**Grade:** 8

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**Title of Project:** The Effect of Seed Storage Conditions on the Drought-Tolerance of Soybean Plants

**Purpose:** To determine the effects of seed storage conditions on the drought-tolerance of its soybean plants.

**Problem:** Soybean seeds do not grow very well under the stresses of drought.

**Observations/Research Paper Topic:**

**Qualitative Observations Before Testing**

* All the soybean seeds are the same color and size.
* Drought stress causes soybean plants and all other plants to not grow very well.

**Quantitative Observations Before Testing**

* Each storage condition will end up having an equal amount of soybeans in each container since I have an ample amount of soybean seeds.

**Qualitative Observations During Testing**

* The plants in which their seeds were stored at room temperature, appear to have the smallest and least-healthiest leaves for both the drought and non-drought conditions.
* The plants in which their seeds were stored in the refrigerator appear to be mostly big in size with occasional medium sized leaves for both the drought and non-drought conditions.
* The plants in which their seeds were stored in the freezer appear to be a mixture of bug and medium in size for both the drought and non-drought conditions. These plants appear the tallest.

**Quantitative Observations During Testing**

* For drought conditions, an average of 9 seeds per storage condition germinated between days 5-7.
* For non-drought conditions, an average of 9.22 seeds per storage conditions germinated between days 5-7.

**Qualitative Observations After Testing**

* The plants in which their seeds were stored in the freezer appear the healthiest, while the plants in which their seeds were stored in the freezer appear the least healthy.

**Quantitative Observations After Testing**

* The plants in which their seeds were stored in the freezer, have the longest average root length of 5.4 inches under drought conditions.
* The plants in which their seeds were stored in the freezer, have the longest average shoot length of 5.7 inches under drought conditions.

**Hypothesis:** If I test the effects of seed storage conditions on the drought-tolerance of its soybean plants, then the soybean seeds which are stored in the freezer ( -6° to 5° fahrenheit) and with a moderate relative humidity (54% to 56% relative humidity) will have the best outcome on the drought tolerance of its soybean plants.

**Materials & Procedures:**

 **Materials**

* Fungicide treated soybean seeds
* 6 tin storage containers with lids
* 3 thermometers
* 3 humidity readers
* Freezer
* Refrigerator
* 4 Bulb Supreme Hydroponics Grow Light (54 Watt)
* Moisture meter
* Soil pH reader
* Light meter
* Soil
* Room-temperature water
* ¼ cup measuring cup
* 2 cup measuring cup
* 1 cup measuring cup
* Popsicle sticks
* 6 plastic bins
* Trowel
* Gloves
* Paper
* Pencil
* Tape
* Markers
* Camera
* Water
* Ruler

**Procedure**

1. Place ¼ cup of fungicide treated soybean seeds in each of three tin containers with lids.
2. Label each of the three containers for the **seed storage conditions**, as follows: “**Refrigerator**”, “**Freezer**” or “**Room Temperature**”.
3. Place each container in the location labeled on the container. For example, the tin labeled, “Refrigerator” should be placed in the refrigerator for storage.
4. Store each of the tin containers filled with soybean seeds in its respective location for a total of seven days.
5. For each of the seven days, take and record a morning and evening temperature reading in addition to a relative humidity reading of each storage location. The temperature and humidity monitors were tested against a Calibration Standard which is a device which measures with a high degree of accuracy in order to confirm the accuracy of the monitors. The Calibration Standard was measured against an even more accurate standard which is a National Institute of Standards and Technology (NIST) standard.
6. After seven days, take each container of seeds out of its storage location. The seeds are now ready to be planted.
7. Drill holes in the bottom of a plastic planter (35’x7”x6”), spaced six inches apart, for drainage purposes.
8. Add soil to the plastic planter. Fill the soil two inches from the top of the planter.
9. Each seed storage condition (Room Temperature, Refrigerator, Freezer) will have two different soil conditions. One soil condition will be **moist (non-drought)** with the ideal amount of water for a soybean plant. The other soil condition will simulate **drought** conditions and will lack the sufficient amount of water.
10. Create three even sections in each planter, one for each storage temperature.
11. There are two planters for **Trial 1**:

 **Planter 1**: The first planter will have a sufficient amount of water (**moist soil**).

It has three sections each labeled with a popsicle stick which indicates the storage temperature of soybean seeds planted there. One popsicle stick will be labeled, “**Room Temperature Moist**”, another will be labeled, “**Refrigerator Moist**” and lastly, the third popsicle stick will be labeled, “**Freezer Moist**”.

**Planter 2**: The second planter will simulate **drought** **soil** conditions. It will also have three sections each with a popsicle stick labelled with the storage temperature of soybean seeds planted there. One popsicle stick will be labeled, “**Room Temperature Drought**”, another will be labeled, “**Refrigerator Drought**” and lastly, the third popsicle stick will be labeled, “**Freezer Drought**”.

1. Using gloves, plant ten seeds from each of the three storage temperatures into each of the two soil conditions. There should be a total of 30 seeds in each of the two planters for a total of 60 seeds for Trial 1.
2. Plant the seeds two inches apart from each other and two inches below the soil surface.
3. Place a grow light 20 inches above the top of the planter.
4. Use a light meter to make sure every part of the planter is in the same light range. Let the seeds grow for a total of 12 days. Take daily soil moisture readings, pH readings, and temperature readings of the room.
5. According to the moisture reader, if the planter which simulates a sufficient amount of water for plant growth does not have an optimum moisture reading, then add either one or two cups of water to the soil in order to maintain a sufficient moisture level.
6. According to the moisture reader, if the planter which simulates drought conditions has a low moisture level, then do not add any water to the soil so that the drought conditions are maintained. In the drought simulating planter, ensure that just enough water is added so that the plants will germinate and grow, but not so much water that it simulates optimum water conditions.
7. Record the day on which each seed germinated for each storage condition.
8. After 12 days, record the health and appearance of the leaves of each plant.
9. Using a trowel, carefully dig up each plant and measure their shoot length (leaves to the start of the roots), measure the root length (start to end of roots) and also record the number of lateral roots extending from the taproot (main root).
10. Record the vigor index of each plant. To find the vigor index, add the root length and the shoot length then multiply the sum by the percent (%) germination (number of seeds germinated out of ten seeds).
11. The storage condition for both non-drought and drought growing conditions with a combination of the highest vigor index, highest average and median root length and highest average and median shoot length is the optimum storage condition.
12. Repeat this procedure two more times for a **Trial 2** and **Trial 3**.

**Data Analysis:** Soybean seeds which were stored in the **freezer**, had the best drought-tolerant soybean plants. The soybean plants in which their seeds were stored in the freezer had the highest average vigor index for both drought and non-drought conditions and had the longest average and median root length for both drought non-drought conditions and the highest median shoot length for drought conditions. The soybean plants in which their seeds were stored in the **refrigerator** had a higher median shoot length than the freezer by only 0.2 inches for non-drought conditions, but overall the freezer did the best. The soybean plants in which their seeds were stored at **room temperature** had the lowest average vigor index for both drought and non-drought conditions, had the shortest average and median root length for both drought and non-drought conditions and had the shortest average and median shoot length for both drought and non-drought.

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