Growing Plants on Water Gel Polymers Beads

Objective:

Students will:

Investigate how corn and bean seeds grow in a soil mixture that contains different amounts of water gel polymer beads.

Introduction:

Because of droughts in many agricultural places, various products have been tried to promote water conservation. One promising product is a commercially available water-absorbing material composed of polyacrylamide polymer beads which can absorb hundreds of times their weight in water. We will test to see if adding polyacrylamide polymer beads to a mixture of seeds and potting soil will help plants to resisted the effects of an artificial drought created by a lack of watering, (1)

Figure 1, Bean seed sprouting.

Materials: (per person)

- 6 corn seeds (pop corn or sweet corn) and 6 bean seeds (kidney bean, white bean or lima bean). Soak seeds over night in water.
- 6 clear, plastic cups, 8 oz or larger but all the same size.
- Dry potting soil.
- Water Jewel beads (Ashland or equivalent)
- Foot long ruler with centimeter scale.
- Water.
- Measuring cup marked in English and metric volume units.
- Permanent marker.
- Centigram balance.

Procedure:

- Label plastic cups 0, 1, 2, 3, 4, 5 with the permanent marker (also add your initials).
- Add Water Jewel beads to the bottom of each cup. Zero beads in cup 0, ten beads in cup 1, twenty beads in cup 2, thirty beads in cup 3, forty beads in cup 4 and 100 beads in cup 5.
- Add 100 g (about ¾ cup in volume) of dry potting soil to each of the 6 plastic cups, except no soil in cup 5, just keep the 100 gel beads exposed..
- Record the weight of each cup with the soil and the beads. This will be our base line.
- Add 100 ml of water to each cup, about (3.5 fluid ounces).

- Add 1 bean seed and 1 corn seed to each cup, even cup 5 with no soil.
- After seeds are added weigh each cup and record the weigh on the lab sheet.

- Place the cups together but not in direct sunlight until the seeds sprout.
- Record the weight of the cups each day for two weeks. Do you expect the weight to go up or down?

- DO **NOT** add any more water. We want to see if the water beads help to hold water in the soil for the seed roots.
- Continue daily weighing for 2 weeks; skip weekends if cups are in school.
- At the end of two weeks, the experiment is over.
- Extension – after the first 2 weeks, the students can water the remaining seeds again and test for another two weeks. This time measure the height of the plant or stop the experiment and plant the seeds outside.

- Each student should plot the weight of each cup as a function of time. This will give 6 lines on the same graph, one for each cup. Note if and when you see the seeds germinate.
- Plot all the student results on a single graph using vertical box and whiskers plot for each day. This will require 1 plot for each cup, (2).

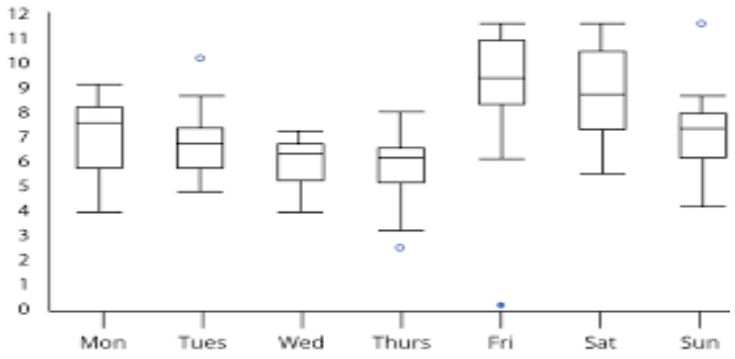


Figure 2, Example of a box plot of weight as a function of days.

Discussion:

We know that if we do not water plants, the soil will eventually lose its water. So we can imagine that as the water is lost, the soil container should lose weight since the water has mass. The speed of the water ***evaporation*** from the soil depends on a number of factors like room temperature or humidity or content of the soil. We hopefully are controlling for some of these factors by using the same type of potting soil in each cup and keeping the cups in the same conditions of light and heat. On the other hand, if the seeds sprout and begin to grow, the cup should gain weight as the plants grow and they gain mass.

Water gel beads are known as a type of super-absorbent polymer, SAP. Polymers are very large molecules composed of repeated patterns of chemical units called monomers, which are strung together. There are many natural polymers; these include: bone, horn, cotton, silk, rubber, paper, and leather. There are also man-made polymers, as well. Fabrics such as rayon and polyester, polystyrene (used in styrofoam coffee cups), and polyvinyl chloride, PVC (used in pipes) are common examples of artificially-occurring, man-made polymers, (3).

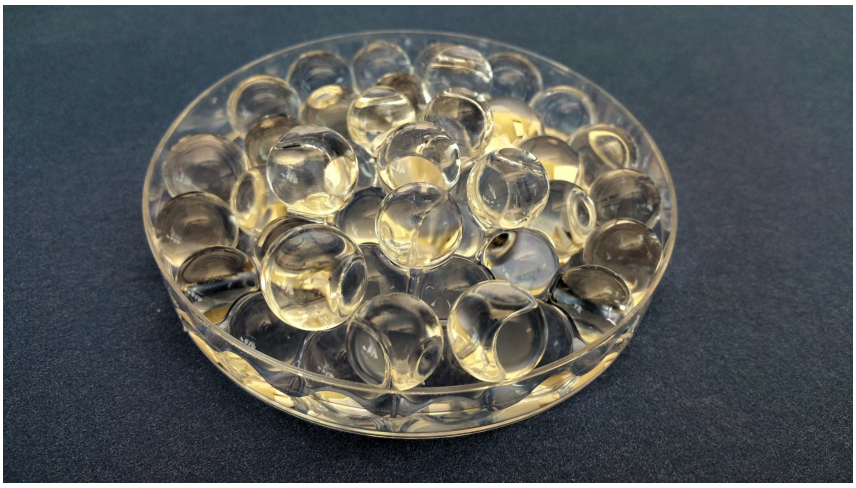


Figure 3, Water gel beads that have absorbed water, (3)

Absorption is the process in which a solid soaks up a liquid like water. In the seed cups there are three solids that can absorb water; these are the soil, the seeds and the water gel beads. It was expected that the absorbent water gel beads would hold on to the water longer than the soil and thus make the water in the beads available to the seeds and not just lost to evaporation out of the soil.

So how does the soil or the water gel bead release water to the seed? The answer has to do with ***osmosis***. Osmosis is the movement of water through a membrane (such as the water gel beads or the seed coats) to achieve equilibrium, or balance. The goal was for the water to initially ***saturate*** the soil, then by osmosis the water would move into the seeds and into the water gel beads. The competing process to osmosis is the loss of water from the soil by evaporation. If too much water is lost by evaporation, then the process of osmosis works against the seed and water moves from the moist seed back into the drier soil. It was anticipated that the water stored in the water gel beads would also move back into the soil, as it dried out, and some of this new source of water for the soil could move back into the seeds.

References:

1) Letey J, Clark P, Amrhein C. 1992. A greenhouse experiment finds water-sorbing polymers do not conserve water. Calif Agr 46(3):9-10. Website Active August 2017, http://calag.ucanr.edu/Archive/?article=ca.v046n03p9

2) Purple Math. 2017. Quartiles, Box and Whiskers. Website Active August 2017, http://www.purplemath.com/modules/boxwhisk.htm

3) Home Science Tools. 2017. Water Beads, Super Absorbant Polymer Science. Website Acitve August 2017, https://www.homesciencetools.com/a/water-beads-superabsorbent-polymer-science

Definitions:

Define the following terms:

1) absorbance -

2) evaporation -

3) osmosis -

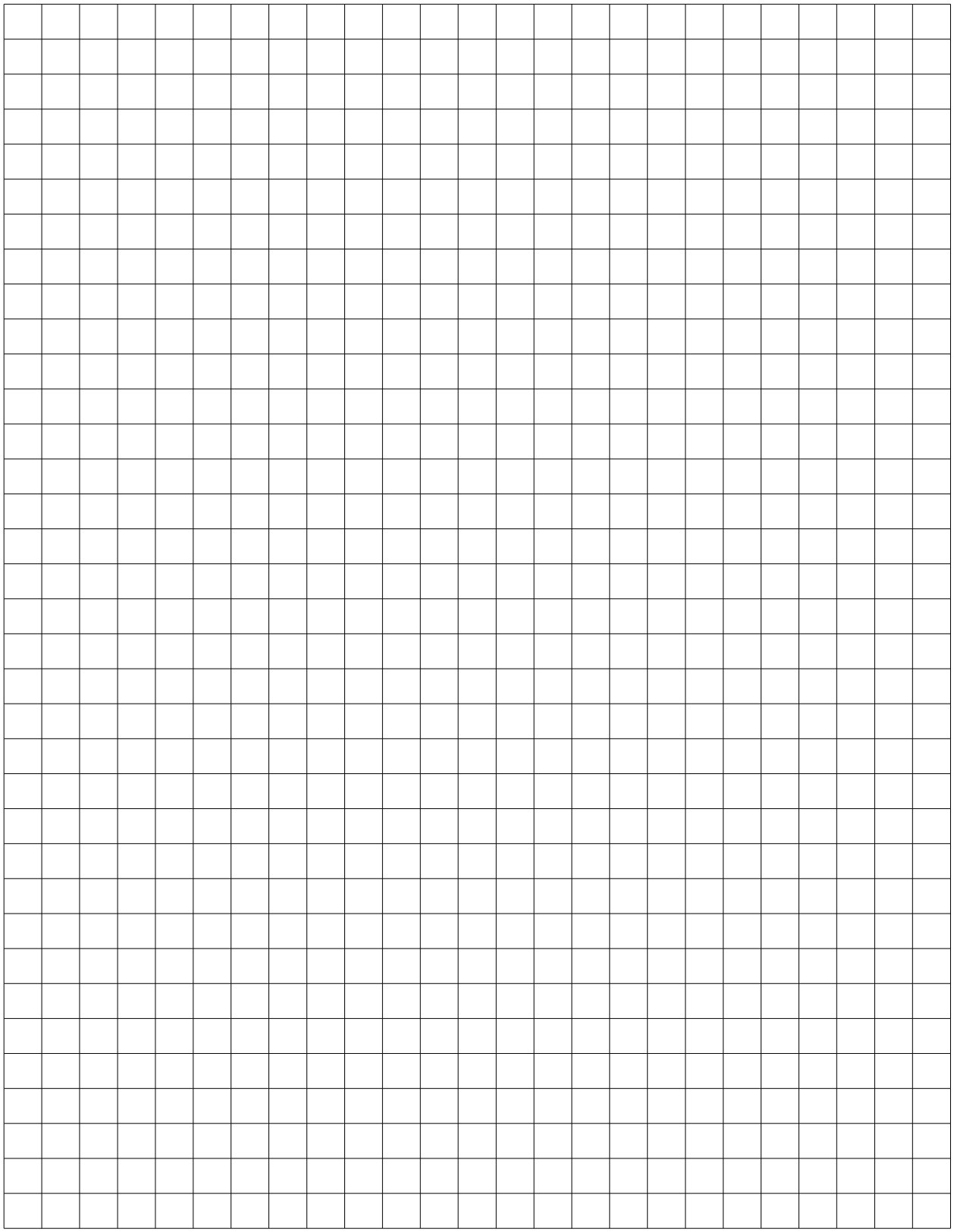
4) saturation -

Name _____ Date _____

Growing Plants on Water Gel Polymers

Days	Cup 0 Wt (g)	Cup 1 Wt (g)	Cup 2 Wt (g)	Cup 3 Wt (g)	Cup 4 Wt (g)	Cup 5 Wt (g)
Initial dry wt, no water, day 0						
First wt, with water, day 0						
Day 1, wt						
Day 2, wt						
Day 3, wt						
Day 4, wt						
Day 5, wt						
Day 6, wt						
Day 7, wt						
Day 8, wt						
Day 9, wt						
Day 10, wt						
Day 11, wt						
Day 12, wt						
Day 13, wt						
Day 14, wt						

Name _____ Date _____



Name _____ Date _____

Cup	What mass was lost in 2 weeks, (g)	When did seeds sprout, (Day ?)	How tall were plants on day 14, (cm)	Comments
Cup 0				
Cup 1				
Cup 2				
Cup 3				
Cup 4				
Cup 5				

Lab Questions:

1. Which seed sprouted first, corn or bean, and in which cup (0-5)?

2. Which Cup surprised you the most in this experiments: Cup 0 to Cup 5. and why were you surprised? What happened that you had not expected?

3. If you did this experiment again, would you start with 50 mL of water or 150 mL. Support your answer.

Green Question(s)

4. Based on this experiment, would you add Water Gel Beads to soils or not. Support your answer.

5. Did you end up watering the cups after two weeks or put the plants in the ground.