

Peppers Galore

Exploring Genetic Diversity in Crops

WARNING

This activity involves working with chili peppers, which contain capsaicin oil.

This oil can cause minor burns when in contact with skin or eyes.

Please make sure students take proper precautions by using gloves and not touching tender skin, face or eyes.

Overview

Together with the air we breathe and the water we drink, crop diversity is one of the most fundamentally important resources for human life on earth. Increasing and sustaining agricultural productivity requires that we make use of the vast diversity of crop varieties that have evolved over thousands of years through a dynamic interaction between nature and careful selection and breeding by humans. Each crop variety is adapted to particular types of soil, climate and growing seasons. Each variety has traits selected to meet particular conditions and human needs and desires, resulting in specific traits related to disease resistance, cold or heat tolerance, taste, nutritional qualities, etc.

The purpose of this field exercise is to focus your attention on an individual crop plant, its traits, and how these traits can help adapt to the plant to the physical environment and impact factors such as crop water use and stress tolerance.

Resource References

The Pepper Primer: This is a general introduction to chili peppers. Download this presentation from <http://studentfarm.ucdavis.edu/edumat>.

Seed Saver Exchange (<http://www.seedsavers.org/>) is a non-profit dedicated to saving and sharing heirloom seeds. Their website has a database of rare crop varieties and more information on their seed banks and genetic resource preservation efforts.

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Introduction

Crop diversity is the variance in genetic and observable characteristics of plants used in agriculture. Crops may vary in branching pattern, height, flower color, fruiting time, fruit and seed size, shape, color or flavor. They may also vary in less obvious characteristics such as their response to heat, cold or drought, or their ability to resist specific diseases or insect pests. It is possible to discover variation in almost every conceivable trait, including nutritional qualities and tastes.

The variability we see within a crop can result from different environmental conditions, for example, a crop growing in nutrient poor soil is likely to be shorter than a crop growing in more fertile soil. In addition, and our main focus here, this variability can be the result of genetic differences, such as different genes that influence how long it takes a crop to mature or its resistance to a disease. It is these heritable traits that are of special interest as they are passed on from generation to generation and collectively determine many of the plant's characteristics and overall potential. Through combining genes for different traits in desired combinations, plant breeders are able to develop new crop varieties to meet specific conditions. A new variety might, for example, be higher yielding, more disease resistant and have a longer shelf life than the varieties from which it was bred.

Both farmers and scientists depend on having an available supply of genetic diversity so that they can ensure productive harvests. Genetic variability provides farmers resilience to pests and diseases and allows scientists and plant breeders access to more diverse genetic resources. Genetic diversity is an irreplaceable resource—once particular genes have been lost through extinction, they are lost forever. For this reason, some scientists and plant breeders are trying to maintain plant genetic diversity through seed banks or variety preservation networks like the Seed Savers Exchange.

This activity uses chili pepper plants to explore these concepts because they display tremendous genetic diversity. Chili peppers (also known as chiles) are native to the New World (with known centers of origin in Bolivia and Brazil), but spread through colonial trade networks to nearly every continent, where they were quickly adopted and bred by local farmers. This proliferation expanded the chili family's genetic pool and created chiles of all shapes and sizes that were adapted to many different climatic conditions. The Chiltepin pepper featured on the handout is called the "Mother of All Chiles" in Northern Mexico and closely resembles the wild, chili pepper form. The Chiltepin's leaves are sparse, the plant is bushy and the fruit is brightly colored and held upright on the plant for seed dispersal by birds. The fruit is also extremely spicy—the capsaicin (the oil that creates spice in chiles) that is concentrated in these peppers helps protect them from being eaten by mammals. Chiltepin peppers are harvested by people in Northern Mexico from the wild and eaten, but the variety has never been domesticated entirely. Comparing the characteristics of the Chiltepin to modern pepper varieties demonstrates the art of plant breeding and illustrates the genetic diversity within the pepper family.

To Lead This Activity You Need to Know

Facilitators of this activity need to have basic understanding of the following concepts in order to effectively lead students through this activity:

- Basic concepts of genetics and breeding.
- Basic understanding of plant anatomy.

Key Concepts

- Different plant varieties within the same family demonstrate genetic diversity.
- Plant breeders use genetic diversity to create favorable traits for food crops.

Objectives

- Engage participants in observing different plant traits and thinking through plant breeding goals and processes.
- Teach participants that food crops are the result of thousands of years of genetic manipulation by humans and that preserving genetic diversity is critical to maintaining our food supply in changing conditions.

Materials

- Copies of Chiltepin Pepper Handout—1 for every 2 students
- At least 2 different varieties of pepper plants (plants in fields or in pots are the most ideal, but activity can be modified for just pepper fruits and pictures of pepper plants)
- Gloves for handling peppers

Activity (45-50 minutes)

Before starting, warn students about the capsaicin oil in peppers. Have students use gloves when handling peppers and instruct them to not touch their sensitive skin, faces or eyes while wearing the gloves.

Create work groups of one to two students. Students will compare the varieties of pepper plants to each other and to the photographs of the Chiltepin pepper (see p. 5) and record their observations on the *Modern Pepper Diversity Observations* handout (p. 6).

To guide student observation, you might ask them to observe the following categories of traits, prompting them with questions:

1) Leaf and canopy traits

Choose a full-grown leaf from the top of the canopy. What is its length and width? What color are the leaves (light green, dark green, purple, other)? Are the leaves covered with hairs?

What is the position of the leaves on the stem, e.g. upright, angled or horizontal?

Measure or estimate the height of the plants. Is the leaf canopy dense or open? Put a sheet of paper on the ground under the plant and estimate the amount of the paper that is receiving direct light vs. the amount that is shaded by the plant.

2) *Fruit traits*

How many fruits are present on the plant? Are the fruits small (<5 cm long), medium (5-15 cm) or longer than 15 cm? Do the peppers point up or down? Is the fruit wall thin or fleshy? What color are the fruits?

Are there numerous seeds in each fruit, or are there few seeds loosely arranged in the fruit?

How thick is the flesh of the fruit?

Are the fruits all ripening at the same time or is there staggered development?

Are there any fruits with sunburn?

Discussion and Reflection (10-15 minutes)

- 1) Is there a group of traits that the modern varieties that you examined all share? What traits tend to be different between the different modern varieties? Why do you think different traits might be the same or different?
- 2) How are the modern varieties different from the Chiltepin? Why do you think plant breeders selected for these traits in the modern varieties?
- 3) Depending on the varieties that you chose, do you see any similarities between varieties from temperate vs tropical environments? Between varieties with large fleshy fruits vs. small thin-walled fruits?
- 4) Which varieties would be more appropriate for low input farming that doesn't use much water or fertilizer and which one for intensive, high input cultivation where productivity and fruit size is very important? Consider the methods and labor required for harvesting the crop, and the conditions used to store or transport the peppers to market.
- 5) Can you imagine conditions where the pepper varieties would have a hard time surviving? What kinds of traits might protect them from those conditions? Where might breeders turn to find the genetic material for those traits to breed into peppers?

The “Mother of All Chiles” - The Chiltepin Pepper



Modern Pepper Diversity Observations

<u>Variety Name</u>				
<u>Plant Shape & Size (height, width)</u>				
<u>Leaf Shape & Size (length, width)</u>				
<u>Leaf density & stem branching pattern</u>				
<u>Fruit and Flower Position & Orientation on Plant</u>				
<u>Stem, Leaf, Flower Colors</u>				
<u>Fruit Shape & Size (length, width)</u>				
<u>Fruit fleshiness, firmness, etc.</u>				
<u>Other Observations</u>				