

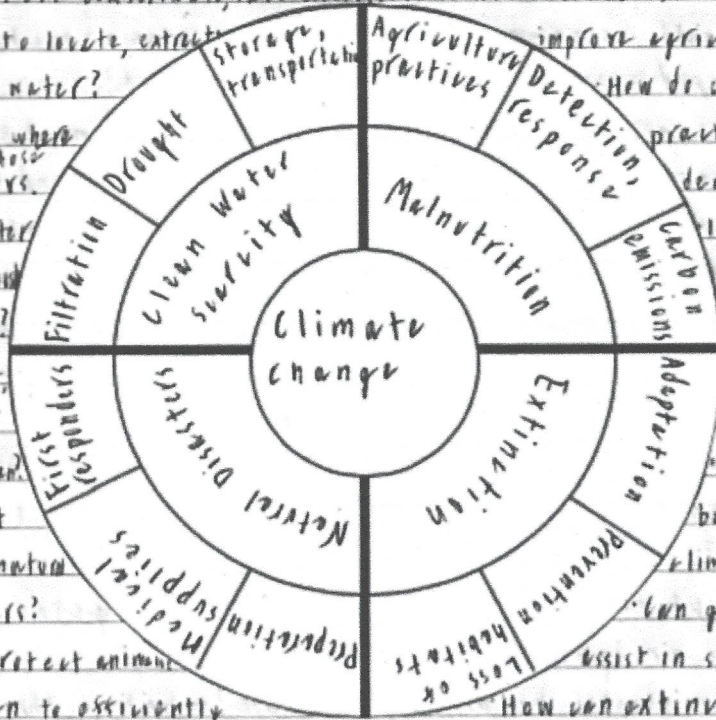
11/6/20

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Portable, lightweight water filter? Combat lack of fertile soil with added
Natural biofiltration for water ingredients? Genetically engineer?
supply? Various plants, algae? How does excess CO_2 in atmosphere affect
Harvest water from other sources nutrient density in plants? How improve?
(i.e. tree, plant) without damage? How detect nutrient levels individually?
Efficient position of water / jugs across population?
to be most comfortable, save energy? Can excess carbon be collected, applied to

Robot to locate, extract
wastewater? Agriculture improve agriculture?
Detection, response? How do current agriculture
practices affect nutrient
density?

System where
shower, vs.
tap water
are mixed
filtered?
Extract,
purify
from waste?
Product
future natural
disasters?
How protect animals
Design to efficiently
deliver medical supplies?
Application to request supplies? Protect polar ice caps from ^{melting} ~~flowing~~?
Analyze quickest route to
respond that avoids danger? How different is natural selection
identify areas in need of
assistance? Camera recognition? species created? Fitness levels?
Inexpensive kits for home with
necessity supplies?
Neighborhood checklist, organization?



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Read and Understood By

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7/5/20
Date

Signed

Date

10/11/20

Objective: This document will record the details of the experimentation process of the STEM 1 project. The procedure below is my best memory of the actions that I took and what occurred each day. The purpose of these records is to serve as guidance for the potential replication of the experiment.

Sunday, December 13, 2020

Preparing the Solutions:

1. Two days after placing the seeds to incubate in the refrigerator, the solutions were prepared and the seeds were treated and then planted. I had brought all the necessary supplies, which included distilled water and zinc oxide nanoparticles, to the school. Dr. Crowthers and I were in the physics classroom, where the laboratory supplies are located. After drawing the schematic (on the previous page) on the whiteboard, we began to prepare the zinc oxide nanoparticle solutions.
2. A digital balance was utilized to measure 200 milligrams, or 0.200 grams, of zinc oxide nanoparticles in order to prepare the stock solution. The balance included sliding side covers that were closed when measuring, in order to preserve accuracy. The balance was placed inside a contained laboratory environment that had a clear barrier to protect the user from the chemicals they were handling inside.
3. I had received the nanoparticles from the shipment in a clear plastic bag. The appropriate safety measures were taken throughout the process. Gloves and goggles were worn when handling the nanoparticles.
4. Dr. Crowthers demonstrated how to properly use the balance and supplied me with a small plastic weigh boat to place the zinc oxide nanoparticles in to be measured. I prepared the balance by measuring the mass of the empty weigh boat and pressed the "tare" button to set this unladen mass to 0.0000 grams. Therefore, just the mass of the zinc oxide nanoparticles inside the weigh boat would be measured. With a plastic spoon, I scooped out small amounts of nanoparticles, measuring intermittently. I added or subtracted an estimate of nanoparticles until the weight was closest to 0.200 grams. The final reading of the balance was 0.2005 grams.
5. I added the measured nanoparticles to a small beaker with 20 milliliters of distilled water. A magnetic stirrer was placed within and the solution was mixed above a spinning magnet, on high speed for thirty minutes. By the end, the solution was white in color, as the whitish-silver zinc oxide nanoparticles had been evenly dispersed throughout. There were some bubbles at the top of the solution that were generated from the speed of the mixing process.
6. While the solution was being mixed, Dr. Crowthers instructed me on how to properly utilize a micropipette. I must carefully insert the end of the pipette into one of the sterilized tips in the boxes that he supplied me with. Then, to draw in liquid, one must press down on the button on the top, without excessive pressure, until they feel a stop. The micropipette must be handled pointing straight-down or at a slight angle, because if the tip points too far upward, then the liquid could drip into the micropipette mechanisms and damage it. Then, to expel the liquid, the button on the top of the micropipette can be pushed all the way down, past the stop, further than when taking in liquid. If the button is pushed all the way down when drawing liquid in, it may take in too much liquid, and not

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2. To measure the plants, the ruler was placed as close to the plant as possible. The end of the ruler was slightly below the surface in order to obtain the most representative measurement, as the 0.0-centimeter marking was a bit further in than the end. The height measurement was taken at the point where the topmost leaf of the plant reached.
 3. The plants were measured under a large light for accurate viewing.
 4. If the plant stem was bent or curvy, the top of the plant was extended, by my fingers, to its fullest height. The measurements were recorded as accurately as possible, to the nearest 0.1 centimeter.
 5. The measurements were recorded in a spreadsheet, according to the experimental group and the date measured.
 6. Observations about the plants were noted. If a plant's roots had broken or became unattached, it was recorded as a note or comment in that plant's spreadsheet cell. It was also recorded if a plant displayed any unique qualities, such as significant sturdiness or height, or if it was flowering.
 7. Using a micropipette, each cell was watered with their respective solutions. This was the practice even if a cell was empty or contained more than one plant; all cells received the same amount of liquid.
 8. Ten milliliters of distilled water into the 10 mg/L vial to prepare to create the zinc oxide nanoparticle solution in advance, for the next time that I watered in plants.
 9. A 100-1000 microliter size micropipette was utilized to water the plants with 0.5 milliliters each day, and then adjusted to measure ten milliliters of distilled water to prepare for the solution. A 0.5 to 10 microliter size micropipette was utilized to measure one microliter of water to add to the ten milliliters of distilled water in the vial to create the 10 mg/L zinc oxide nanoparticle solution. This procedure required replacing the micropipette tip before watering the plants with tap water, and after creating the zinc oxide nanoparticle solution but before preparing ten milliliters of distilled water in the vial for the next day's solution.
 10. Steps 2 through 7 of the procedure above were repeated exactly on most days of the experiment. They will be known as the standard procedure.

Thursday, December 24, 2020

The standard procedure was followed.

Observations:

- Some of the stems were not strong enough to support the plant, so they had fallen over into the soil. This could have caused some of the measurements to be shorter than the plant's real height.
- All plants were watered with 0.5 mL.
- By accident, watered half of ZnO throughout cells with regular tap water.
- For some of the plants, the root became unattached while it was measured.
- There was an instance of two plants growing in the same cell.

Monday, December 28, 2020

The standard procedure was followed.

Observations:

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Start with 200 mg ZnO

$$0.2 \text{ g} \left(\frac{1.5 \text{ mg}}{1 \text{ mL}} \right) (v_1) = 0.015 \text{ mg} \cdot 300 \text{ mL} \quad \frac{1.5 \text{ mg}}{\text{mL}} (v_1) = 4.5$$

$$1 \text{ g} = 1,000 \text{ mg}$$

$$\frac{1.5 \text{ mg}}{1 \text{ L}} = \frac{1.5 \text{ mg}}{1000 \text{ mL}} = \frac{0.015 \text{ mg}}{1 \text{ mL}}$$

$$v_1 = 0.3 \text{ mL}$$

0.5 : 1 0.2 : 2.5

5 : 5 0

2.5 0 mL

or each solution at least

0.5 : 1 0.2 : 1.5 0

5 : 3 0 0

1.5 0 0 mL

0.5 mL/day

Every 3-4 days

~10 times per trial

2 trials

+ initial soaking volume
in milliliters (mL)

3 0 0 seeds each trial

or with 6 groups and 25 seeds in each

* - New experimental group

Soaking

0.0 $\frac{\text{mg}}{\text{L}}$

0.5 $\frac{\text{mg}}{\text{L}}$

1.0 $\frac{\text{mg}}{\text{L}}$

* 5.0 $\frac{\text{mg}}{\text{L}}$

10.0 $\frac{\text{mg}}{\text{L}}$

* 15.0 $\frac{\text{mg}}{\text{L}}$

Watering

0.0 $\frac{\text{mg}}{\text{L}}$

* 0.5 $\frac{\text{mg}}{\text{L}}$

* 1.0 $\frac{\text{mg}}{\text{L}}$

* 5.0 $\frac{\text{mg}}{\text{L}}$

* 10.0 $\frac{\text{mg}}{\text{L}}$

* 15.0 $\frac{\text{mg}}{\text{L}}$

mL of water

Final volume is 200 mL

1/2 Add 100 to 100 → 200

1/2 Add 60 to 240 → 300

1/2 Add 150 to 150 → 300

1/3 Add 266.67 to 133

ZnO 400 mL

per seed

$$\left(\frac{0.5 \text{ mL}}{1 \text{ day}} \right) (20 \text{ days}) (20 \text{ cells}) = 200 \text{ mL}$$

$$15.0 \text{ mg/L} \quad \text{Final vol: } 15.0 \text{ mg/L} \rightarrow 600 \text{ mL}$$

0.4 L

9 mg ZnO > 15 mg/L
into 600 mL

$$\left(\frac{15.0 \text{ mg}}{\text{L}} \right) (0.6 \text{ L}) = 9 \text{ mg}$$

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3/8/21

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