...?

After listening to everyone's thoughts, I think...

Nervous about speaking? It's normal.  
Here are some things that might help:

Breathe. Use a triangle breath to regulate your nerves and prepare yourself to speak.



Go back to your article and look for where you noted **personal connections** to the text. Speaking about something you have experience with may be easier in the group discussion.

Look at the sentence starters above. Write out what you are going to say by filling in the blanks and be on the lookout for when to add your thoughts.

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**Reflection** Think about what you read and what others said in the group discussion to answer the following questions.

1. Rate your participation during the discussion by checking the ways you participated below:

- Shared information by stating (at least 1)
  - My article's claim, quoted directly from article**
  - My analysis of the claim
  - Relevant connection or background information**
  - Evidence, quotes directly from article
- Responded to others ideas by (at least 1)
  - Pointing out a counterclaim
  - Asking for examples
  - Asking for evidence
  - Saying more about others' ideas**
  - Prompting someone else to respond
- Showed respect for others' ideas by (at least 1)
  - Paying attention to people who are talking**
  - Staying on-topic
  - Re-engaging the group after a period of silence or if you go off-topic
  - Monitoring time
- Answered the essential question by (at least 2)
  - Saying my ideas about the essential question**
  - Using evidence to back up my ideas**
  - Providing a different answer or idea
  - Giving OR asking for a summary

2. What did you get out of this activity?

- I learned  a lot  a little  nothing
- I participated  a lot  a little  not at all
- My thinking changed  a lot  a little  not at all
- I enjoyed it  a lot  a little  not at all

3. How would you answer the essential question in 2-3 sentences? Consider the claims and evidence from your article, along with connections, background information, and counterclaims and evidence brought up during the discussion. Use the graphic organizer on the previous page to help you with your writing.