Activity 1. What do rice plants need to grow?

Objective

Design and conduct an experiment to determine what rice plants need in order to grow.

Background

Plants are an essential part of our lives. They provide us with food, shelter, fuel, and clothing. And yet, we often don't pay much attention to them. What do plants need to grow?

Materials

- Rice seeds
- Containers
- Soil
- Water source and watering method *(a beaker and a faucet is fine!)*
- Other resources to be determined

Part I: Brainstorming

1. What things do plants need in order to grow?

   Most students will have some idea that plants need soil, water, air, fertilizer, etc. One approach is to have students answer the question on paper and then discuss it as a class. (And let them modify their answer… the point isn't to be "right" but to make them commit to an answer.)

2. You and your group will design an experiment to investigate one of these "needs". Which "need" will your group be investigating?

   Here groups will volunteer for, or the teacher will assign, each student group one of the variables: light, water, salinity, soil, temperature, fertilizer, or any of the others you can think of.

   Water, salinity and temperature are the most relevant variables to rice in Africa and the colonies. However, you may be constrained by the materials you have in your classroom.

Part II: Experimental Design

1. A **variable** is something that you change in an experiment. What is your variable?

   The same as the "need" they decide to investigate in the previous question (Part I, question 2).

2. In order to understand the effects of your variable, all the other conditions should be exactly the same. These conditions are held **constant**. Why is it important to have conditions held constant?

   Unless an investigator can "isolate" her variables, she doesn't know whether she's seeing the effects of that variable or some confounding factor.

3. Fill in the table to show which conditions you are going to hold constant and which you are going to vary. For the constants show what you will do.

Characteristic	*Example Experiment*		Your Experiment	
Characteristic	Constant or variable?	What will you do?	Constant or variable?	What will you do?
Light	*constant*	*windowsill*		
Water	*constant*	*keep soil damp*		
Salt	*constant*	*no salt*		
Fertilizer	*constant*	*3 pieces per pot*		
Soil	*VARIABLE*	*VARIABLE*		
Temperature	*constant*	*room temperature*		
other				

4. Your hypothesis.
   A hypothesis is a possible explanation or an educated guess about what you will find. It is a starting point for your experiment.
   This section may require some class discussion.

   How do you think your variable will affect rice plants?
   Example hypothesis:
   I expect that _*soil*_ will cause the plants to _*grow*_ because *they need a place to put their roots*.
   Too much _*soil*_ will lead the plants to _*not grow*_ because *they won't be able to get out of the soil to the light*.
   Not enough _*soil*_ will lead the plants to *not grow* because *they won't have a place to put their roots or a way to take in water*.

   Your hypothesis:
   I expect that _____ will cause the plants to _____
   because_____.
   Too much _____will lead the plants to _____
   because_____.
   Not enough _____will lead the plants to _____
   because_____.

5. Controls and treatments.
   To see the effect of your variable, you must compare it against a **control**.
   This section may require some class discussion.

5a. For your variable, what do you think is the "best practice" for your variable? This will be your control.

This is not a conventional control. However, it will provide a baseline for comparison, and that is the purpose of a control.

Example control:
Rice plants will grow best when _____*soil*_____ is _____*present and not packed down*____.

Your control:
Rice plants will grow best when _____is _____.

5b. What are your treatments?

Example treatments:
To understand the importance of _____*soil*_____, I will compare my control to
1) _____*seeds in a pot with no soil*_____, and
2) ____*seeds in a pot with twice as much soil as my control, packed down*_____.

Your treatments:
To understand the importance of _____, I will compare my control to
1) _____, and
2) _____.

6. What supplies will you need? How will you get any that are not already available in the classroom?
   The point of this question is to make students think through what else they will need and whether or not they can get it.

7. How will you measure your results?
   Typically, students measure some part of the growing seedling; length is the most obvious candidate if you are going to encourage intermittent measurements. If students just measure the plants at the end of the experiment, they could measure number of leaves, color of the seedling, length…

8. What will you need to do every day?
   The point of this is to get students to think about what their daily tasks will be. (Usually involving watering!)

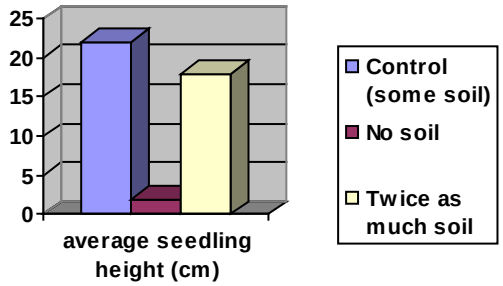
If you have the time and interest, you could have your students peer review each other's experiments.

Part III: Data and results

1. Use this space to record your data:

Plant	Control:	Treatment 1:	Treatment 2:
1.			
2.			
3.			
4.			
Total			
Average			

2. Graph your data.



This requires the creation of a simple bar graph. An example:

Part IV: Your Conclusions

3. What does this experiment tell you about the importance of your variable? (What did you learn from your experiment?)

This is a good place to emphasize that it is easy to draw conclusions… but in science those conclusions must be based on data.

4. Did you have any unexpected results? What were they and why do you think they happened?

It's also important to encourage students to come up with well-thought out explanations for why results were not as expected (e.g., might results be due to the biology of the organisms, due to some fault with the procedures, or multiple factors?). If students attribute unexpected results to "experimental error" make sure they are specific about what they think went wrong and why.

5. How could you improve your experiment? (Are there ways your experiment could be improved to better answer the initial question? Did you come up with questions you can't answer using your data?)

Encourage students to think creatively and critically here! Was it a good experiment? Would more plants, more time, or a different experimental set-up have improved their experiment? Were there more interesting treatments? Could their controls have been better? Were the measurements students took helpful? What else could they have measured?

This is also a good time to point out that scientists often run an experiment more than once, especially when they are fine-tuning their investigative technique. (Is there a better measurement technique? Should the plants be a different age?)

Part V: What do rice plants need in order to grow? (Learning from each other)

Each group will give a 3 minute presentation describing 1) what their experiment told them what rice plants need to grow and 2) making a recommendation of the "best practice" for their variable. You will need to answer the questions below (by taking notes!)

1. What does this experiment tell you about the importance of each variable for rice plants?

Variable	Importance	"Best Practice"
Light		
Water		
Salt		
Fertilizer		
Soil *(Example)*	*Plants need soil for their roots. When rice plants have no soil, they die. When the soil is dense, rice plants grow more slowly.*	*Use soil. Don't compact it.*
Temperature		

Teacher Notes. What does rice need to grow?

Overview and concepts

Overview

After reviewing what students know about what plants need to grow (soil, water, light, warmth), students design and conduct an experiment to determine what rice plants need in order to grow.

Concepts covered

Soil, water, light. Can be used to discuss photosynthesis.

Activity notes

Time frame

- Activity: One day for discussion and experimental design.
- One half day for starting the experiment.
- Two weeks of monitoring plants. Students will need a few minutes each day to take care of plants and perhaps take measurements.
- One day to wrap up the experiment.

Materials

- Rice seeds
- Containers
- Soil
- Fertilizer? (Not essential, but students will want it.)
- Grow lights
- Water source and watering method (a beaker and a faucet is fine!)

- To use temperature as a variable: hot environment (incubator/oven?), cold environment (refrigerator)
- To use light as a variable: dark place, windowsill, growlights
- To use salt as a variable: salt
- To use water amount as a variable: device for measuring water.

Preparation

- A few weeks before the activity, make sure that you have all the rice seed you need. Extra rice can be kept fresh for up to a year in a sealed container kept in a refrigerator.

Teaching Tips

- The subsequent parts of this experiment are more important than this one… so if time runs short… this activity is the most expendable.
- This information could be covered in a discussion about what students already know about the needs of plants. Students will get their opportunity to grow plants later, so they would lose little by abandoning this part. On the other hand, if this is students' first introduction to plants, it may be useful to invest the time in figuring out what they need.
- It is best to focus student groups on the variables they can best control:
    - Amount of water: water-logged (add water daily), damp soil, dry soil (add no water).

  - Light: (growlights all day and night, daylight, dark. In the dark, plants will germinate, and grow gangly reaching for light, but won't flourish.
  - Salinity: no salt, little salt, lots of salt in soil. (Some varieties handle salt better than others.)
  - Temperature: hot (incubator), room temp, and cold (refrigerator).
  - Fertilizer: no fertilizer, small amount of fertilizer, a LOT of fertilizer. The treatment with lots of fertilizer will do the worst because it will burn the plants. I would not expect much difference in anything you can measure on a seedling between no fertilization and low fertilization. Perhaps eventually you'd see a difference in yield.
  - Another, less dramatic exploration: soil. Students could grow seeds on paper towels, in soil and in water. (Or in sand and soil). It turns out that plants need anchorage of some sort, but they don't actually need soil.
- Each group should only vary ONE variable. The synthesis at the end (comparing different groups that used different variables) should help students understand the effects of different variables.