Willie and the Beanstalk

To Germ or Not To Germ?

Science, Math

Grade Level: 9-12

Time: Two 50 min. class period

Standards:
Life Science
Math

For Kansas standards, visit www.ksde.org

Materials
Per Class:
Gallon size plastic bags (each pair of students will need 3)
Distilled water
1 gallon household bleach
4 cups lemon juice
100 soybean seeds
1tablespoon measuring spoon
1 roll of paper towels
Excel spreadsheet or other data collection software

Per Student:
Copy of Student Handout A: Seed Germination Lab

Overview
Students will learn at what pH a soybean seed will best germinate.

Objectives
1. Student will learn how to conduct a proper science experiment.
2. Students will use an acid and a base along with a control group to test their theories about the germination percentage as it relates to soil pH.
3. Students will calculate the germination percentage and create a graph showing their results.

Background Information
Being able to determine the germination rate of a given seed crop is very important to today's agriculturists and farmers alike. With the growing world population, the human race is going to need to optimize its land by producing more with the same amount of land. There are literally hundreds of different things in the environment and soil that affect germination. The focus of this lesson is how soil pH can affect soybean seed germination.

In chemistry, pH refers to the acidity or basicity of a substance. It is measured on a scale from 0-14 with 0 being acidic and 14 being basic. Seven is the neutral point, and distilled water fits into this category. There are very few substances that are exactly neutral. When it comes to farming, the pH of soil can play a big part in determining the success of a crop. Different soils across the Unites States have different pH readings due to the soil type and weather conditions present in

the area. It is very important to know the pH of a soil before starting a cropping program. The pH of a soil solution is important because that solution affects the availability of the nutrients (nitrogen, phosphorus, and potassium) necessary for plants to grow. If the pH is at a certain point, these nutrients will be made unavailable to the plants causing them to become nutrient deficient. Nutrient deficiency leads to growth problems and possible deformations.

If a famer plants 100 acres of farm ground to soybeans, he or she would have to know how many seeds could be planted. The reason for this is that if too many seeds are planted, then there will be a lot of plant competition for a limited amount of resources. Imagine watering a rose with just a cup of water. That plant could use up that amount of water in just a few days. Now, if there are ten rose plants and just one cup of water, they would all get watered but each one will get less water and require a shorter time between waterings. The same is said for grain crops. For a given area in Kansas and around the world, there are expected rainfall amounts for a specific area. It may vary year to year but the average tells farmers about how much rain will fall on any given farm per year.

With this information, it is important that field crops are not under-populated. It is also important that field crops are not over populated. If farmers do not account for under-population, they may allow excess water and nutrients to be available for other plants, like weeds. So, through years of experimenting and trial and error most farmers have come up with a plant population rate for their fields. Some seeds will not germinate as well as others and this can drastically affect the plant population. For example,

Soybeans: approximately 90% will germinate
Corn: approximately 95% will germinate
Wheat: 92-95% will germinate
Grain sorghum (milo): 50-80% will germinate

Preparation

1. Gather all materials needed for seed germination lab.
2. Set up seed germination lab area.
3. Make copies of Student Handout A: Seed Germination Lab.

Instructional Format

1. Share and discuss background information with students.
2. Conduct a quick percentage calculation review.
3. Students follow procedures for the seed germination lab.
4. Students observe seeds for the next 7-10 days
5. Students collect and report their seed data
6. Students answer conclusion questions (assessments).

Procedures

Percentage Calculation Review

1. Ask the students to raise their hands if they had breakfast this morning.

2. Write the number of students who raised their hands on the board.
3. Ask the students to turn that number into a percentage of those who ate breakfast and those who did not.
4. Explain how this is done: take the number of students who ate breakfast divided by the total number of students in the class. Then multiply this number by the factor of 100. This number gives the percentage of those who ate breakfast this morning.
5. This process can be repeated several times with other questions.

Seed Germination Lab

Teacher will demonstrate first and then the class will follow the same procedures.

1. Read the Student Handout A: Seed Germination Lab.
2. Label three bags: neutral, acidic, basic.
3. Dampen (don't drench) a paper towel with distilled water.
4. Place three soybean seeds on the paper towel and fold it over so that the seed is covered but can still be seen.
5. Place that paper towel in the bag labeled 'neutral'.
6. Dampen (don't drench) a paper towel with distilled water and a tablespoon of lemon juice.
7. Place three soybean seeds on the paper towel and fold it over so that the seed is covered, but can still be seen.
8. Place that paper towel in the bag labeled 'acidic'.
9. Dampen (don't drench) a paper towel with distilled water and a tablespoon of bleach.
10. Place three soybean seeds on the paper towel and fold it over so that the seed is covered, but can still be seen.
10. Place that paper towel in the bag labeled 'basic'.
11. Keep the towels moistened over the next several days with distilled water.
12. Observe how the seed grows and how long it takes to germinate.

<u>Conclusion Questions (Assessments)</u>

1. What have you learned from participating in this germination lab?

   Answers will vary.

2. Is it necessary for a producer to know what the germination percentage is of the seed planted? What type of production loss would you incur if a farmer didn't know the germination percent age?

   It is important for farmers to know what the germination percentage is for the seeds they plant so they can prepare for optimum results. Before planting, a farmer may want to know what he or she can expect as a return for investment. In addition, planting for the exact amount needed will result in a lower-than-preferred yield, which could result in loss of profit.

3. Why is soil pH important in crop growth?

The pH of a soil can determine whether or not certain nutrients are chemically available for plants to use. If these nutrients are not chemically available to the plants, they will be nutrient deficient, which leads to growth and reproduction problems.

Resources

Goddard Space Flight Center (2005). Soil Science Education. http://soil.gsfc.nasa.gov/

Exploring Kansas Crops Educator's Guide (2004). Kansas Foundation for Agriculture in the Classroom. To order, visit *www.ksagclassroom.org*.

Adapted from lesson plan created by Jason Ketterl, Oberlin, KS.

To Germ or Not To Germ?

Seed Germination Lab

Write answers in a notebook or on a separate piece of paper.

Goals

1. Experience statistics as it is practiced in biological research:
    a. Collect data appropriate to a specified purpose and recognize limitations in existing data.
    b. Explain the benefits of the statistical approach to design of experiments and use it.
    c. Analyze data using appropriate graphs and numerical tools.
    d. Derive appropriate, actionable conclusions from data analysis
    e. Present results and conclusions in both technical and non-technical terms, in writing and orally.

Pre-Lab Questions

1. Clearly define a problem and state the objectives of your experiment. State the hypothesis.

2. Identify the response variable, factors, potential levels of each factor, and units.
    a. What are some variables that may not be able to be controlled?
    b. Is the data collected going to be accurate and able to be reproduced in any location?

3. Identify what other factors need to be controlled during the experiment to eliminate potential biases.
    a. Identify how measurements, material and process may involve unwanted variability.
    b. What conditions would be considered normal for this type of experiment?

4. Choose an experimental design.
    a. Keep the design and analysis as simple as possible. A straightforward design and analysis is usually better than complex designs.
    b. How many trials will be run? Is the cost of replicating the experiment worth gaining a better understanding of the sample-to-sample variability?

5. Explain how your experimental design is built upon previous research.
    a. Identify relevant background on response and explanatory variables:
        Theoretical relationships
        Expert knowledge/experience
        Previous studies

Post-Lab Questions

1. Explain the results of the experiment.
    a. Which seeds appeared to germinate the best?

2. Is there anything that could have done to make the lab work better?