# Hypothesis

If the acid concentration (vinegar) in a solution used to water plants is increased then the number of radish seeds that germinate and the growth, exhibited by the mass and length of the radish seedlings, will decrease.

Acids, such as vinegar, break down the cell tissue of plants, such as radishes. Therefore, increasing the acidity of the solution the radish is grown in will decrease the ability of the radish seeds to germinate.

Predictions

If the acid concentration (vinegar) in the solution increases then fewer radish seeds will germinate, and growth will decrease compared to radish seeds in solutions with lower acidity. If the control group with 0% acidity will have the greatest number of radish seeds germinate (maximum of 10) then that number should steadily decrease as the acid concentration increases from 0% to 0.1% to 1.0% to 10.0% acidity.

Results

The number of seeds germinated stayed steady over the course of the week. There was some error in counting due to condensation build up on the interior of the Petri dishes. This can be seen on day 2 of the 0.1% acid sample and days 3 and 4 of the 1.0% acid sample. On the first day of growth, 8 out of the 10 seeds in the control group sprouted and 7 out of the 10 seeds in the 0.1% acid solution sprouted. No more seeds sprouted in either of these groups throughout the remainder of the growing period. None of the seeds in the 10.0% acid solution ever sprouted during the growing period (Figure 1). The average mass of the seeds increased from day 0 to day 7 in all samples. There is no large difference between any adjacent average masses but there is a large difference between 0% acidity and 10.0% acidity. None of the sample averages weighed more than 1 gram (Figure 2). The average length increased from day 0 to day 7 in all samples that had seeds germinate samples. There was no growth in the 10.0% acidity sample so there was no change in average length. All samples were within the 20-120mm range (Figure 3).

Figures

**Figure 1. Radish seed germination in vinegar solutions over a week.** 10 seeds were planted in each sample. The control group with 0% acidity had the highest number of seeds germinate with 8 seeds. None of the seeds planted in the 10.0% acidity solution germinated.

**Figure 2. Average mass of radish seeds in acid solution.** Except for the 10.0% acid sample, all samples had growth throughout the week. There is large a difference between the mass of the control group and the mass of the seeds grown in 10.0% acid. There is very little difference between the control group and the 0.10% sample. None of the samples reached an average mass of over 1 gram.

**Figure 3. Average length from shoot to root of radish seeds in acidic solutions**. There is a large difference between the control group (0% acidity) and all other samples but there is very little difference between any of the other samples. 0% and 0.1% acidity had growth during the week while 1.0% and 10.0% did not. The 0% had the most growth with an average of approximately 110mm by day 7.

Conclusion

The data from this experiment supports the original hypothesis. Growing radish seeds in an acidic solution impedes the growth of the radishes. Higher levels of acidic decreases chances of seed germination and reduces plant growth. At some point a solution with an acidity between 1.0% and 10.0% completely kills the radish seeds. This supports the prediction that the acid will negatively impact the germination and growth of the radish seedlings. This agrees with other pH level experiments. While there were slight variations, generally the control had the most growth and 10.0% acidity has the least for all criteria. There was error and difference of opinion in the number of 1.0% seeds that germinated due to condensation on the petri dish. This data is observational data, so it is subject to human error.

In the event the experiment is reperformed, there are many factors that could be adjusted to improve the accuracy of the experiment. Vinegar is already a watered-down version of acetic acid, only around 4-6% of vinegar is acetic acid, so using much smaller percentages of pure acetic acid would make it easier to control the exact amount of acid in the solutions. It would also be interesting to try the experiment with other acids that naturally occur in soil such as oxalic or malic acid. It would also be good to have better control of controlled factors such as amount of light and temperature and have a longer growing period.