About the Experiments

Plants need suitable conditions to thrive and soil provides a physical medium for seeds to germinate and allow roots to explore, thereby anchoring the plant in place. Water and nutrients are needed along with an abundant supply of sunlight! There are two main sources of nutrient applications to soil – 1) inorganic fertilizers that can be purchased commercially and 2) organic amendments such as composted materials and discarded, natural foods. This experiment will focus on organic amendments.

Ages	Time	Difficulty
5-12	1-2 hours at start-up, few minutes a day for 6+ weeks	Moderate

What You'll Need for the Experiment

- **A suitable space to grow your plants for up to 6 weeks.** This can be a table next to a large window receiving lots of sunlight or a flat area outdoors that won't get disturbed and has plenty of sunshine.
- **Containers to grow your plants.** These can be of different sizes and shapes, but should be sturdy enough to hold moist soil for the duration of the experiment. They could be as large as 5-gallon buckets or as small as 6-ounce plastic drinking cups. Containers should have drainage holes on the bottom to allow excess water to drain from the soil. You will also need a large cookie sheet or similar item to hold the cups as well as the drained water.
- **Seeds**. Consider various broadleaves such as turnip, sunflower, or beans or some common grasses like wheat or corn. You may even consider radish, spinach, or collards, which are short-duration vegetables that can mature and be edible within 6 weeks.
- **Soil**. Enough to fill all containers. Any soil can be used, including soil from your garden, dirt from your backyard, or sand.
- **Organic materials to amend the soil**. Dried grass clippings, dried leaves, used coffee grains, egg shells, compost, cardboard egg containers, leftover fruits and vegetables. Any of these will do.
- **Spreadsheet** to track progress of the experiment.

Let's Do This!

1. Choose 1-3 organic amendments. You will also have a "soil only" plant, which will be the control experiment. For each experiment, you'll need three plant test subjects. For example, if you choose coffee grains, eggshells, and grass clippings, you'll need a total of 12 test subjects – three for each amendment and three for the control. You can also add a fifth test subject that includes a mixture of all three amendments.

2. Individually mix each organic amendment (generally about 2% of the soil weight should be of the amendment) with soil thoroughly and weigh out the desired amount of amended soil into the three containers (make sure you label the containers!). The containers should be 3/4th filled with the amended soil. Add soil without an amendment to the three control containers.

3. Place seeds into a small indentation of the soil in each container. Note that some seeds may not germinate or may die for various reasons. Therefore, plant 5-6 seeds for each container and thin to 3 plants per container a few days after emergence.
4. Add water to each container and allow excess water to drain through holes at the bottom.
    - ***Note*** *for more controlled experiments: You can determine the water-holding capacity of the soil before planting seeds by soaking the containers with full water and allowing ½" of water to accumulate in a tray in which the containers are held. After 1 day of soaking, weigh the containers and this will be the maximum weight of the container plus soil. If you weigh the container without soil and the weight of the container plus dry soil, you will be able to calculate with accuracy the soil water content at saturation. Plants often perform best when soil is maintained between 40 and 80% of saturation. As an example, if the container weighs 10 g and the dry soil is 500 g, then the total weight after soaking at saturation may be 660 g.*
5. Place the containers in a room temperature environment not exposed to direct sunlight until seedlings emerge. Once most seedlings emerge, evaluate the need to thin out excess plants and then place in more direct sunlight for allowing plants to grow vigorously.

6. Water plants according to their needs. This could be once per week initially when plants are small to once per day when plants are large and growth conditions are most favorable. The plants will wilt and die if not enough water or too much water is provided.

Measurements to evaluate the experiment

7. There are a variety of measurements you can make to evaluate the results of the experiment. Create a spreadsheet and make a column for each container in the experiment and each row or line of information can be an observation that has a response recorded for each experimental unit.
8. Take weekly photos to create a visual documentary of plant growth and changes.
9. Simple qualitative measures might include color of the plant, tendency to wilt, stopped growing, has odd-shaped leaves, attracted by insects, etc. Simple quantitative measures might include days to emergence, number of seedlings emerged and height from soil at

1 week, 2 weeks, etc. up to the end of the experiment. Size of leaves could be determined periodically. Sensor measurements of leaf color can provide a quantitative evaluation of plant health.

10. After 6 weeks, consider whether sufficient evaluations have been made, or if plants should be evaluated further for product tasting (in the case of leafy greens), bulb growth (in the case of radish or turnip), or cutting plants at soil level and making measurement of wet weight and/or dry weight (after placing cut plants separated by container into paper bags and placed in direct sunlight to dry for several days or in an oven at 150 F for a day or until dry.

What did you learn?

1. Which amendment produced the most growth potential? Why do you think some amendments are better than others?
2. How did the different plants with amendments compare to the control plants?
3. Did the plants taste different?
4. Where there any color or size differences among the plants?
5. Which plants grew fastest, which were the slowest growing?
6. Do you think positioning of the plants and their distance to sunlight mattered?
7. Which week had the most growth for the bulk of the plants?
8. Do you think the experiment results would be different if another seed type was used?
9. Could you grow other plants with organic amendments alone?
10. Would you like to be a life-long gardener or farmer? Why/why not?