Vinegar: What Concentration Best Impacts Plant Growth

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Abstract

The purpose of this experiment was to determine how different concentrations of vinegar affect the growth of radish plants. The research question was: *How does different concentrations of vinegar affect the growth of radish plants?* The hypothesis stated that as vinegar concentration increases, radish plant height will decrease.

Four radish seeds were planted in each pot, and five vinegar solutions were prepared using distilled water and 5% acetic acid vinegar. The plants were watered every two days and measured every four days for twenty days. Final heights were recorded at the end of the experiment.

The results showed 0 growth even among very low 1% acetic acid mixtures, demonstrating the high potency of vinegar. Vinegar prevented seed growth due to dehydration of plant cells caused by acetic acid. These findings show that vinegar can be used as a makeshift weed-killer to decrease sprouting and unwanted seed growth.

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Question and Variables

Research Question:
How does different concentrations of vinegar affect the growth of radish plants?

Hypothesis:
As vinegar concentration increases, radish plant height will decrease.

Independent Variable:
Vinegar concentration

Dependent Variables:
Seed species, water amount, light exposure, pot brand and type

Control:
One group of plants was watered without vinegar.

Background Research

Vinegar is an acidic liquid produced through a two-step fermentation process where yeast converts sugars to alcohol, and bacteria (Acetobacter) convert that alcohol into acetic acid and water. It can be found in most households as it is a commonly used cleaning supply. Vinegar is found in different concentrations and strengths of the acid to get different results. Acetic acid causes intense dehydration of plant cells, which can damage or kill plant tissue.

Radish seeds (*Raphanus sativus*) are among the fastest-growing garden seeds, sprouting in 3–4 days and maturing in 25–30 days, making them ideal for quick harvests. They require direct sowing, full sun, and cool temperatures. Because they grow quickly, they are useful for observing plant growth changes in a short experiment period.

Vinegar is often suggested as a household weed killer because of the damaging effects of acetic acid on plant cells. This experiment tests how different concentrations affect early plant development.

Materials List

- Radish Seeds (plants used for testing)
- 10 Small Plastic Pots (3x3 inches)
- Potting Soil (same type used for all plants)
- Distilled Water (used for diluted vinegar solutions and control group)
- Vinegar (5% Acetic Solution)
- Measuring Tools (to measure plant height)
- Marker (to label pots)
- Sunlight (natural light source)
- Notebook (to record data)
- Tray (to place pots on)
- Sanitization material (to prevent germ spread)

Experimental Procedure

1. All materials were gathered and made readily available, and the space for the experiment was cleared.
2. Each pot was labeled with the assigned vinegar dilution, and two pots were designated for each dilution group.
3. Each 3x3 inch pot was filled to the top with soil.
4. Four radish seeds were planted in the center of each pot.
5. The pots were placed on a tray and located in an area that received natural sunlight.
6. Five vinegar solutions were prepared using distilled water and 5% acetic acid vinegar:
    - (1) 100 mL water / 0 mL vinegar (control)
    - (2) 80 mL water / 20 mL vinegar
    - (3) 60 mL water / 40 mL vinegar
    - (4) 40 mL water / 60 mL vinegar
    - (5) 20 mL water / 80 mL vinegar
7. Each solution was mixed thoroughly.
8. Each pot was watered with 40 mL of its designated solution every two days.
9. The height of each plant was measured every four days and recorded on a data table that remained unchanged throughout the experiment.
10. Final heights were recorded after twenty days.
11. The experiment area was cleared, and all materials were disposed of properly.

Data Analysis and Discussion

The data showed a lack of growth across vinegar-treated groups. Even very low concentrations of vinegar resulted in no plant growth.

Observation:

- 0 growth even among very low 1% acetic acid mixtures.
- Sprouts stopped growing and were unable to develop properly.

The lack of growth shows that vinegar is extremely potent. I underestimated the potency of acetic acid and didn't realize that even low concentrations of vinegar (<1%) can cause no growth in seedlings.

An unpredicted factor was the need to move seedlings out of the pot container without damaging roots in order to get the best growth results.

These results suggest that vinegar severely impacts early sprouting stages of radish plants.

Conclusion

Claim:
Vinegar was very potent still made of acetic acid regardless of the dilution. These results show that vinegar can be used as a makeshift weed-killer that you can just water over soil to decrease sprouting and unwanted seed growth.

Evidence:
0 growth even among very low 1% acetic acid mixtures shows a huge potency and effect proving that vinegar is very strong.

Reasoning:
Vinegar was able to prevent any seed growth due to a weak root base from unmature seeds and the rapid dehydration caused by acetic acid, which destroys seed cell membranes. The intense dehydration of the cells prevents proper development and growth.

Ideas for Future Research

- Test even lower concentrations of vinegar (below 1%)
- Compare vinegar to commercial weed killers

- Test vinegar on more mature plants instead of seedlings
- Increase the sample size for more accurate data

Future research could explore how acetic acid affects different types of plants and whether soil composition changes the results.

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