

The Farmer in the Lab

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Time	Grade Level	Content Area [s]
Four weeks	Grade 5	Life Science

Materials

- Seed of a resistant variety of wheat (Largo was used in this example)
- Seed of a susceptible variety of wheat (Amigo was used in this example)
- Locally important crop pest (Greenbug Biotype E aphids were used in this example)
- Pots
- Potting soil
- Grow lights
- Watercolor paint brushes
- Crushed ultra voile
- Hot glue gun/hot glue
- Scissors
- Utility knife
- Recycled pop bottles

Note: Seeds can be sourced online or locally from a science supply, nursery, or seed supply company.

Objective

Students will explore the development of pest-resistant varieties of wheat.

Activity Outline

- 1 Make cages to contain aphids by following the steps below:
 - a. Remove the label from the pop bottle
 - b. Use scissors to cut off the top and bottom area of the bottle to form an open-ended cylinder
 - c. Cut two 4-5 cm diameter holes on opposite sides of the plastic bottle to allow for ventilation
 - d. Cover the side and top holes with voile and attach the voile using a hot glue gun

- 2 Divide students into pairs. Each pair will plant five Amigo and five Largo seeds in equal-size pots. They should be planted 2.5 cm below the top of the soil and 6 cm apart under grow lights and identical conditions. Two pots of each variety will act as controls and will not receive the aphid treatment. Pots should be labeled with the type of seed variety planted. Different seed varieties should be kept separate in different pots.
- 3 Students will water the plants every three days with equal amounts of water. They should record the height of the wheat plants and qualitative observations in their science notebooks. When the plants reach 12 cm in height, place two aphids on each wheat plant using a watercolor paintbrush. Use the “cages” from the recycled pop bottles to cover the plants and keep the insects contained. Ensure that the bottom opening of the cage is firmly placed in the soil to prevent aphids from escaping. Students should continue to make qualitative observations concerning the health of the plant for three weeks. Continue to water at intervals but refrain from picking up the cages to do so.
- 4 Count the total aphid population following three weeks of infestation by collecting the aphids with a small paintbrush and brushing them into a petri dish. An average of the aphid counts on both varieties of wheat will pinpoint which wheat variety supports larger aphid populations. Students can infer from the number of aphids on the two wheat varieties that one seems to have fewer aphids and look healthier.
- 5 Students note the striking differences (both measured and observed) between the two wheat varieties. Help students understand that the natural resistance of the plant can be determined by counting the number of aphids on the wheat plant; the resistant plants will have smaller aphid populations. Discuss which variety may be a better choice for a farmer to plant and why the choice helps with crop protection and production.
- 6 Students graph the aphid populations found on the two wheat varieties based on the pooled class data and make conclusions and inferences based on their graph.

Safety

As a safety precaution, the teacher should make the cages because sharp scissors or utility knives and hot glue guns are required. Check for allergies before bringing any food into the classroom. Students must wash hands thoroughly after working with potting soil.

Goals

Students will better understand problems faced by farmers and understand how local problems may affect global food supplies.

Formative Assessment

Students recorded the growth and health of the wheat plants in a journal. This helped students realize the importance of detailed data collection. Classroom discussion revealed what students understood and what needed further explanations.

Post Assessment

In an essay question, ask students to explain why wheat varieties could be used in a pest management system. Students should also define the control variable, independent variable, and dependent variable in this investigation.

Background Info for Teachers

GBE (Greenbug Biotype E) is a serious perennial pest on much of the wheat grown in the United States. It damages the wheat with its piercing, sucking mouthparts and toxic saliva. Largo wheat is resistant to GBE, which means it shows little to no damage after infestation. Amigo wheat, however, will be severely damaged and may even die within two weeks of infestation.

Internet Resources

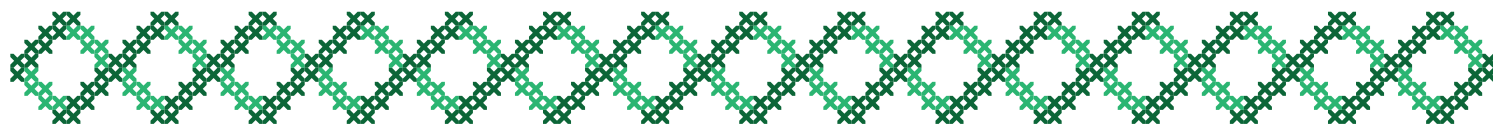
Sources for wheat seeds:

www.ufseeds.com/product/winter-wheat-seeds/

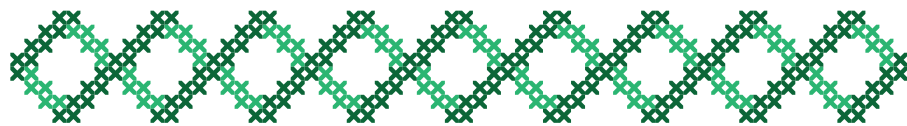
www.johnnyseeds.com/farm-seed/grains/wheat/

<https://hancockseed.com/products/wheat-seed-50-lb-bag>

www.territorialseed.com/category/s?keyword=wheat



The Farmer in the Lab



Agriculture connects students with their community and offers opportunities for scientific investigation.

By Jeanine Huss and Cheryl Baker

The farming days of our past may be gone, but that is no excuse for children to not know where their food comes from. In *Animal, Vegetable, Miracle: A Year of Food Life* (2007) Barbara Kingsolver laments, “North American children begin their school year around Labor Day and finish at the beginning of June with no idea that this arrangement was devised to free up children’s labor when it was needed on the farm” (p. 8–9). Kingsolver believes that people are disconnected from their food because they do not understand that the food they purchase at a grocery store originated on a farm, often shipped from thousands of miles away. Before learning about broader issues such as climate change and rain forest destruction, elementary students should learn about local plants and animals to gain an understanding of local resources (Sobel 1998).



Agriculture can play a key role in fostering scientific literacy because it brings important plant and ecosystem concepts into the classroom. Plus, agriculture, like science, is not static and includes much trial and error, investigation, and innovation. With help from community experts at the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS), my fifth-grade students explored the development of pest-resistant varieties of wheat. For ideas for finding similar resources in your community, see “Using Local Resources,” p. 43.

In the Lab

As a classroom teacher in Oklahoma I spent several weeks in a USDA-ARS/

NSF-sponsored teacher’s workshop. The workshop’s three main goals included (1) learning about the USDA-ARS sites and their research by conducting small-scale experiments, (2) facilitating similar experiments in K–12 classrooms, and (3) developing an appreciation and a deeper understanding of agriculture in K–12 students. Similar outreach exists at all ARS research stations because of their mission to help with K–12 education. The plant geneticist at my lab focused on the development of alternatives to chemical pesticides to control insects and diseases. These alternatives include genetically resistant crop plants and biological control of insect pests using their natural enemies.

Specifically, this ARS program is breeding new wheat genotypes, as Oklahoma is a major wheat-producing state.

Figure 1.
Materials list.

Materials needed	Obtained from	Approximate cost
Seed of a resistant variety of wheat (we used Largo wheat)	USDA-ARS, Cooperative Extension Service, or farmer	Free
Seed of a susceptible variety of wheat (we used Amigo wheat)	USDA-ARS, Cooperative Extension Service, or farmer	Free
A locally important crop pest (we used Greenbug Biotype E aphids)	Cooperative Extension Service, or farmer	Free
Pots	Student, nursery, home improvement store	\$4/15 cm diameter
Potting soil	Nursery, home improvement store	\$12.97/60.5 L
Grow lights	Nursery, home improvement store, science supplier	\$23.00/light
Watercolor paint brushes	Any department store	\$18.49/18 brushes
Crushed ultra voile	Material store	\$10.49/91.4 cm
Hot glue gun/hot glue	Any department store	\$7.99 gun \$1.09 glue
Scissors	Any department store	\$11.20
Utility knife	Any department store	\$2.82

Making cages to keep aphids in:

1. Remove the label from the pop bottle.
2. Use scissors to cut off the top and bottom area of the bottle to form an open-ended cylinder.
3. Cut two 4–5 cm diameter holes on opposite sides of the plastic bottle to allow for ventilation (cutting the holes at different heights helps with cage stability).

4. Cover the side and top holes with voile, a white, lightweight fabric with a tight weave so aphids cannot escape. Attach the voile using a hot glue gun.

*As a safety precaution, the teacher should make the cages because sharp scissors or utility knives and hot glue guns are required.

This process involves traditional plant breeding methods in which plants with desirable resistance characteristics are intercrossed with locally adapted plants to produce offspring that may have the desirable characteristics of both parents. Selection within the subsequent generations may then result in a locally adapted variety that has the added quality of resistance to the insect pest. This type of human selection of plants with desirable traits has occurred since humans changed from nomadic to agrarian societies.

It is possible to tailor these investigations to a range of age groups and any area of the country by choosing locally important crops and insects. Students can then better understand problems faced by farmers in their region and understand how local problems may affect global food supplies.

Breeding a resistant crop takes several generations, so this investigation had to be modified for students. We decided to grow two varieties of wheat and observe and count the number of aphids on the wheat plants for our classroom.

In the Classroom

This investigation occurred during a unit about plants—students had little experience growing plants or knowledge of insect pests. Students knew that their food came from a grocery store, but did not understand the process of raising crops and harvesting them. The fifth-grade students and teacher had started an herb and butterfly garden at the school, providing additional experiences with plants and insects. These students also participated in vermiculture in their classroom using red wiggler worms.

The USDA-ARS lab provided aphid colonies and two varieties of wheat seeds. The two varieties of wheat, Amigo and Largo, respond differently to an aphid pest known as *Greenbug Biotype E* (GBE). Despite their small size, aphids are easy to work with because they can be seen easily using the naked eye or a hand lens. See the complete materials list in Figure 1, p. 41.

GBE is a serious perennial pest on much of the wheat grown in the United States. It damages the wheat with its piercing, sucking mouthparts and toxic saliva. Largo wheat is resistant to GBE, which means it shows little to no damage after infestation. Amigo wheat, however, will be severely damaged and may even die within two weeks of infestation. Check for allergies before bringing any food into the classroom. Students must wash hands thoroughly after working with potting soil.

Students were divided into pairs; each pair planted five Amigo seeds in a pot (24 cm diameter, 30 cm deep) and five Largo seeds in an equal-size pot. Each pot was labeled either *Amigo* or *Largo* wheat. The seeds, planted at 2.5 cm below the top of the soil and 6 cm apart, grew under special grow lights in the classroom, all under identical conditions. (My students had experience conducting investigations and were familiar with indepen-



dent and dependent variables.) Two pots of each variety acted as controls and did not receive the aphid treatment.

Students watered the plants every three days, measured the height of the wheat plants, and recorded the measurements and qualitative observations in their science notebooks. Measuring the plants provided students with data to graph, allowed students to witness part of the life cycle of the wheat plant, and gave students the task of caring for and observing their plants.

When the plants reached 12 cm in height, students placed two aphids on each wheat plant using a watercolor paintbrush. “Cages” made from recycled two-liter pop bottles covered the plants and kept the insects contained (for instructions, see Figure 1). Students continued to make qualitative observations concerning the health of the plant for three weeks. Then, to count the total aphid population following three weeks of infestation, students collected the aphids by using a small paintbrush to gently brush them off the wheat plant and into a petri dish. Students quickly placed the lid back on the petri dish to prevent aphids from escaping. Students recorded the number of aphids on each of their plants in their science notebooks. They also recorded and compiled the class’s aphid counts. An average of the aphid counts on both varieties of wheat helped students pinpoint which wheat variety supported larger aphid populations. Students could then infer from counting the number of aphids on the two wheat varieties that one wheat variety seemed to have fewer aphids and looked healthier. The plants with aphid damage became *chlorotic* (yellow) and did not stand upright. The height of the Amigo wheat plant became stunted and died quickly following an aphid infestation.

Students noted the striking differences (both measured and observed) between the two wheat varieties. The teacher helped students understand that the natural resistance of the plant could be determined by counting the number of aphids on the wheat plant (i.e., resistant plants would have smaller aphid populations). This would also show which variety may be a better choice for a farmer to plant. Students graphed the aphid populations found on the two wheat varieties based on the pooled class data. Students then made conclusions and inferences based on this graph. Once the insect counts were completed, students bagged the plants and aphids for disposal. (Because you will be working with a pest species that already occurs locally, there is no worry about contaminating nearby crops with new pests.)

Assessment

Assessment of this investigation took two forms. Students recorded the growth and health of the wheat plants in a journal. This helped students realize the importance of detailed data collection. Classroom discussion revealed what students understood and what needed further explanations.

As part of a summative assessment of the plant unit, I asked students in an essay question to explain why wheat varieties could be used in a pest management system. Students also defined the control variable, independent variable, and dependent variable in this investigation for another essay question.

Students enjoyed caring for and measuring the plants and counting the aphid populations. The students showed surprise after witnessing the difference in the two wheat varieties, with only a few aphids on the healthy Largo variety and hundreds of aphids on the dying Amigo. Frequent plant measurements helped students understand the process of plant growth.

Classroom discussions helped students understand how their results showed how host plant resistance or susceptibility can affect the health of the plant and how plant breeding is responsible for the development of resistant varieties that can reduce insect damage and therefore reduce the use of insecticides in agriculture.

In the Future

By using crops and insects that are important in our local environment, students gained a greater appreciation of how their food is produced. Class discussion focused on the connection between local agriculture and

our investigations by addressing the kinds of crops grown in the community. Most students were not aware of local farms near their city. The students learned how naturally occurring plant resistance could be used to reduce the insect damage to a crop without requiring pesticides. This led to a discussion about eating locally produced foods, buying organic produce, and supporting sustainable agriculture. Connecting with local agricultural/plant scientists will help students appreciate the importance of agriculture in their area. Students started reflecting on the amount of time needed to grow wheat and produce the bread they buy at the grocery store.

Students could appreciate the length of time needed to grow wheat after watching it grow in their classroom over the course of several weeks. This made the process of growing and harvesting crops, then bringing the wheat to a mill and making bread, much more realistic to the students. This basic understanding of

local issues can then be used to help students grasp the intricacies of larger environmental issues.

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References

- Kingsolver, B. 2007. *Animal, vegetable, miracle: A year of food life*. New York: HarperCollins.
- Sobel, D. 1998. *Mapmaking with children: Sense of place education for the elementary years*. Portsmouth, NH: Heinemann.

Using Local Resources

Experts in your community can provide guest lectures, resources/materials, or information for teaching agricultural topics. Here is a list to get you started. I also recommend checking your local university.

- 1. Agriculture in the Classroom**
www.agclassroom.org/
- 2. Cooperative Extension Offices**
www.outreach.usda.gov/USDALocalOffices.htm
- 3. Master Gardeners Programs**
www.ahsgardening.org/gardening-programs
- 4. The U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS)**
www.ars.usda.gov/pandp/locations.htm

Local farmers and gardening enthusiasts can also provide useful resources or materials. Find your local farmers' markets at www.localharvest.org.

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades K–4

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Standard C: Life Science

- Life cycles of organisms
- Organisms and the environments

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academies Press.

