

The Effect of Simulated Microgravity on Potato Sprout Development and Gravitropism: An Open-Source Collaborative Study

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February 8, 2025

Abstract

This document provides an open-source experimental protocol for investigating the impact of simulated microgravity on potato sprout development and gravitropism using a clinostat. The goal is to explore how gravitational forces influence plant development, with potential implications for space-based agriculture. Researchers, educators, and citizen scientists are encouraged to replicate the experiment, contribute data, and collaborate on analysis and interpretation.

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1 Introduction

Gravitropism, the directional growth of plants in response to gravity, is a fundamental biological process. Potatoes, like other plants, exhibit positive gravitropism in their roots (growing downwards) and negative gravitropism in their shoots (growing upwards). This experiment explores how simulated microgravity, achieved using a clinostat, affects potato sprout development and gravitropism.

A clinostat is a device that slowly rotates a sample, effectively averaging out the gravitational vector over time. By removing a consistent downward pull, this method simulates a microgravity environment, offering insight into how plants might develop in space. Understanding these mechanisms is crucial for advancing space agriculture and supporting future long-term space missions.

This protocol is released under an open-source license to encourage community participation and data sharing.

2 Experiment Protocol

2.1 Objective

To investigate the effect of simulated microgravity on potato sprout growth, orientation, and overall development.

2.2 Background Information

Plants sense gravity through specialized cells called statocytes, which contain starch-filled organelles called amyloplasts. The sedimentation of amyloplasts triggers the gravitropic response. In microgravity, the absence of a consistent gravitational force disrupts this mechanism. Clinostats simulate microgravity by continuously rotating the sample, preventing amyloplasts from settling in a fixed direction.

2.3 Hypothesis

Potato sprouts grown under simulated microgravity on a clinostat will exhibit:

1. Reduced gravitropic curvature compared to control sprouts grown under normal gravity.

2. Altered growth orientation, with sprouts growing in various directions rather than strictly upwards.
3. Potentially different growth rates or morphological adaptations compared to controls.

2.4 Materials

- 10 small, sprouting potatoes of uniform size and development.
- 5 plant growth containers suitable for both vertical and horizontal mounting.
- Clinostat (capable of rotating at a controlled speed, e.g., 1 rotation per minute).
- Growth medium (e.g., agar or potting soil).
- Distilled water.
- Ruler (cm).
- Camera for time-lapse photography (optional).
- Image analysis software (optional).

2.5 Procedure

1. Prepare the growth containers with the selected growth medium.
2. Select 5 potatoes and mount them vertically in control containers.
3. Select the remaining 5 potatoes and mount them horizontally in clinostat-designated containers.
4. Place the horizontally mounted containers on the clinostat and start rotation (record time).
5. Maintain the control containers in an identical environment (temperature, light) without rotation.
6. Water all containers equally and regularly, recording the schedule and quantity.
7. Observe and record sprout growth (length, orientation, curvature) every 2 days for 10 days.

2.6 Data Collection and Results

Table 1: Potato Sprout Growth and Orientation

Days	Condition	Sprout Length (cm)	Angle of Growth (degrees)	Curvature (cm ⁻¹)	Com
2	Control				
2	Clinostat				
4	Control				
4	Clinostat				
6	Control				
6	Clinostat				
8	Control				
8	Clinostat				
10	Control				
10	Clinostat				

2.7 Data Analysis and Interpretation

Participants are encouraged to analyze their collected data by:

- Calculating the average growth rate per condition.
- Performing statistical tests (e.g., t-test) to compare control and clinostat-treated samples.
- Using image analysis software to quantify curvature and growth angles.

Sample Calculation for Growth Rate:

$$\text{Growth Rate} = \frac{\text{Final Length} - \text{Initial Length}}{\text{Number of Days}} \tag{1}$$

2.8 Conclusion

Based on the analysis, determine whether the data support the hypothesis. Discuss implications for gravity’s role in plant development, space agriculture, and adaptation mechanisms.

2.9 Potential Sources of Error

- Variations in potato size and initial sprout development.

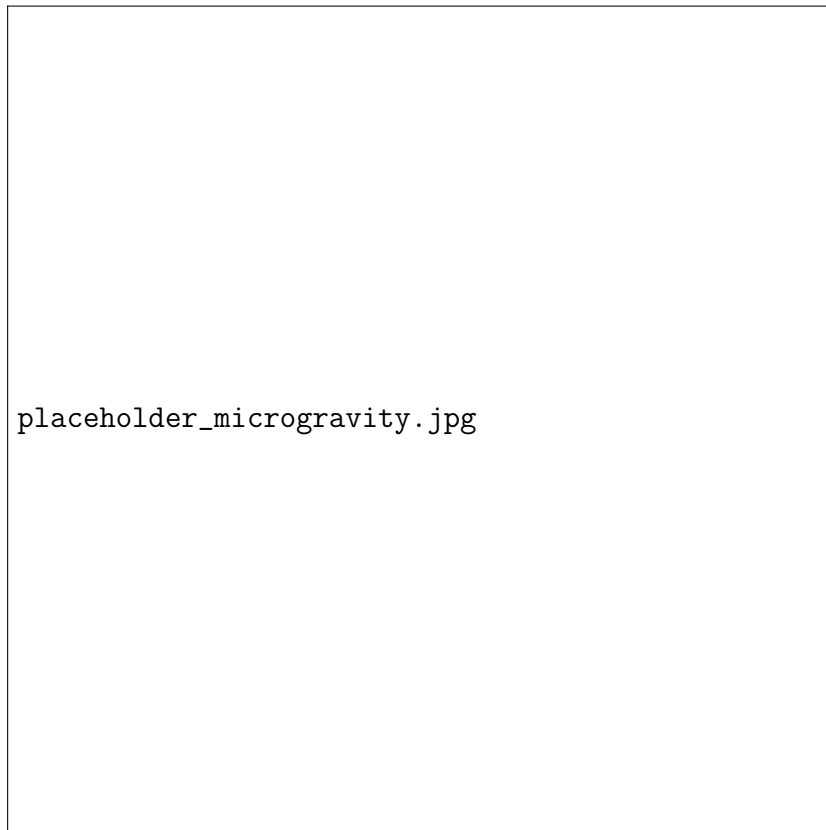


Figure 1: Potato Sprouts Grown under Normal Gravity (left) and Simulated Microgravity (right).

- Environmental inconsistencies (e.g., temperature, light intensity).
- Measurement inaccuracies.
- Limitations of the clinostat in perfectly simulating microgravity.

2.10 Figures/Images

- Photos of the experimental setup (including clinostat).
- Photos of the potato sprouts at different time points.
- Graphs of sprout length vs. time for each condition.
- Graphs of growth angle vs. time for each condition.
- Graphs of curvature vs. time for each condition.

3 Open Science and Collaboration

This protocol is released under a **Creative Commons Attribution 4.0 International License**. Researchers, educators, and citizen scientists are encouraged to replicate the experiment and contribute data.

How to Contribute:

- Submit your data via email or through the project website: www.marielandryceo.com.
- Join the collaborative research group on GitHub (if applicable).
- Share experimental images and findings via a shared repository.

All contributors will be acknowledged in future publications.