A new laboratory activity to help students learn about allelopathy and experimental design

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Video Abstract

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Abstract

A new report in the journal Biochemistry and Molecular Biology Education describes a laboratory activity meant to help students understand allelopathy – a type of chemical warfare used by plants to secure the resources needed to grow. In this process, plants release biochemicals that affect the growth or development of neighboring plants. It is a common tactic of invasive plant species. The mechanism has also been used in agricultural production systems as a sustainable and organic way to manage weeds and soil fertility. For example, horseradish produces the molecule sinigrin, which is hydrolyzed in the presence of the enzyme myrosinase to generate allyl isothiocyanate, or AITC. AITC has been shown to have allelopathic effects on lettuce, including reduced and delayed seed germination rates, decreased root hair growth, and decreased root length. Mustard green also contains AITC and is widely utilized to control weed growth in current agriculture production. Students build on this concept in the laboratory activity. The activity involves germinating lettuce seeds in Petri dishes under three conditions: with water, with horseradish extract in an unsealed dish, and with horseradish extract in a sealed dish. Because AITC is volatile, the sealed condition generates the highest local concentrations of the chemical. Students track germination and root growth by taking photographs with their smartphones and measure root length in the photos using open-access image analysis software. Inferential statistics can be used to compare measurements. The lettuce seeds exposed to the extract in the sealed environment will show lower germination rates and slower root growth compared to the other conditions due to the inhibitory nature of the bioactive allelochemicals present in the extract. A survey of 76 sophomore and junior undergraduate students showed that the majority of students enjoyed the activity and found it valuable. Their test results also improved on identical quizzes that were given pre- and post-laboratory. The students' total test scores more than doubled after completing the activity. Overall, the activity provides a simple, cost-effective way to make learning about allelopathy inviting, meaningful, and fun, while allowing students to develop knowledge of plant physiology, statistics, and experimental design.