LESSON 20

Investigating Plant Competition

Grade level: 6-12
Subject Areas: Biology, writing, technology
Duration: 1-2 hours, distributed across 2 or 3 class sessions, plus a few minutes daily to collect and record data for 8-10 days, and report preparation.
Setting: Classroom
Season: Any
Conceptual Framework Topics: Plant growth, ecological competition, invasive species ecology

OBJECTIVES

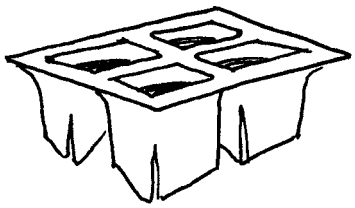
Students will understand that competition for limited resources may affect plant germination and growth. They will understand that this is one detrimental effect of invasive plants on native and crop plants.

METHOD

Students investigate interspecific plant competition for limited resources by germinating and growing seeds in the presence of varying numbers of other plants.

MATERIALS

- ✎ Planting flats with 2x2 cell inserts (Note: Using a clear, plastic lid, available at most greenhouses or garden supply stores, will help maintain moisture and maximize germination. It can be removed when plants are about 5 cm tall.)
- ✎ Potting soil
- ✎ Spinach seeds
- ✎ Alfalfa seeds
- ✎ Rulers
- ✎ Grow-lights or south-facing window
- ✎ Some small treats (e.g., pieces of candy or cookies); enough for each student, but with just a few in a small container to begin



BACKGROUND

Invasive plants are successful largely due to several evolutionary strategies that allow them to outcompete the native plants in their new environment. These usually include abilities to reproduce and/or grow rapidly. Superior seed production, high germination rates, and rapid growth rates all help these plants get ahead of the competition for space, sunlight, water, and/or nutrients that other plants offer. *Interspecific* (between species) plant competition may take place aboveground, with stems and leaves, belowground, with roots, or both.

Teacher Help: Your students should have a basic understanding of plant biology before beginning this lesson. For lower grade level classes you may need to introduce or review some of the scientific terms found in this lesson plan prior to beginning (i.e. *hypothesis* and *interspecific competition*).

(Adapted from the *Invasive Plants Taking Root in Alaska Curriculum*)

Extensions
Build on the concepts of competition by investigating the effect of nutrient availability on competition. Again, have students design their own experiment or follow the procedures in **Lab Sheet 2** for this lesson. Additional materials you will need: Miracle Gro® water-soluble fertilizer (24-8-16)

Have your students research competitive strategies of invasive plants in Montana.

PROCEDURE

1. Have your students set up and carry out the experiment using the instructions on the lab sheets. After they have completed the lab, have them summarize their information and address the questions.

2. Lead a class discussion on what they observed and see if they come up with the ideas of plants competing for resources and affecting growth. To encourage full understanding of how competition works, show students the container with just a few treats in it (make sure there are not enough for every student). Ask them who would like to have one. Likely most or all will say yes. Now ask if there are enough for everyone. When they say no, ask what would happen if you put the treats in the front of the room and said whoever wanted one should take one. They will probably describe at least some kids rushing up to the candy and grabbing at it. Who will get it? Probably the fastest and/or biggest. Explain that this would be a *competition* for the candy. The students would compete to get there first. Ask if there are other ways they could compete for it. Now show them the rest of the treats and explain if necessary that there are enough pieces for everyone. Ask if they would have to compete for one now. Explain that ***competition only takes place when there's not enough of the resource to go around***.

3. Can your students relate this to what they observed with their plant experiments? What kinds of resources might plants compete for? Brainstorm possible ways plants might outcompete others; discuss adaptive strategies such as fast growth and reproduction.

An alternative strategy to this lesson would be to first introduce the concept of competition with the candy demonstration. Then ask students to come up with some ideas for how to investigate whether plants inhibit seed germination and/or growth in other plants. Allow them to design and set up their own experiments with your guidance, or give them the student lab sheets and go over the procedures with them.

STUDENT LAB 1

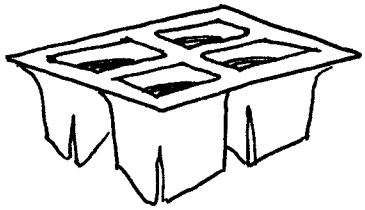
Plant Competition

Plants have adapted a variety of strategies to compete with nearby plants when they have the potential to use resources in short supply. Some plants germinate very early in the spring to get ahead of neighboring plants. Some may grow very quickly to reach soil, water or sunlight first, or grow long, deep roots to obtain water and nutrients. How do you think invasive plants perform as competitors?

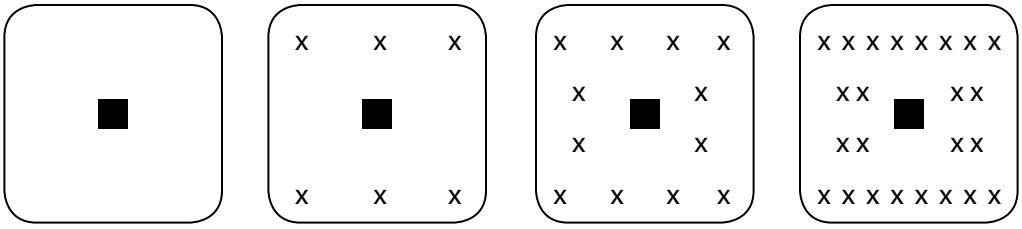
In this experiment you will test effects of increasing competition on your target plant.

DAY 1

1. Obtain two 2x2 cell inserts for planting and fill to top with moistened potting soil. Make a shallow (½") indentation (a pencil eraser works well) in the middle of each cell to plant the seeds. Carefully drop two spinach seeds in the indentation. This will be your "target plant" and will represent the native plant under competition for this lab.



2. In three of the cells, place additional, evenly spaced indentations around the target for planting 6, 12 and 24 "invading" neighbors. One cell should have no neighbors and will be used to compare with those plants under competition.



■ Target plant (spinach) x - Invasive competitors (alfalfa)

3. Carefully drop two alfalfa seeds into each of the indentations and label each cell with your initials, date and number of competitors.

4. Barely cover with a small amount of soil, spray with water and place into a planting flat containing a half gallon (3.7L) of water. Place under growing lights if available (16h light) or by south-facing window. Soil should be kept fairly wet until plants have germinated and water should be added to the flat as needed.

5. Write a hypothesis about how the various seed densities will affect the growth of the target plant. Do you expect to see differences in growth among the different plants? What other kinds of observations or measurements could you make to determine whether or not the presence and number of other plants has an effect on plant growth?

Design a data table to hold your data. The data table should have a space for all the information you'll need to record to answer your question.

DAYS 3-15

6. Measure and record the height of the middle or target plant and record number of leaves. Also make notes about anything else you notice about the invasive neighbors or how the plants are growing.

7. Make your final observations and plot them on a graph.

8. Summarize the outcomes in a lab report. Address the following:

- Did the data you collected support your hypothesis?
- Which target plants would you predict to make the most seeds? Why?
- How does this experiment relate to the issues of native and invasive plant species?
- What would happen to the "native" plants if they had to compete with more and more invasives?

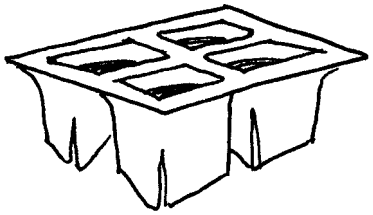
9. Write a conclusion that summarizes what you learned in this activity.

STUDENT LAB 2

Plant Competition Extension: Effects of Nutrition

One of the ways that plants compete with one another is for essential, but limited, nutrients in the soil. Plants need soil nutrients such as nitrogen and phosphorus to photosynthesize and grow. Many invasive plants have special adaptations that allow them to outcompete native plants in gathering nutrients. In this lab, you will investigate how the availability of nutrients can affect plant competition.

DAY 1

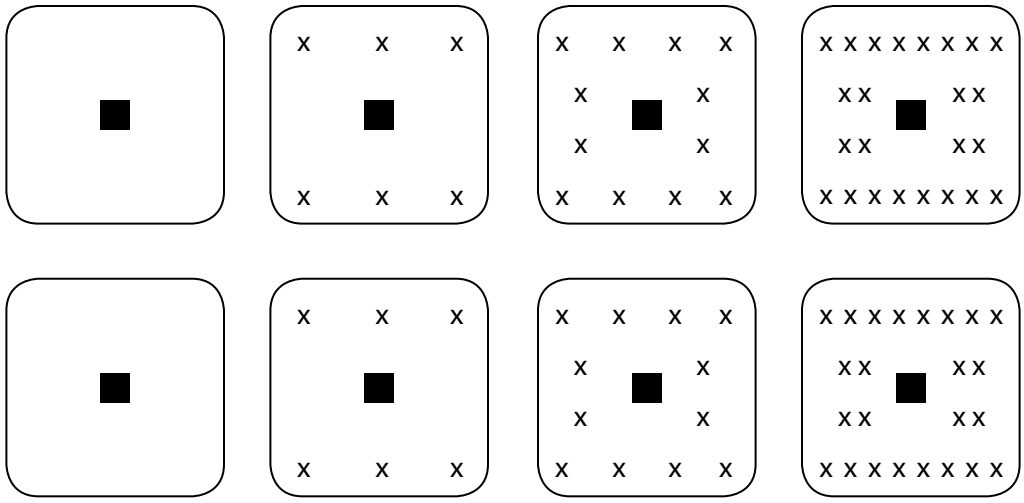


Prepare **TWO** sets of plants (8 cells) as in Lab 1 by:

1. Obtaining four, 2x2 cell inserts for planting and fill to top with moistened potting soil.

2. Make a shallow (½") indentation (a pencil eraser works well) in the middle of each cell to plant the seeds. This center plant will be your "target plant" and will represent the native plant under competition for this lab. Carefully drop two spinach seeds in the indentation.

3. In three of the cells, place additional, evenly spaced indentations around the target for planting 6, 12 and 24 "invading" neighbors. One cell should have no neighbors and will be used to compare with those plants under competition.



■ Target plant (spinach) x - Invasive competitors (alfalfa)

4. Carefully drop two alfalfa seeds into each indentation and label each cell with your initials, date number of competitors.

5. Barely cover with a small amount of soil, spray with water and place **ONE SET** into a planting flat containing a half gallon (3.7L) of water. **ONE DUPLICATE SET** should be set in a separate flat containing ½ gallon (3.7L) of dissolved Miracle Gro® fertilizer (24-8-16) solution (½ teaspoon).

6. Place under growing lights if available (16h light). Soil should be kept fairly wet until plants have germinated and water should be added to the flat as needed.

7. Write a hypothesis about how the plant densities will affect the growth of the target plant *with different amounts of available fertilizer.* Do you expect to see differences in growth among the different plants?

8. Design a data table to hold your data. The data table should have a space for all the information you'll need to record to answer your question.

DAYS 3-15

9. Measure and record the height of the middle or target plant and record number of leaves. Also make notes about anything else you notice about the invasive neighbors or how the plants are growing.

10. Make your final observations and plot them on a graph. Summarize the outcomes in a lab report. Address the following:

- Did the data you collected support your hypothesis?
- How did the plants grown with added nutrients compare to those grown without them?
- Does it appear that nutrients were limiting the growth of the target plant? What about the competitors (invasives)?
- Which target plants would you predict to make the most seeds? Why?
- What does your experiment have to do with the issue of invasive weeds and native or crop plants in Montana?