The Effects of the Amount of Monosaccharides in Soil on *Vigna radiata*

RESEARCH QUESTION:

How does the amount of monosaccharides in soil affect the height of a *Vigna radiata*?

RESULTS:

The *Vigna radiata* with no added monosaccharides in their soil grew taller in height vs. *Vigna radiata* with added monosaccharides in their soil.

Round 1 *Vigna radiata* with 0 grams of monosaccharides in their soil

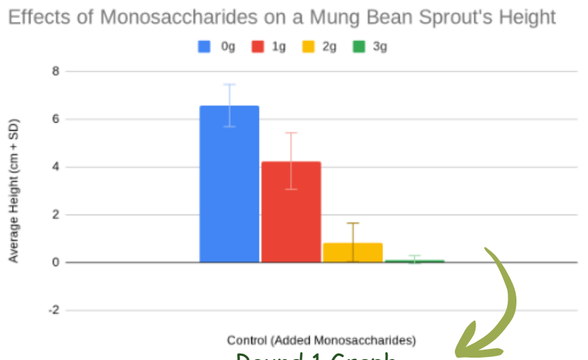
PROJECT DESIGN:

- Germinate mung bean sprouts
- Plant in sandy-loamy soil
- Water every 24-48 hours with amount of monosaccharides needed per treatment
- Measure height of mung bean sprouts after 14 days

Germination of mung bean sprouts

CONCLUSIONS:

The *Vigna radiata* with no monosaccharides in their soil grew the tallest potentially due to disruption of osmosis in the *Vigna radiata's* roots with added monosaccharides in their soil.



Round 1 Graph

ROLE OF MONOSACCHARIDES

- Monosaccharides are one of the fundamental building blocks of life
- Monosaccharides have provided the sugars required in the chemical foundations for organisms to develop
- Hexosomes are the most common type of monosaccharide (glucose, fructose, and galactose)
- The way a plant grows is heavily dependent on the nutrients that are in soil
- Monosaccharides are the simplest form of carbohydrates

Figure 1: 0g monosaccharides/60 ml water after 14 days of growth:

Figure 2: 1g monosaccharides/60 ml water after 14 days of growth:

Figure 3: 2g monosaccharides/60 ml water after 14 days of growth:

Figure 4: 3g monosaccharides/60 ml water after 14 days of growth:

(All images are from round 1)

THE IMPORTANCE OF PLANT HEIGHT

- Taller plants allow for climate control, as most tall plants provide more shade
- Taller plants promote biodiversity as trees allow habitats and food sources for other ecosystems like birds or insects
- Plant height in agriculture is crucial in determining crop yield for mechanized harvesting by regulating plant density and resources provided like water

Figure 5: Germination of mung bean sprouts after 2 days

SIMILAR EXPERIMENT

David E. Sadvava was the Pritzker Family Foundation Professor of Biology, he wrote a book titled: "Life: The Science of Biology"

- He was researching how the amount of H2O affects how much O2 is produced through photosynthesis
- Sadava's research informs how the amount of H2O can impact a plant's photosynthesis, determing how much water a plant needs
- He performed an experiment using isotopes to identify the source of O2 produced during photosynthesis

Conclusion: All the oxygen gas produced during photosynthesis comes from water

Figure 6: Up-close image of a *Vigna radiata's* roots with 0 grams of monosaccharides

SIMILAR EXPERIMENT

Wang Huibo currently works at the Univeristy of Macau and researchs nanotehcnology and materials chemistry

- He was researching how the concentration of carbon dots affects the growth and photosynthesis of mung bean sprouts
- Conducted this experiment by planting mung bean sprouts with different concentrations of carbon dots using technology like transmission electron microscopy
- He informs that carbon dots do promote the growth and photosynthesis of mung bean sprouts through root elongation, stem elongation, and biomass

Conclusion: carbon dots enhance photosynthetic activity by improving the electron transport train

Figure 7: Up-close front view of a Vigna radiata's *roots and stem*

RESEARCH QUESTION & HYPOTHESES

Research Question:

How does the amount of monosaccharides in soil affect the height of a *Vigna radiata*?

Hypotheses:

Round 1: If the amount of monosaccharides in a *Vigna radiata* are increased then the height of the mung bean sprout will increase because it will provide a source of energy and building blocks for its rapidly developing cells.

Revised Hypothesis after Round 1: If the amount of monosaccharides in a *Vigna radiata* is increased then the height of the *Vigna radiata* will decrease because the higher sugar concentration is drawing water out of the *Vigna radiata's* roots, causing damage.

Figure 8: Up-close view of Vigna radiata's height 7 days into our experiment

VARIABLES, CONTROLS, AND MATERIALS

Variables and Controls for Round 1 and 2:

IV: Amount of added monosaccharides in the Vigna radiata's soil.
DV: Height of the Vigna radiata measured in centimeters.
Control: Plants with 0 grams of added monosaccharides.

Figure 9: Material set-up after the seeds were planted into the soil

Materials for Round 1 and 2:

- Soil (Sandy-loamy)
- Vigna Radiata seeds (240 seeds)
- 266 ml clear plastic cups (around 40)
- Monosaccharides (Glucose powder)
- Watering Can
- Labels for treatments
- Gloves
- Measuring Tape
- Container
- Cloth
- Water
- Measuring Scale
- Measuring Cup
- Marker
- Spoon
- Spray Bottle
- Plastic Bottles
- 4 Trays (14 x 8)

EXPERIMENTAL DESIGN

1. Germinate Mung Bean Sprouts:

- Rinse mung bean sprouts under water
- Soak mung bean sprouts in water overnight
- Rinse mung bean sprouts 2-3 times per day for 2 days

2. Plant Mung Bean Sprouts:

- Take 266 ml clear plastic cups and label according to treatments
- Fill the plastic up with 35 grams of sandy-loamy soil
- Take five germinated mung bean sprouts and plant in soil

3. Water every 24-48 hours

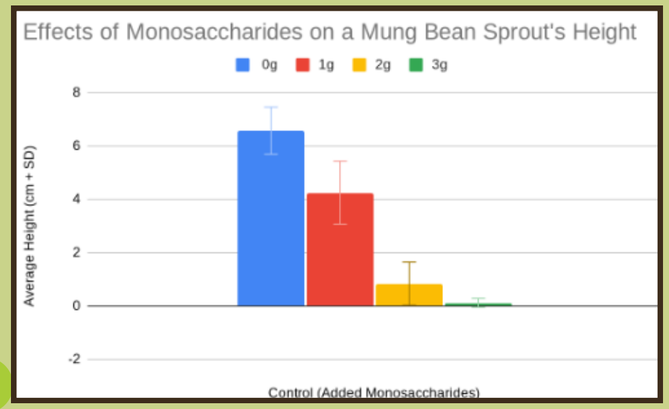
- Take 60 ml of water
- Stir monosaccharides in water for 60 seconds
- Water mung bean sprouts every 24-48 hours (depending on soil moisture)

4. Measure height after 14 days

- Measure mung bean sprouts height with measuring tape in centimeters
- Write data down in a table to ind averages of each treatment
- Enter gathered information into ANOVA Test
- Put gathered information into bar graphs with error bars

RESULTS

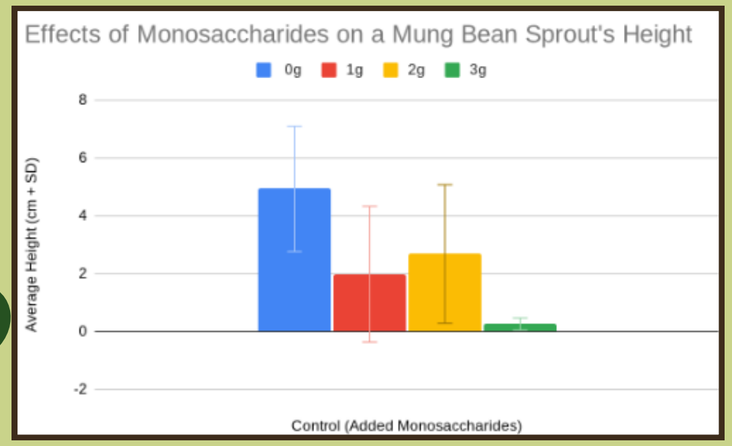
Summary Table and Graph (Round 1):



Summary Table		
Grams of Monosaccharides	Average Height (in centimeters)	Standard Dev.
0	6.57	0.883
1	4.25	1.182
2	0.84	0.8
3	0.12	0.168

- The more monosaccharides added into 60ml of water grew the least in height
- Our control treatment with no monosaccharides grew the most in height
- The error bars did not overlap between any of our treatments except for 2 and 3 grams of monosaccharides.

Summary Table and Graph (Round 2):



Summary Table		
Grams of Monosaccharides	Average Height (in centimeters)	Standard Dev.
0	4.93	2.164
1	1.98	2.344
2	2.68	2.395
3	0.26	0.261

- Our control treatment grew the most in height
- The treatment with the most monosaccharides grew the least in height
- The error bars overlap between all the treatments except for the treatment with 3 grams of monosaccharides.

CONCLUSION

- Data from our graphs show that more monosaccharides added caused shorter plant height
- Round 1 statistical ANOVA Test p-value was 3.0349e-05, significantly lower than 0.05, showing there was a significant change between our treatments
- Round 2 statistical ANOVA Test p-value was 0.0003, which is also significantly lower than 0.05
- Supporting that there was a change between our treatments and the independent variable did impact the dependent variable

Overall, the *Vigna radiata* with no monosaccharides in their soil grew the most in height. While the *Vigna radiata* with monosaccharides in their soil grew less in height. Showing a trend that the more monosaccharides in their soil, the less they grow in height.

Round 1:

p-value
3.0349e-05

Round 2:

p-value
0.0003

THINGS TO NOTE

Weather:

- Most days in round 2 of our experiment were gloomier than days in round 1
- Potentially disrupting plant growth

Seed Placement:

- In round 1, seeds were planted in the soil, while round 2 they were placed on top of the soil
- Potentially causing plant growth to slow

Although it is unknown for why the *Vigna radiata* grew shorter in height in round 2 compared to round 1

Figure 10: *Vigna radiata's* roots swirling up at the bottom of the plastic cup

FUTURE RESEARCH

Some improvements for future research is to extend the amount of time the mung bean sprouts have to grow.

- Change from 14 days to 28 days

Also finding the correct amount of water the mung bean sprouts could improve their overall growth, leading to more accurate data and results. We could also find the trendline between the dependent and independent variable of what the decline in height is for what amount of monosaccharides in soil. Also doing this experiment in different seasons could be compared to each other.

Figure 11: *Vigna radiata's* with 1 gram of monosaccharides right after their first day of watering

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RAW DATA TABLES:

Round 1

	Trial	Amount of Monosaccharides (Control) 0g	1g	2g	3g	
	1	6.4	1.6	0.1	0	
	2	7.6	4.7	1.5	0	
	3	7.3	3.9	1.5	0	
Height of Plants in Centimeters	4	5.5	4.4	0	0.3	
	5	5.7	2.8	0	0.3	
	6	5.7	4.8	0.1	0	
	7	7.0	4.6	0.1	0.4	
	8	5.0	4.0	2.3	0	
	9	6.8	5.8	0.4	0.4	
	10	7.1	6.0	0.6	0	
	11	8.0	3.5	1.5	0	
	12	7.2	4.9	1.9	0	
	Average	6.56	4.25	0.84	0.12	
	Standard Dev.	0.883	1.182	0.809	0.168	

Round 2

	Amount of Monosaccharides				
	Trial	*0g*	*1g*	*2g*	*3g*
	1	9.5	8	0.75	0.25
	2	5	0.5	4.5	0.75
	3	5.75	4.5	7	0.75
Height of Plants in Centimeters	4	6.75	0.75	6.25	0.25
	5	3	1.75	0.75	0.25
	6	1.5	0.5	1.5	0.25
	7	1.75	0.5	0.25	0.25
	8	5.5	1.5	0.25	0
	9	4.75	0	1.75	0
	10	5.75	1.75	3.75	0
	Average:	4.93	1.98	2.68	0.26
	Standard Deviation:	2.164	2.344	2.395	0.261