



# The pH of Water's Effect on the Germination of Seeds

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### Abstract

This research project investigated how the change in pH of water affects the germination of rapid radish seeds. Seed germination is a critical stage in plant growth and development. The research question guiding this study was: How does the change in pH of water affect the germination rate of rapid radish seeds?

To test this, rapid radish seeds were placed in petri dishes and watered with solutions at pH levels of 3, 5, 7, 9, and 11. Each group contained 17 seeds and was kept under constant light. Seeds were sprayed three times per day for seven days, and the number of seeds that germinated was recorded daily.

The results showed that seeds watered with pH 5 and pH 7 had the highest germination rates, while seeds exposed to very acidic (pH 3) and very basic (pH 11) conditions had much lower germination.

In conclusion, the results demonstrate that water pH has a significant effect on seed germination, with moderate pH levels around a pH of 6 being the most favorable. These findings highlight the importance of water quality in plant growth and agriculture.

### Research Question

How important is pH of water when it comes to germination?

#### The importance

- Seeds are the starting point for all plant life
- Without successful germination, then there are no plants
- Without plants humans don't have food and oxygen

#### Global Environment Problem

- Acid rain caused by pollution can dramatically change the trajectory of the germination of seeds
- Acid rain is extremely acidic fully changing the pH

### Introduction

This research started with the question: does the pH of water really matter when you're trying to sprout seeds? Germination is the first big step in a plant's life, and if a seed cannot get past this stage, there's no food, no oxygen, and no habitats for the rest of us. When growing seeds you must keep them damp and water them in order for them to grow. But, the pH of water isn't always the same, it can change because of minerals, acid rain, pollution, or even things we add to ourselves. That's why understanding how water pH affects seeds isn't just a project question, it matters for anyone who grows plants.

Germination starts off after a seed soaks up water. That water makes the special enzymes inside the seed start breaking down stored food so the seed can sprout roots and shoots. But, if the pH is even a little bit off then the enzymes will not work to their full. If the water is too acidic or too basic, the enzymes slow down or stop, making it harder for seeds to sprout. For example, a study on *Chenopodium album* seeds found that extreme pH levels (either very high or very low) in the water led to fewer seeds sprouting than when the water was neutral. Water pH also changes what dissolves around the seed. Depending on the pH, some nutrients might become unavailable, or harmful substances could show up. If a seed does manage to sprout in the wrong pH, it might be weaker because it didn't get the right nutrients. The University of Minnesota Extension points out that pH affects which nutrients are available to plants, so the water's pH during germination can have a big impact from day one.

Overall, background research shows that water pH may affect seed germination by changing enzyme activity inside the seed and by influencing how nutrients and minerals affect the seeds growth. Because plants are essential for food production, environmental health, and human survival, understanding how water pH affects seed germination is important in a larger scientific context. This makes the research question meaningful and worth investigating in a controlled experiment.



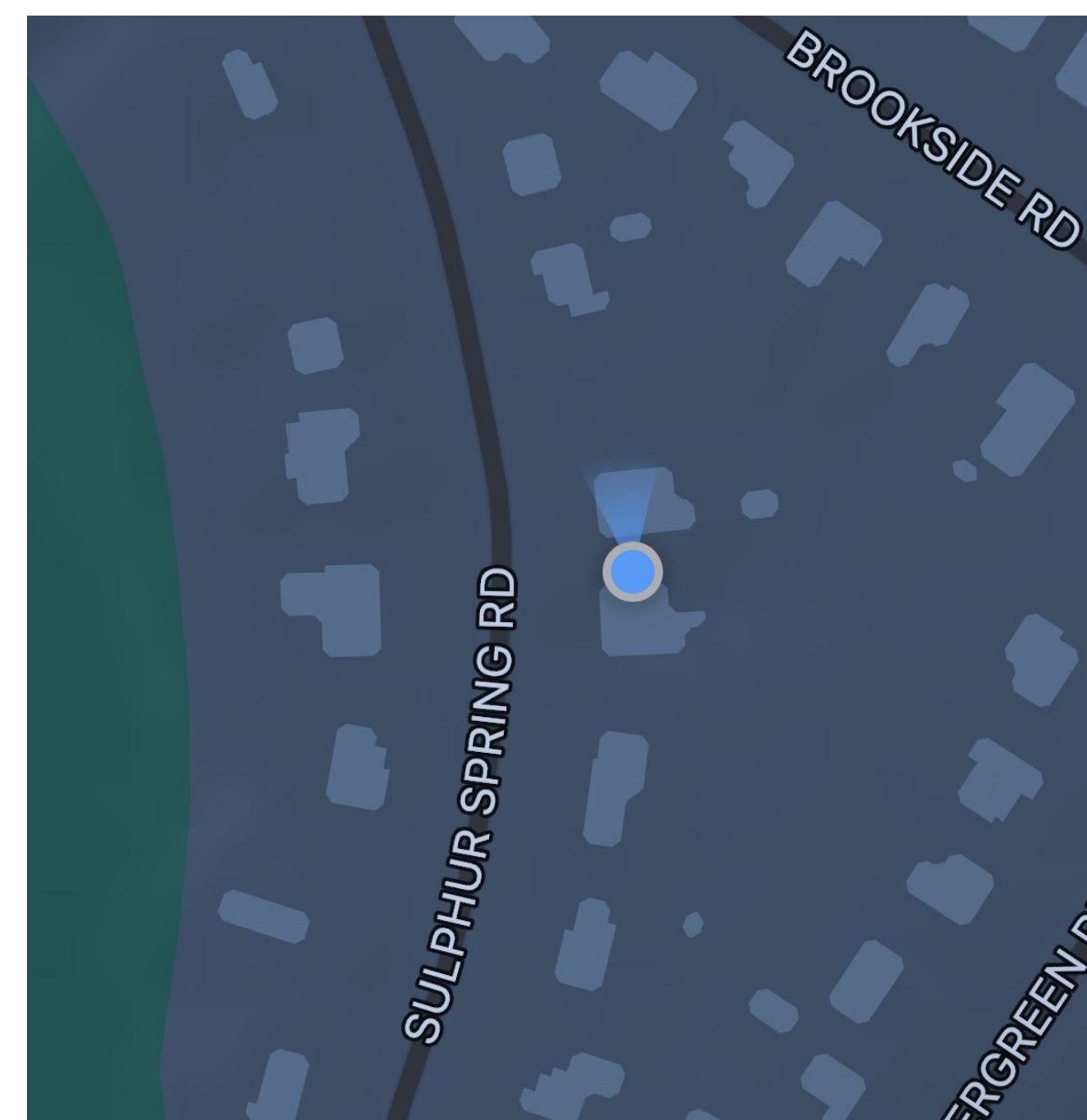
### Research Methods

#### Planning Investigations

- We planned to observe any changes with our eyes
- We decided to keep a constant of checking the seeds and watering two times a day at the same times
- The location was kept constant in a basement with the constant light source
- We followed the globe pH protocol to make sure that our steps were scientifically accurate when coming to pH
- We also looked at NASA's earth, sciences, resources that taught us about water, pH and quality
- To get ready for experiment, we started by mixing our variables into the water to actively change the pH
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#### Carrying Out Investigations

When carrying out our investigation, we made sure to keep everything very constant and equal for each seed, working in the same place with the same initial liquids helped to make sure everything remained the same. We used equal sprays distributing the water to each seed every single day twice for a week. We use the globe pH protocol and biosphere to compare our different pH liquids to seed germination.



### GLOBE Badges

#### I am a Problem Solver

While working on environmental investigations, researchers may learn how they can be a part of possible solutions to the problems they are investigating. This badge will be awarded to projects that demonstrate how GLOBE researchers are using Earth system science for a better world.

#### Make an Impact

The report clearly describes how a local issue led to the research questions or makes connections between local and global impacts. The students need to clearly describe or show how the research contributed to a positive impact on their community through making recommendations or taking action based on findings.

#### Be a STEM Professional

The report clearly describes collaboration with a STEM professional that enhanced the research methods, contributed to improved precision, and supported more sophisticated analyses and interpretations of results.

### Results

#### Analyzing Data

How does the pH of water affect the germination rate of rapid radish seeds?

Procedure for the data analysis included

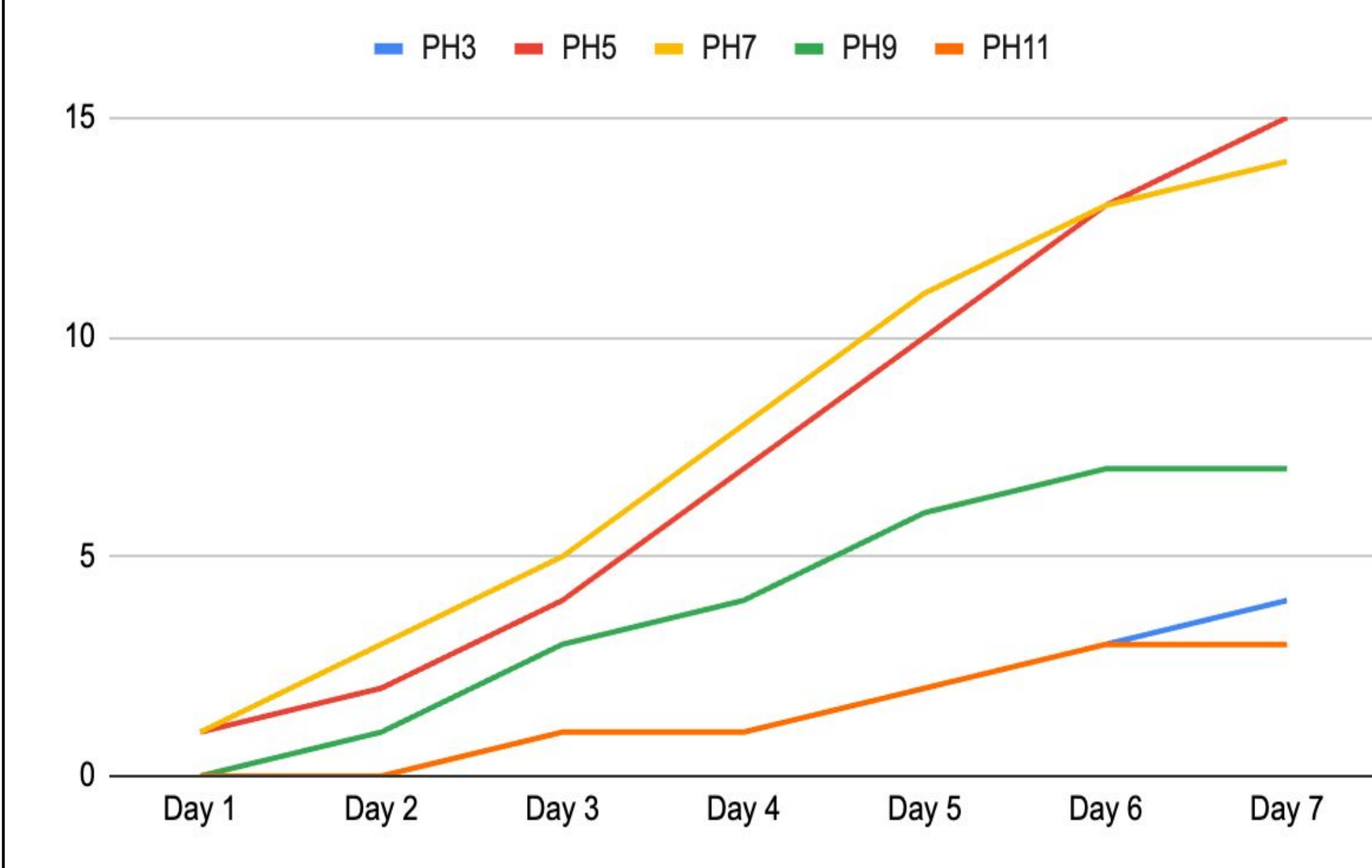
- Visiting the seeds 2 times every day at the same time
- Spraying each seed pallet with its designated spray bottle
- 3 even sprays for each seed pallet from the a constant distant
- Noted seed growth and any changes in the seeds

Data analysis

The data resulted from this experiment show that water pH clearly affected the germination of rapid radish seeds. Seeds watered with pH 5 and pH 7 had the highest germination over the seven days, while seeds watered with very acidic (pH 3) and very basic (pH 11) water had much lower germination.

How does different Ph of water affect the germination of seeds?	PH3	PH5	PH7	PH9	PH11	
Day 1		0	1	1	0	0
Day 2		0	2	3	1	0
Day 3		1	4	5	3	1
Day 4		1	7	8	4	1
Day 5		2	10	11	6	2
Day 6		3	13	13	7	3
Day 7		4	15	14	7	3

#### How does different pH of water affect the germination of seeds?



### Discussion

The data resulted from this experiment show that water pH clearly affected the germination of rapid radish seeds. Seeds watered with pH 5 and pH 7 had the highest germination over the seven days, while seeds watered with very acidic (pH 3) and very basic (pH 11) water had much lower germination. Seeds grown at pH 9 did germinate, but not as successfully as those closer to neutral pH. Overall, the results suggest that extreme pH conditions make it more difficult for seeds to germinate, while moderate pH levels are more favorable.

Our hypothesis predicted that seeds watered with a pH of neutral to acidic levels would germinate better than seeds exposed to very acidic or very basic water. The results supported this hypothesis because the highest number of seeds germinated at pH 5 and pH 7. The lowest germination occurred at pH 3 and pH 11 since the levels were too high for seed growth. This outcome was expected based on what is already known about how plants grow and how sensitive seeds are to environmental conditions.

There is a scientific explanation for why these results occurred. Germination relies on enzymes inside the seed that break down stored food to provide energy for the growing seedling. These enzymes work best within a certain pH range, usually close to neutral. When the water pH is too acidic or too basic, enzyme activity can be disrupted, which slows down or stops germination. Other studies have found similar results, showing that seeds tend to germinate best at neutral or slightly acidic pH levels and poorly at extreme pH values.

Even though the experiment produced clear results, there were possible sources of error. The pH of the water may have changed slightly over time, especially since baking soda was used to make the water more basic. In addition, spraying the seeds by hand may have caused small differences in how much water each petri dish received. To improve the experiment, a pH meter could be used daily, fresh pH solutions could have been prepared, and a better measured dropper could be used instead of spray bottles to control water amounts more accurately.

Overall, the experiment tested the hypothesis well because water pH was the only variable that was changed, while factors such as seed type, light exposure, number of sprays, and containers were kept the same. Repeating the experiment or testing additional pH levels would help make the results more reliable and strengthen the conclusions.

### Conclusions

- This experiment showed that water pH affects the germination of rapid radish seeds.
- The hypothesis was supported because seeds exposed to pH 5 and pH 7 had the highest germination rates.
- Seeds exposed to more acidic and basic pH levels had lower germination rates.
- These results provide clear evidence that the pH of water plays an important role and affects seed germination growth.
- One success of this experiment was keeping conditions constant across all trials and test groups.
- If the experiment were repeated, the number of trials could be increased to improve accuracy.
- The experiment could also be extended over a longer period of time to observe continued growth.
- This research is important because seed germination is the foundation of agriculture and food production.
- Understanding how water pH affects germination can help farmers, scientists or gardeners to improve crop production.
- These findings contribute to a better understanding of plant growth and environmental science which can support future research projects.

### Bibliography

#### References

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