

## Germination Crit. B

### Research question:

How does pH affect the germination growth of a soy?

### Objective:

The objective is to see the difference on the growth (germination) of a soy when there is a factor changed in this process (pH), by looking at the difference in mass, calculating the mass difference (%).

### Background information:

Germination is the growth of a seed after it is planted in soil and remained dormant for a certain period of time, and it develops into a new plant. For plants and fruits that reproduce through seeds and pollen, the seeds eventually grow into young plants through the process of seed germination.

When seeds are planted, they remain inactive until conditions are suitable for germination. Special proteins, enzymes, begin the process of seed growth. First, the seed grows into a root to have a water access underground. Then, shoots appear, and leaves grow. Finally, by photomorphogenesis, leaves grow towards the sun.

("What is Germination? - Definition from MaximumYield", 2019)

("What is Seed Germination? - Definition, Process, Steps & Factors - Video & Lesson Transcript | Study.com", 2019)

Some factors that may affect germination:

1. Water: Seedlings generally need to be kept moist but not wet. This water should also be chlorine- free.
2. Oxygen: Most seed will not germinate in saturated soil. The plants seeds produce need to breath just like we do, so drainage in seed trays is very important!
3. Substrate:
  - a. pH: Most plants will grow in slightly acidic soil (pH around 6), but some species (parsley, potatoes) prefer much more acidic conditions. A few species (asparagus, leeks,) prefer alkaline soils.
  - b. Compaction: Substrates that are more compact will generally keep seeds more evenly moist. Soils that are overly compacted (like soils that are driven over by a tractor) will be too compact.
4. Light: Some seeds germinate just fine in the dark while other seeds need light to break dormancy. Even though some species don't require light to germinate, all young seedlings do need light so light can't hurt in either case.
5. Nutrients and Minerals: Seeds already contain stored nutrients, so often, seeds don't usually need additional nutrients to germinate, however young plants do. Most substrate mixes are formulated to contain the necessary nutrients.

("7 Factors that Affect Seed Germination", 2019)

Acid rain is any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This could be rain, snow, fog, hail or dust that can be acidic.

In some plants, levels of pH below 5.0 can be toxic and they can affect the growth of the plant. Also, plants lose the capacity of absorbing the nutrients and the solubility of them. However, there are also some plants which grow in more acidic conditions than others.

("La importancia de la acidez del pH para tus plantas | CANNA España", 2019)

("Gardening: The pH of your soil can affect plant growth and health", 2019)

It is a result of sulfur dioxide and nitrogen oxides emitted into the atmosphere and transported by wind and air currents. Sulfur dioxide and nitrogen oxides react with water, oxygen and other chemicals, therefore, forming sulfuric and nitric acid. This are mixed with water and other materials before falling to the ground.

("What is Acid Rain? | US EPA", 2019)

The pH tells us the acidity or alkalinity of a solution (value 7 is neutral). It measures the hydrogen ion concentration of the solution. The meaning of its acronym is, hydrogen ion potential (p → potential + H → hydrogen = pH). If the solution has a high concentration of hydrogen ions, it has a low pH (lower than 7), but if the solution has a low concentration of hydrogen ions, it has a high pH (more than 7).

(library, projects & Activity, 2018)

### Hypothesis:

We think that when the soil or water is higher, the plant will grow less, because as we could read in the background information, when the levels of pH were under 5.0, it could be toxic, therefore the plant can die, and it would not grow much because as we can see at the background information, it loses the capacity of absorbing nutrients. If the levels are between 5.5 and 7.0 it will provide optimum conditions and the plant will grow more, because it has the good amount of minerals and water so the plant can grow in great conditions.

That is why if the levels of pH are less than 5, the plant would grow very little, because it will die because of the toxic acidic water used to water it. Between 5 and 7 (pH levels), the plant will go more, because these are optimum conditions.

### Variables:

INDEPENDENT VARIABLE → Levels of pH in the water (measured used by a pH meter).

DEPENDENT VARIABLE → The mass of the plant after a week of growth (g) (using an electric scale).

CONTROLLED VARIABLE → Nutrients (amount of soil), light, oxygen (keeping the plant in the same place) and water (measuring cylinder), because they are factors which can affect the growth of the plant.

Materials:

- 5 petri dishes
- pH meter
- HCl and NaOH
- Beaker (50 mL)
- Electric scale
- Weighing boat
- Thermometer
- Measuring cylinder (10 mL and 25 mL)
- 2 pipettes
- Water
- Cotton
- Soy seeds
- Permanent marker

Method:

1. First, make water solutions with pH 3, 4, 5, 6, and 7 using HCl to make it go down or NaOH to make the pH higher, using pipettes. We will use 25 mL of water measuring it in the measuring cylinder of 25 mL.
2. Then, pour each solution in a different beaker and with a thermometer measure the temperature to keep it controlled and equal to the rest of solutions.
3. Later, using a permanent marker, write in each petri dish the pH level of the water that we will use to water the plants that will grow in that petri dish.
4. Now, using the electric scale measure one by one the seeds and note the results in a table.
5. Put some cotton and 5 seeds in each petri dish
6. Next, water each petri dish with its corresponding solution. Use 10 mL measured in the measuring cylinder.
7. Water the plants every 3 days.
8. When one week has passed, measure again the weight of each seed and calculate the mass percent gained or lost.

## Germination Crit. C

**TABLE:**

Table showing the increase and decrease of the germination of a soy seed, during a week, watering the plant with water with different pH levels.

	T1			T2			T3		
pH	Initial Mass	Final Mass	Mass %	Initial Mass	Final Mass	Mass %	Initial Mass	Final Mass	Mass %
3	0,06	0,21	250	0,07	0,17	143	0,07	0,22	214
4	0,08	0,38	375	0,07	0,29	314	0,06	0,28	367
5	0,06	0,39	550	0,06	0,14	133	0,07	0,40	471
6	0,06	0,50	733	0,06	0,46	667	0,07	0,41	486
7	0,06	0,41	583	0,07	0,43	514	0,06	0,35	483

T4			T5			AVERAGE	SD
Initial Mass	Final Mass	Mass %	Initial Mass	Final Mass	Mass %		
0,07	0,13	86	0,08	0,21	163	171	57
0,07	0,31	343	0,08	0,26	225	325	54
0,08	0,48	500	0,08	0,46	475	426	149
0,06	0,41	583	0,07	0,35	400	574	120
0,07	0,39	457	0,07	0,37	429	493	53

**GRAPH:**



## CONCLUSION:

At the end of the experiment, we can see that the mass difference of the soy seed increased when the pH levels were increased, except for pH level 7, because it decreased (not much, because it is the second pH level in which the seeds increased more). This means that when the levels of pH are between 5, 6 and 7, the germination of the seed is better, because of the optimum conditions that the pH level provides to the plant to absorb the nutrients better (in this case, just water), but as we explained in our hypothesis, if the levels of pH are under 5, it can be toxic or plants lose capacity of absorbing nutrients, therefore, the plant will grow less.

("What is Germination? - Definition from MaximumYield", 2019) ; ("What is Seed Germination? - Definition, Process, Steps & Factors - Video & Lesson Transcript | Study.com", 2019)

My hypothesis was right, because I explained that the plant will grow more when the levels of pH were in the range of 5.5, 6 and 7. At the end we saw that as the pH was 5 and not 5.5, it made a difference and that seeds which germinated more were the ones of 6 pH. The reason of this is what I just explained before. The seed has the ability of absorbing more nutrients at an optimum pH level, which is more than 5.5, because if not, the plant will lose that ability of absorbing and it will grow less.

("La importancia de la acidez del pH para tus plantas | CANNA España", 2019) ; ("Gardening: The pH of your soil can affect plant growth and health", 2019)

This is why the graph shows an increasing pattern (except for pH 7, because pH 6 higher). As you can see, we have:  $171 < 325 < 426 < 574 > 493$ .

The trend of the graph is not very strong, because not all the results are very accurate, because as you can see in the SD, the numbers are high, so there are some errors in the method which I will explain in the evaluation. It follows a directly proportional on the first 6 pH levels, because when we increase the pH, the germination (mass difference %) also increased. But in the pH 7, it decreased, so I think that if we had continued with more pH levels, the graph would continue decreasing, because of the pattern it followed.

As I said before, the numbers of the SD are high and the errors bars also, so there have been some errors which affected the accuracy and precision of the results. I will explain them in the evaluation.

## EVALUATION:

As I have said before, there are some errors that we could have made in the method that could have made less accurate our results, and that's why the error bars and the SD numbers are so high:

- When we needed to water all the seeds, not all the seeds would have received the same amount of water, which could have made them grow more or less than others, and that changes the average and the deviation error increases.

For the next time, I would try to divide the petri dishes in a different way and water with the same amount of water, each seed (for example, 5 mL for seed 1, 5 mL for seed 2, another 5 mL for seed 3...), so they receive the same amount of water.

- Also, another error could have been that the petri dishes were placed one on top of the other, so the first receives more light than the second and possibly, more carbon dioxide to carry out its processes to grow and the other do not receive it in equal amounts, so it could have made some changes in the results.

For the next time, I would place the petri dishes in the same place (but not on top of each other), near to a window to receive light and the same amount of carbon dioxide to grow better.

- Finally, more trials could have been done, because each seed is different to every other seed, and they all grow in a different way (talking about genetics), so, with more trials, the results (of the average) would be a bit more accurate and precise.

For the next time, I would carry out more trials to have more accurate results, because little details can make a difference in the results and that's why they need to be improved for the next time.

### References:

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