Plant Competition

Grade Level: Elementary, Middle School, High School
Ecological Concepts: Competition
Arizona Science Standards: Science as Inquiry; Life Science

Materials:
1) Seeds of fast growing plant species
2) Pots, potting soil
3) Trowels*
4) Rulers
5) Writing/drawing materials
*May be borrowed from SCENE.

BACKGROUND
All organisms require certain **resources** for growth and reproduction. How well an organism accomplishes these goals depends on many factors such as the quality of the habitat, nutrient availability, and the make-up of the **community**. Organisms that live in a resource-poor habitat, or are living with more organisms than the habitat can sustain, are not likely to do as well as those in better habitats with more resources.

Any factor that is essential for growth and reproduction is a **limiting factor**. Too little of it will result in death, or at the least, very minimal growth. Organisms of the same species are most likely to compete for essential resources. Plants in the Sonoran Desert do not usually have to compete for light, but do often compete for water, a very limited resource most of the year. Other resources plants compete for are nutrients such as nitrogen and phosphorus, and space for growth.

GUIDED INQUIRY
Observation/Exploration: Examine the habitat to get an idea of how well the plants are growing and what the plant density is. Density is calculated as the number of organisms, in this case, plants, per unit area. For example, five plants in a 10 m^2 plot would equal a density of 0.5 plants/m^2.

Group Discussion and Question Period: What resources do plants need most? What happens if plants receive too little of a resource? What happens if lots of plants are growing very close together? Do plants of the same species grow better together than plants of different species?

Important aspects of guided inquiry are encouraging students to generate multiple hypotheses, and letting students make decisions about what data are important and create their own data sheets. Keeping these ideas in mind, the sample in the box below illustrates how ONE OF MANY possible investigations around this topic might develop.

Sample Hypothesis: Let's use the question, "What happens if lots of plants are growing very close together?" Our hypothesis could be, "Plants growing closely together will not grow as well as those growing farther apart because of competition for resources."

Sample Experiment Design: Choose a fast growing desert plant species, such as a wildflower. The **independent variable**, or treatment, will be plant density. Set up ten pots with potting soil. Plant three seeds in each of five pots for the low density treatment. Plant fifteen seeds in each of the other five pots for the high density treatment. This gives five **replicates** of each **experimental unit**. **Control** for factors such as light and water by placing all the pots in the same location in the habitat and watering them the same amount. Randomly place the pots so that not all pots of one treatment are next to each other. Label each pot as to what treatment it contains, high or low density. Cover the pots with a **fine mesh netting** to keep out herbivores. The netting will need to be tall enough to accommodate growing plants.

The **dependent variable** will be plant growth measured as height. Let the plants grow for a set period of time, and measure height again.

Prediction: Plants grown at low density will grow taller than those grown at a high density.

Record Results: Record heights for each plant in centimeters. Raw data can be presented on a **bar chart** with individual plant heights on the vertical axis and plant density treatment on the horizontal axis.

Sample Analysis of Data and Presentation: Total the height measurements for all plants in a treatment. Average the height for plants in each treatment. Compare the averages. Which plants grew most? Make a **bar graph** or **frequency distribution** with plant density treatment listed on the horizontal axis and average plant heights on the vertical axis. If data were taken multiple times on the same plants, make a **line graph** plotting the heights over time, with days on the horizontal axis and average plant height each measurement day on the horizontal axis.
NOTE: If you use seedlings for this experiment instead of growing the plants from seeds, you will need to record the height of the seedlings when you start the experiment, and then subtract that height from the final height measurements at the end of the experiment in order to get the actual amount of growth.

Discussion: Was your hypothesis supported? If yes, go on to test other hypotheses. If not, why not? What did happen? Why? This is a great opportunity to revise your hypothesis and do another test.

MORE:
(1) Elementary:
(a) Test a different limiting factor such as water. Set up a similar experiment but use the same number of plants per pot. Water five pots with twice as much water as the other five pots. Compare the heights of the plants as before.

(2) Middle School:
(a) Find the **mean**, **median**, **mode**, and **range** of the data.
(b) Run an experiment similar to the one above with plants at two densities, but leave them uncovered after they are a reasonable height. Observe for herbivory. Does density affect how much herbivory a plant suffers?
(c) Calculate plant densities in different areas of the habitat and in other parts of the schoolyard.

(3) High School:
(a) Calculate the **variance** and **standard deviation** of the averaged data.
(b) Grow plants of the same species at other multiples of densities, e.g., 2x, 4x, 10x.
(c) Compare different plant species at the same densities. Which are the better competitors?
(d) Calculate plant cover. This is a measurement of how much of the ground is covered by living plants. For example, a grassy lawn would have 100% coverage, while an area the same size with only two cholla cacti may only have 10% of the ground covered, or shaded, by the cactus. For plants above ground level, estimate the area of plant cover (the area of the ground shaded by the plant) by measuring length and width of the horizontal canopy of the plant, and multiplying to get area. Total individual plant cover estimates and divide by the total habitat area to calculate plant cover.