The Combined Effects of Varying Gravity Levels and Light Exposures on Garden Cress Development Using a Low-Cost 3D Printed Clinostat

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Advancing manned space exploration and habitation may require rethinking the fundamental expectations of plant growth. Plants orient themselves through gravitropism and phototropism; or using gravity and light. This study examined how altering these stimuli affects garden cress development and yield. Gravity levels were altered by fabricating multiple versions of a novel low cost 1D clinostat ($24 versus $150+ off-the-shelf); requiring only 3D printed and easily purchased parts. Plants experienced either a dark or light environment – each with an Earth, Martian, microgravity, and control group. After harvesting, growth orientation, biomass, and proportion of germination and sprouting were compared. The study hypothesis that plants with less stimuli would have a smaller proportion of sprouting due to disorientation was generally supported. Notably in the dark, under microgravity, some plants grew upside down – sprouting roots rather than shoots. In conclusion, without the stimuli necessary for gravitropism and phototropism plant development was significantly hampered. ANOVA tests confirmed that both light and gravity had a statistically significant effect on biomass production and that the stimuli effects interact. T-tests established that the control produced a larger biomass than the microgravity and Mars groups and that the Mars group's biomass exceeded the microgravity group's only in the light environment. NASA's Artemis program aims to better understand how to live on other celestial bodies before pursuing a mission to Mars. Astrobotany will be integral to such manned space exploration. This study hopes to bolster the understanding of plant development and yield in partial and microgravity conditions.