Allelopathy Lab

**Introduction**

From childhood most of us have known that animals are territorial and that they aggressively defend resources needed for survival. Vivid memories of carnivores attacking territorial challengers have been embedded into our minds from numerous nature shows and classroom discussions.

What many of us do not realize is that plants can be just as aggressive in defending their resources. Many plant species are capable of poisoning the soil and air around them. They do this by exuding toxic chemicals called allelotoxins from their leaves and roots. Allelotoxins prevent the germination of seeds and the encroachment of vegetative growth from other plants. By keeping competitors at bay, the defending plant can reserve precious resources such as soil nutrients, water, and sunlight for itself. Those plants which have evolved the strongest defenses will be the most likely to survive.

For instance, have you ever noticed the ground under a pine tree? Generally, if you go out to examine a pine forest, you will discover that no plants are growing beneath the trees. This paucity of growth is due to more than just a lack of sunlight. This happens because fallen pine needles contain acid which leaches down into the soil as they decompose, thus, lowering the pH beyond the range of tolerance for most plant species. The acidic soil which does not affect the pine trees, essentially eliminates other contenders for precious water and mineral resources beneath the forest floor.

In all ecosystems, species, both plant and animal, are competing for limited resources. Numerous strategies are applied in the ongoing struggle for survival. Most of us are familiar with camouflage, mimicry, ambush predation, and thorns, spines, and needles. As stated above, plants, because they cannot move from place to place, have evolved a heavy reliance on allelotoxins – poisonous chemicals. Some of these allelotoxins are transferred to other plants through volatilization which is when allelochemicals are exuded into the air, and, in turn, are absorbed through the leaves of competing plants killing them. Other protective strategies by plants include the release of defensive chemicals into the soil through their roots, which assures that intruding roots from other species cannot grow, and are thus rendered incapable of monopolizing valuable water and mineral supplies. Other defenders poison the soil around them as their leaves drop to the ground and transfer allelochemicals onto the topsoil and thus prevent the germination of seeds from their own species or other species.

Competition, which can be defined as one organism having a negative or restrictive effect on another, may be intraspecific, occurring between individuals of the same species, or interspecific, occurring among different species. In addition, it should be noted that there are two general ways an organism can limit the resources available to another organism: exploitation competition or interference competition.

Allelopathy is a type of chemical interference competition utilized by plants. The word allelopathy is derived from two basic root words: allelon (of or from each other) and pathos (to suffer). Allelopathy involves a chemical inhibition of one species by another. Molecules produced by one plant, mostly secondary metabolites, are released into the environment and then influence the growth and development of neighboring plants. For example, in the Mojave Desert of the Southwestern United States, where water is a limiting factor for growth, creosote shrubs exude allelochemicals from both their leaves and roots that prevent other desert plants from encroaching upon their immediate territory. When viewed from a distance, the creosote bushes are spaced out, like pegs in a cribbage board, for as far as one can see with a life-sustaining three to five meters between them.

**Materials**

* Petri Dishes
* Paper towels
* Blender or mortar and pestle
* Markers for labeling
* Graduated cylinders
* Metric ruler
* Test seeds: radish (if small size seed is desired) or mung bean (if larger size seed is desired)
* Leaves from one or more allelopathic plants. The following is a list of some of the more notable allelopathic plants. Other local plants can be tested as well. (Note: **do not** attempt to use poison ivy, poison oak, castor bean, or oleander; all of these are dangerous plants)

Black walnut Creosote Eucalyptus

Pine needles Apricot Sage

Mint Ragweed (allergy caution) Sunflower

Tree of heaven Wormwood Chrysanthemum

Crown vetch Rice

Sorghum Creeping buttercup Pea

Chinese lespedeza Fragrant sumac Alfalfa

**Procedure**

1. Each group should obtain two Petri dishes. One Petri dish will serve as the control group and the other will serve as the experimental group. Obtain the crushed dried leaves of one or more known allelopathic plants.
2. Design a method to test the effects of the allelopathic plant material on seed germination and growth. There are several possible ways to do this. Decide as a group which method you will use. You may use any of the materials listed above in your design.
3. Describe your **design** in detail and **record your data**. Then **answer the following questions**.

**Data Analysis**

1. What percent of the seeds germinated in the control and the various test conditions?
2. Was there evidence of allelopathy in your experiment? Describe.
3. Were there any effects observed for the post-germination growth of the plants?
4. What is the danger of using seeds such as radish and mung bean which may not be found in the ecosystems of the allelopathic plants being tested?
5. What were some of the possible sources of error in your experimental design? What are the confounding variables?
6. How might knowledge about allelopathic chemicals be used to create natural herbicides and help to promote sustainable agriculture?
7. Do you think that scientists should use their bioengineering skills to remove the genes from allelopathic plants that are responsible for producing allelotoxins and splice those genes into non allelopathic food crop plants in an effort to reduce the need for herbicides and insecticides?
8. Why might knowledge of allelopathic effects be important to farmers who are concerned about crop to crop and weed to crop interactions?
9. Many ecosystems are dependent on low intensity ground fires as opposed to catastrophic wildfires which can destroy important soil decomposers such as fungus and nitrogen fixing bacteria. How do allelochemicals help to reduce the possibility of catastrophic wildfires occurring in forest and other ecosystems?