**Big Roots for Big Problems**

**Drought Experiment!**

**Group size:** 1-3

**Materials:** seeds of native and non-native plants, small pots, seedling trays, growing medium and sand, data sheets

**Background:**

 This activity is designed to demonstrate the relationship between roots and drought tolerance in plants. Plants that are able to maintain growth through drought conditions are also able to continue to feed insects and mammals, provide nectar to pollinators, mediate water loss from soil, and so on. Roots that are deep, fibrous, and have a complex structure or more likely to be able to access and retain water in dry soils. Many of the exotic species that are dominant in human-modified ecosystems are adapted to these highly disturbed conditions, but do not have root systems that are suited for drought tolerance and maintaining ecosystem services long-term. The native species that are used to replace these exotic species in landscaping are selected primarily to increase native diversity and because of the native insects and other animals they support, but also typically have impressive root systems adapted to drought. In this activity students will collect data on plant growth in different species of native and exotic plants that have been subjected to different levels of simulated drought.

**Advance preparation:**

*\*Seeds must be sown well in advance of when the lesson is planned to allow time for germination (1-2 wks), root establishment (2-4 wks), and drought experiment (at least 4 weeks)*

1. Select at least 3 native and 3 exotic species. You should choose species that will germinate relatively quickly (see suggestions below). Many native species will have low or no germination without a period of ‘cold-stratification’ or exposure to temperatures under 40o F, so if you wish to use these species then be sure to make time for that.
2. Sow seeds in open seed flats in a seed-germination growing medium (these are widely available and usually labeled as such) and keep moist.
3. Prepare a large batch of a [growing medium:sand] mixture at a ratio of [10:1] to [5:1]. You want your soil to be droughty. You can use the some growing medium that you used to germinate seeds.
4. Transplant seedlings into small pots (any size but 2-4” square pots are good) when their first true leaf is fully emerged (the first ‘leaf’ in grasses and pair of ‘leaves’ in wildflowers are cotyledons or ‘seed-leaves.’ You probably already know this.)
5. To provide replication of each species across three different watering regimes, you will want at least 15 individuals of each species (e.g., 5 individuals/species/regime).
6. Allow at least one week for transplants to acclimate to their new home. Water daily.
7. OK, now you need to apply the drought treatment. For each species, divvy up the plants into three groups randomly. Start the treatments, and make sure they last at least 4 weeks. *Before you start the treatments, you may choose to collect ‘baseline data’ by counting leaves on each plant and/or measuring the length of the longest leaf. If you do you this, you will need to mark each plant uniquely so that your baseline value can be subtracted form the appropriate post-treatment value of the appropriate plant.*
	1. Treatment 1 (‘control’): water 3X/week
	2. Treatment 2 (‘stressed’): water 1X/week
	3. Treatment 3 (‘drought’): water 1X/every other week

**Procedure:**

1. Students will collect data on the plants in order to compare how each species responds to different levels of drought. Start by discussing what tolerance of drought would look like. Ask students to describe it. (*Basically, there would be very little difference in growth across the treatments.*)Now generate predictions: *Which species will better tolerate drought? Will native and exotic species respond differently?*
2. Data collection: you will need to decide on a **response variable**.
	1. If you collected baseline data (see 7, above), you can count leaves or measure the longest leaf and calculate the difference between the start of the experiment and now. You could also use this method if all plants were the same at the beginning of the experiment (e.g., all had one leaf).
	2. A more reliable measure of growth is dry biomass. You could i) clip each plant, ii) place it in a small, labeled paper bag, iii) let it dry in a sunny spot for about one month, and iv) weigh it in grams.
3. Record this data on data sheets (see attached)
4. Enter data into Excel spreadsheet (see attached). Graphs will automatically be generated showing growth relative to the ‘control’ for the ‘stressed’ and ‘drought’ treatments for i) each species individually, and ii) natives and exotics as groups; the coefficient of variation, which calculates how great differences are across the treatments for i) each species individually, and ii) natives and exotics as groups
5. Interpret graphs. Does the data match your predictions? Why? Why not?