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| **Essential Question:** How can we ensure that soil provides the water and nutrients needed for healthy soybean growth? | | | | |
| **Hypothesis:** | | | | |
| **Identify the following variables**  **Independent:**  **Dependent:**  **Controls:** | | | | |
| **Materials**   * Three different soil types (sandy loam, potting mix, clay loam) * 3 coffee filters * 3 beakers (250 mL) * Water * Graduated cylinder * Stopwatch | | | | |
| **Procedure:**   1. **Setup:**     1. Fold a piece of filter paper so that it creates a cone. Place the cone into each of the beakers. You may wish to secure the filter with a rubber band- do not make the filter tight, though, make sure there is a “well”.    2. Label the containers. 2. Using the graduated cylinder, measure out 125 mL each of soil types. 3. Pour one sample of soil into each of the filters , and compact the sample by gently tapping the beaker on the table. 4. **Simulate Rainfall:**  * Start a timer. * Slowly and evenly pour water over the surface of one of the soils. * **Monitor Drainage:** Stop the timer once water stops dripping from the bottom for at least 10 seconds. This indicates the water has saturated the soil. * Make qualitative observations about the percolation. * Note the volume of water used (e.g. 200 ml).  1. **Record Data**: Record the time it took for the water to drain (in minutes) and the total volume of water used in a data table.  * **Record** the amount of water in the beaker. Calculate the amount of water absorbed by subtracting the amount of water in the baker from the amount of water you added. * **Calculate Drainage Rate**: (how quickly water drains through the material),   Drainage Rate = Amount of Water (mL) / Time (minutes)   1. **Repeat** for the remaining soil types | | | | |
| **Data Table**   | **Soil Type** | **Amount of water added** | **Time** | **Drainage Rate**  Amount of Water (mL) / Time (minutes) | **Amount of water in the beaker** | **Amount of water absorbed**  (Added water - water in the beaker) | **Qualitative observations** | | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  |  |  |  | |  |  |  |  |  |  |  | |  |  |  |  |  |  |  | |  |  |  |  |  |  |  | | | | | |
| **Graphing: Create either a bar graph or a line graph of the drainage rates of the soils.** | | | | |
| **Graphing: Create either a bar graph or a line graph of the absorption amounts for each of the soils.** | | | | |
| **Analysis**   1. Discuss which material drained the water the fastest and why. 2. Relate your findings to real-world scenarios. For example, how might fast-draining soil affect the growth of the soybeans? 3. Think back to the slide presentation- what type of soil would be best for the growth of soybeans? | | | | |
| **Engineering Design Challenge**  **You are a team of agricultural engineers tasked with designing a soil amendment that specifically improves water retention in sandy soil to optimize conditions for healthy soybean growth.**  **Criteria:**  **Improved Water Retention:** Your design should significantly increase the water holding capacity of sandy soil compared to untreated sand. This can be achieved through the chosen materials and their proportions in the amendment.  **Plant Growth:** The amended soil should promote healthy soybean growth by providing sufficient water for root development and overall plant health. Consider how the amendment might impact nutrient availability as well.  **Sustainability and Cost-Effectiveness:** Use readily available and affordable materials that are safe for the environment. Focus on materials that can be easily obtained or produced locally.  Presentation: Prepare a clear and concise presentation explaining your design, testing methods, results, and the potential benefits for sustainable soybean production.  **Consider the following while designing:**   * + **Target ratio of chosen materials:** Experiment with different ratios of organic matter, clays, hydrogels (if used), and biochar (if used) to optimize water retention without compromising drainage or nutrient availability for soybeans.   + **Impact on soil structure:** The amendment should improve the overall structure of sandy soil, creating a balance between water holding capacity and air circulation for healthy root development.   **Brainstorm at least 3 different designs and describe them below:** | | | | |
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| **Which of the ideas did you choose and why?** | | | | |
| **Draw a detailed diagram of the soil amendment you chose.** | | | | |
| **Write a detailed procedure of how you will test your design and include what types of data you will collect.** | | | | |
| **If you tested your design, include the data you collected here and a brief analysis of what you discovered.** | | | | |
| **Create short presentations about your designs (and results if tested). In the presentation, explain how the design can benefit soybean farmers by improving water retention and ensuring optimal crop growth.** | | | | |