

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

Kendell Skiver and Maeve Mackey

10th Grade

Ottawa Hills High School

United States of America

Gloria Kreischer Gajewicz

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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.

## **Introduction**

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

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.

## **Methods and Materials**

Hypothesis: If rapid radish seeds are watered with solutions of different pH levels, then the seeds watered in the neutral to slightly acidic range will have the most efficient germination because when the levels are too acidic or too basic the seeds growth is stunted.

Independent Variable:

pH of the water (adjusted by adding baking soda, and lemon juice)

Dependent Variable:

Seed germination (measured by how many seeds germinated and how quickly they germinated)

Controlled Variables:

- Type of seed
- Number of seeds in each dish
- Amount of water applied (number of sprays)
- Light exposure
- Type of container (petri dishes)
- Frequency of watering

Materials

- Seeds (same type for all trials)
- Petri dishes
- Distilled water
- Baking soda

- Lemon juice
- Spray bottle
- pH test strips
- Permanent marker

## **Procedure**

Label each petri dish with its assigned pH level. Prepare water solutions by adding baking soda and lemon juice to distilled water to create basic and acidic pH levels. Use pH test strips to test the pH of each solution and record. Put equal seeds in each petri dish and spray each petri dish three times a day, using the correct pH solution. Keep all petri dishes under a constant light source throughout the experiment. Observe the seeds daily and record whether germination has occurred. Continue the experiment until all seeds have germinated or after a week. Record all observations and germination data in a data table. Once rapid, radish seeds are placed in petri dishes and watered with solutions at pH levels of 3, 5, 7, 9, and 11 with each group containing 17 seeds, and is kept under constant light. Spray all seeds three times per day for seven days, and the number of seeds that germinated was recorded daily. Be sure to wash hands carefully and not spray any solutions near the face.

## Data and Results

Data Table

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



The optimal range is in between pH of 5 and pH of 7 as they prove to be the best for germination. If you were to plot this out on a graph it would show a bell curve to show how the more extreme pH's affect the germination more dramatically. pH of 5 performed better than the

pH of 7 despite the quick start from pH of 7. The more extreme Ph groups showed a very delayed start and didn't continue to grow very well.

### **Analysis and research**

These results suggest that water pH affects the germination of rapid radish seeds. Seeds at pH 9 showed some growth but did not germinate as well as those closer to neutral. The germination percent was calculated by dividing the number of germinated seeds by 17 and multiplying by 100 to compare results across pH levels.

Our hypothesis was that seeds watered with neutral or slightly acidic water would germinate better than seeds watered with very acidic or very basic water. The results supported this hypothesis because the highest germination occurred at pH 5 and pH 7, while extreme pH levels resulted in poor germination.

These results occurred because seed germination depends on enzymes that need optimal pH levels to function. When pH is too acidic or too basic, enzyme activity slows down, making it harder or impossible for seeds to grow. That relates to other studies, with seeds germinating best at neutral or slightly acidic pH levels.

Uncertainty in our research may have occurred because the pH of the water could have changed over time in between days. Also, spraying by hand may not have given equal amounts of water. Improvements could include checking pH daily, using fresh solutions, and measuring water more carefully. Overall, the experiment successfully tested the hypothesis and showed that water pH affects seed germination.

## **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**

In conclusion, this experiment shows the effect that water has on the germination of rapid radish seeds. The hypothesis was supported because the seeds exposed to the pH levels of 5 and 7 showed the highest germination rates, while the seeds exposed to more extreme pH levels showed a lower rate of germination. These results show very clear evidence that the Ph of water has a big effect on the germination and growth of seeds.

One thing that went well during this experiment was maintaining the same conditions across all test groups. One thing we would change if we did this again would be to increase the number of trials or to extend the experiment to a longer amount of days in order to continue to observe. For a future project we could find how the pH of water would affect how tall a plant grows or how a fruit plant is affected.

This research is important because seed germination is the start of all of food and farming. Understanding how water pH affects germination can help scientists, farmers, and gardeners improve their growing conditions of their crops in order to increase production. These results

help to a better understanding of plant growth and how it can be used for other science projects involving the environment.

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