<u>Abstract</u>

Methylcobalamin (MeCbl), the natural form of vitamin B12, has been shown to act as an antioxidant that scavenges reactive oxygen species (ROS). I hypothesized that under heat stress, which creates a buildup of ROS, Vigna radiata seeds primed with MeCbl would germinate faster than seeds primed with only water due to the neutralization of ROS. 6 groups of 20 seeds were primed for 8 hours in 0%, 3%, and 8% MeCbl solutions diluted with reverse osmosis water (RO water). The groups were exposed to either 80°F or 98°F temperatures, and shoot, root, and total lengths were measured daily for 7 days. My hypothesis was supported because among the groups under heat stress, those primed in MeCbl solutions had higher germination rates and measurements than those primed in only RO water, consistent with a model in which MeCbl priming reduces the imbalance between ROS production and neutralization.

Experimental Design

Variables:

- Independent: temperature, MeCbl concentration
- Dependent: seed germination
- Control: seed weight/size, light amount, water amount, priming time

Groups:

- Control: Groups 1, 4
- Experimental: Groups 2, 3, 5, 6

MeCbl	80°F	98°F	
0%	Group 1	Group 4	
3%	Group 2	Group 5	
8%	Group 3	Group 6	

Background Information



Vigna radiata

- Vigna radiata seeds (mung beans) germinate best in the dark.
- 80-86°F is the ideal temperature range for Vigna radiata growth.

ROS

- **Reactive oxygen species (ROS)** is a natural byproduct of cellular processes and a type of free radical.
- Antioxidants scavenge and neutralize ROS.
- **Oxidative stress** occurs when antioxidants are unable to balance out ROS production and neutralization.

Oxidative Stress



Methylcobalamin

- Methylcobalamin (MeCbl) is the natural active form of vitamin B12. It is water soluble.
- B12 is essential for DNA synthesis, red blood cell production, and metabolism in humans.
- Plants do not produce or naturally contain B12.
- Previous studies have shown that methylcobalamin acts as an antioxidant to scavenge excess ROS.



Group 1:



Group 4:





Group 5:





Group 6:



Length

Total

- 4 in RO water, 2 and 5 in 3% MeCbl, and 3 and 6 in 8% MeCbl for 8 hours. Drained.
- 2. Arranged groups on wet paper towels and covered with another. Placed groups with no heat stress (1, 2, 3) in Tray 1. Placed groups with heat stress (4, 5, 6) in Tray 2. Covered trays with aluminum foil.
- Tray 2 using heat lamps.
- RO water to each paper towel daily for 7 days.





A Comparison of Total Lengths by Group on Day 7: T-Tests Fig. 11

Groups	Significance	Reason	
1 v 2 1 v 3 2 v 3	p > 0.05 insignificant	No heat stress \rightarrow no effect of MeCbl	
4 v 5 4 v 6	p < 0.05 significant	Under heat stress, MeCbl-primed seeds had longer total lengths than water-primed seeds → MeCbl effect	
5 v 6	p > 0.05 insignificant	Concentration of MeCbl \rightarrow no effect	
1 v 4	p < 0.05 significant	Effect of heat stress on water-only groups	



• Priming with MeCbl is an **effective**, **economical** and efficient method of increasing germination rates and seedling vigor in high-temperature environments. It is a **natural** alternative to more toxic fertilizers.

• Extreme heat caused by climate change impairs plant growth and reduces crop yields, harming both farmers' income and the global food supply.

• This method would enable farmers worldwide to kick start germination in a **short period of ~8 hours**.

• In the long term, farmers would have higher crop yields with increased **financial security**, and people worldwide, especially in climate-vulnerable regions, would have better **food security**.