Germination Determination

Activity Overview
Students experiment with seed germination and determine the germination percentages.

Objectives
Students will:

- Observe seed germination and growth
- Understand conditions necessary for germination
- Calculate percentages

Subjects Covered
Science and Math

Grades: 1 through 12

Activity Time
Setting up the test: 30-45 minutes; frequent checking and occasional watering, determining germination percentages 30 minutes. Wet stratification takes 30 days and germination would generally take 1-2 weeks.

Season: Any

Materials
Seed, petri dishes, cotton absorbent paper towel or filter paper, thermometer, and cold space such as a refrigerator.

State Standards
Science:

Discover how organisms meet their needs (F.4.1)

Investigate how organisms respond to internal/external cues (F.4.2)

Investigate structure & function of organisms (F.8.1)

Show organism's adaptations (F.8.2)

Identify how technology is used in someone's job (G.4.1)

Discover changes in technology over time (G.4.2)

Determine how science discoveries change technology (G.4.3)

Identify uses of machines (G.4.4)Explore how machines were invented &

Background

When planting from seed it is best to not only know how much seed you are planting, but also how much of that seed is actually viable and thus able to germinate. If a pool of seed is found to have very low germination rates it may be necessary to either find a new source or over-plant by an appropriate amount. The older the seed source the more this is important, for most seed viability decreases over time. This aging process can vary considerably from species to species. Storage conditions can also have a significant effect. If seed is purchased or acquired from a reputable source it is reasonable to assume that the seed has been handled appropriately and has likely been recently tested. But, if the seed is older, or was harvested and cleaned by yourself, it may be a good idea to determine the germination rate.

Most seeds require a period of moist-cold stratification to allow for physiological changes to take place and make the seed viable for germination. Moist-cold stratification is defined as a treatment where the seed are kept in a damp, cool (sub 40 degrees Fahrenheit, but not freezing) condition for a period of time varying from 10 to 30 days.

Activity Description

Setting up the Germination Plates

1. Lay down two pieces of filter paper in a petri dish. (Note: it may be possible to use a heavy-duty paper or cloth toweling as a substitute for filter paper. The paper needs to be able to hold up to repeated handling when wet, and not contain any chemicals which would inhibit germination.
2. Place a sample of your seed on top of these papers. When testing seed it is best to use 100 seed, although as few as 50 seeds may be adequate. A large number of seed is necessary because there can be a great amount of variation in germination rates. Try to spread out the seed as much as possible. Some seed contain germination inhibitors and closely spaced seed may inhibit the germination of each other.
3. Lay down two more sheets of filter paper on top of the seed.
4. Wet the sandwich of filter paper and seed with distilled water. Chlorine and other chemicals in city water may adversely affect germination. Bottled drinking water and clean well water may be acceptable alternatives. Use just enough water to soak the paper, but not enough to produce standing puddles. A squirt/spray bottle easily does this.
5. Determine if your seed needs a period of cold to germinate. In colder climates, most seeds need a period of cold stratification to germinate.

If your seed needs wet stratification, follow the procedure below.

1. For the purpose of a germination test, cold stratification is easily achieved by placing the petri dish with the dampened seed in the refrigerator for

produced (G.4.5)Identify skills needed for a career in science or technology (G.8.1)

Explain how discoveries influence careers (G.8.2)

Illustrate impact of science & technology (G.8.3)

Design an applied science model or machine (G.8.4)

Investigate local problem & propose scientific or technological solution (G.8.5)

Math:

Use reasoning abilities (A.4.1, A.8.1, A.12.1)

Communicate mathematical ideas (A.4.2), logical arguments (A.8.2, A.12.2)

Connect mathematical learning with other subjects (A.4.3)

Use vocabulary, symbols, notation (A.4.4)

Explain solutions to problems (A.4.5)

Use reasoning abilities (A.8.1)

Communicate logical arguments (A.8.2)

Analyze non-routine problems (A.8.3)

Develop effective oral & written presentations (A.8.4)

Explain mathematical concepts, procedures, & ideas (A.8.5)

Recognize & describe measurable attributes & units (D.4.1)

Demonstrate understanding of measurement (D.4.2)

Read & interpret measuring instruments (D.4.3)

Determine measurements by using standard tools (D.4.4)

Determine measurements by using basic relationships or estimations (D.4.5)

Identify & describe attributes in situations not directly or easily measurable (D.8.1)

Demonstrate understanding of measurement facts, principles, techniques (D.8.2)

Determine measurement directly by using standard units (D.8.3)

Determine measurement indirectly (D.8.4)

30 days. If possible, check the temperature of your refrigerator at several locations. The ideal temperature for moist-cold stratification is below 40 degrees Fahrenheit but not freezing. The crisper (or other lower compartment) is frequently cooler, and better, given that you want a temperature below 40.

2. Keep a close watch and make sure the filter paper-seed sandwich is kept moist at all times.

Germination Test

1. Place the petri dish in a well-lit area, but out of direct sunlight. Many seeds need light to germinate. But, watch out, too much bright light (such as direct sunlight) can turn your petri dish into a greenhouse oven! Room temperature is good for germination of most seed. Avoid hot spots such as radiators or heat ducts. Likewise, a cold drafty windowsill may be too cool to allow germination.
2. Keep the filter paper well moistened. Initially it is a good idea to check the moisture level a couple times a day until you know how quickly it is drying out and needs watering.
3. After several days begin to look for emergence of the seedling root (or radicle). It is this event which defines germination. Keep an eye on the increase in percentage of seed germinated. When it becomes clear that no more seed are germinating, count the number of seed that have germinated, and determine the percentage. The time that it takes to reach this point can be affected by the species itself, and the environmental conditions during the germination test. Have patience, and check your seed at least once a day!
4. Calculate the percent germination. Divide number of seed that germinated by total number of seeds.
5. Create a classroom graph depicting germination percentages of each species. Discuss results.

Other factors affecting germination tests:

1. Some seed, such as Tradescantia ohiensis (spiderwort), need to be physically abraded (scarified) before it will germinate. This can be achieved by lightly and briefly rubbing the seed between two pieces of sandpaper. Too much abrasion will cause too much damage and lower germination rates, so be careful!
2. Some seed, especially grasses, require only a cold (not moist) stratification. Purchased seed will usually come cold stratified.
3. Other seed, such as *Eryngium yuccifolium* (rattlesnake master), produce large enough quantities of a germination inhibitor that a standard test is not possible. If you find that you are getting very poor germination test results, it may be that you are dealing with such a species.

See Earth Partnership for Schools Activity , "Seeds to Seedlings: Propagating Seeds in the Classroom" for more information about germination and breaking seed dormancy.

Extensions

- Explore the effects of different moist-cold stratification periods on germination rates.
- Explore other stratification regimes to better hone our knowledge of a specific species' stratification requirements. See Earth Partnership for Schools activities, "What Does a Seed Need?" or "Seeds to Seedlings: Propagating Seeds in the Classroom")
- Design a germination regime that will result in a higher germination percentage.

Additional Resources

- Hartmann, H., Kester, D., Davies, F., Geneve, R. (2002). *Plant propagation: Principles and practices*, 7th Edition. Prentice Hall. Upper Saddle River, NJ
- Hill, L. (1985). *Secrets of plant propagation: Starting your own flowers, vegetables, fruits, berries, shrubs, trees and houseplants*. Storey books: North Adams, MA.
- Riveredge Nature Center. (1999). *Begin with a seed: The Riveredge guide to growing Wisconsin prairie plants.* WonderCat Graphics: Wauwatosa, WI.
- Rock, H. (1981). *Prairie propagation handbook.* 6th Edition. Wehr Nature Center, Milwaukee County Dept. of Parks, Recreation & Cultrue: Franklin, WI.
- Toogood, A. Editor: American Horticultural Society. (1999). P*lant propagation: The fully illustrated plant by plant manual of practical techniques*. DK Publishers, New York, NY.

Assessments

- Submit a journal keeping track of germination including drawings and calculations.
- Compare the different germination rates and hypothesize what may have caused the variability.
- Report on what you learned about testing germination along with recommendations for someone interested in trying this experiment.