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

Biology Honors Period 2

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Abstract:

Monosaccharides, such as glucose, are vital for a plant's energy source and are the fundamental building blocks for making starch and cellulose. This study examines the effects of added monosaccharides on the height of *Vigna radiata.* In this research, *Vigna radiata* were sectioned into different treatments and watered with different amounts of added monosaccharides per 60 ml of water (control treatment 0g monosaccharides). The height of the *Vigna radiata* were measured every 2 days for 2 weeks to find the average growth of height per treatment in the first experiment. In the second experiment, the *Vigna radiata* were measured in height after 14 days of growth. The height of the control treatment, *Vigna radiata,* was compared to the other treatments with added amounts of monosaccharides to see if the amount of monosaccharides affects the height of a *Vigna radiata.* In both rounds of the experiment, the control treatment grew the most in height compared to the other treatments with added monosaccharides. To analyze our data, we used the ANOVA statistical test and the Tukey-HSD follow-up test. Both rounds resulted in a ANOVA p-value under 5%, round 1: 3.0349e-05 and round 2: 0.0010053, indicating that our results are most likely not due to chance. Overall, the results didn't support our hypothesis, as we thought the more monosaccharides added, the more the *Vigna radiata* would grow in height. Although the control treatment with no added monosaccharides grew the most in height, which does not support our original hypothesis.

Researchable Question:

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

Introduction:

Monosaccharides have existed ever since the Prebiotic Era on Earth, around 3.5 to 4.4 billion years ago (Varki 2). Monosaccharides are thought to be one of the fundamental building blocks of life. Ever since they were present, they have provided the sugars required for the chemical foundations for living organisms to further develop. The chemical formula for monosaccharides is $(CH_2O)n$ (n represents the number of carbon atoms, which can range from three to seven). Hexosomes are the most common monosaccharides, and their chemical formula is $C_6H_{12}O_6$. Some examples of hexosomes are fructose, glucose, and galactose, which all have the same chemical equation of $C_6H_{12}O_6$, but their atoms are arranged differently (Cummings 4). Monosaccharides are also the simplest form of carbohydrates, and they cannot be broken down into smaller subunits. The main sugars from monosaccharides are glucose, fructose, and galactose, which are vital energy sources for structural components in most biological organisms (Chey et al 1). The way a plant grows is heavily dependent on the nutrients provided in the soil. Simple sugars from monosaccharides like glucose and fructose impact soil by providing a vital energy source for soil microorganisms. The microorganisms in soil almost instantly absorb and decompose monosaccharides released from rhizodeposition (plant roots). This results in higher rates of respiration and other processes for plants (Gunina and Yakov 3). We want to know, how does the amount of monosaccharides in soil affect the height of a *Vigna radiata*? We would like to know more about this because we are curious if monosaccharides in soil affect in soil will

affect the height of the mung bean sprouts or possibly any other plant as well. Being able to know if our independent variable (added monosaccharides) in soil affects plant growth is beneficial because it could possibly mean it will also affect other plants' growth as well. Potentially benefitting many others as well, since it could be a phenomenon to increase height in plant growth.

Hypothesis:

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.

IV: Amount of added monosaccharides (in grams) in the *Vigna radiata's* soil.

DV: Height of the *Vigna radiata* measured in centimeters.

Control: Plants with 0 grams of added monosaccharides.

Round 2: 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.

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.

Materials:

- 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)

Procedure:

Round 1:

1. First, we rinsed the mung bean sprouts under water
2. Then we soaked the mung bean sprouts in water overnight
3. Then we drained the water from the mung bean sprouts and soaked the mung bean

sprouts in water again (repeated 2-3 times a day, this took 2 days until the beans sprouted)

4. After each soak and rinse, we covered the mung bean sprouts in a dark place, covered with a cloth (we rinsed 1-2 times per day)
5. Then we got clear plastic cups and labeled them for the different amounts of monosaccharides (1, 2, 3 grams per 60 milliliters of water and none). We had 12 for each treatment (48, 266 ml clear plastic cups).
6. We filled up 3/4 of the 266 ml cup with soil (approx 66 ml in the remaining space) or (1.25 ounces of soil)
7. Then we took five sprouted seeds and planted them in the soil
8. Then we took 60 milliliters of water
9. Then we took the amount of monosaccharides or the glucose powder (sugar) needed for each treatment and stirred it into the water for 1 minute
10. We watered the mung bean plant every day (every 24-48 hours, depending on the soil's moisture level)
11. We repeated steps 8-10 for each treatment we performed (no control, 1 gram of monosaccharides per 60 milliliters of water, 2 grams of monosaccharides per 60 milliliters of water, or 3 grams of monosaccharides per 60 milliliters of water.
12. Every 2 days, we measured the plant's height with a measuring tape in centimeters
13. We wrote down the data from each plant into a Google Sheet to find the average of each treatment we performed
14. After we collected the information, we entered the final information into an ANOVA test

15. Lastly, we put that information into a graph to find if there was a real difference in the mung bean sprouts' height when monosaccharides were added into the soil

Round 2:

1. First, we rinsed the mung bean sprouts under water
2. Then we soaked the mung bean sprouts in water overnight
3. Then we drained the water from the mung bean sprouts and soaked the mung bean sprouts in water again (repeated 2-3 times a day, this took 2 days until the beans sprouted)
4. Then after each soak and rinse, we covered the mung bean sprouts with in a dark place covered with a cloth (we rinsed 1-2 times per day)
5. Then we got clear plastic cups and labeled them for the different amounts of monosaccharides (1, 2, 3 grams per 20 milliliters of water and none). We had 12 for each treatment (40, 266 ml clear plastic cups).
6. We filled up 3/4 of the 266 ml cup with soil (approx 66 ml in the remaining space) or (1.25 ounces of soil)
7. Then we took five sprouted seeds and placed them on top of the soil
8. Then took 20 milliliters of water
9. We took the amount of monosaccharides or the glucose powder (sugar) needed for each treatment and stirred it into the water for 1 minute
10. We watered the mung bean plant every day (every 24-48 hours, depending on the soil's moisture level)

11. The first day, we watered the plant with 20 milliliters of water, with the amount of monosaccharides required for each treatment
12. The second day, we put water in a spray bottle with 480 milliliters of water and however much sugar they required (each plant got 5 sprays)
13. We repeated steps 1-12 for each treatment we performed (no control, 1 gram of monosaccharides per 60 milliliters of water, 2 grams of monosaccharides per 60 milliliters of water, or 3 grams of monosaccharides per 60 milliliters of water.
14. Every 2 days, we measured the plant's height with a measuring tape in centimeters
15. We wrote down the data from each plant into a Google Sheet to find the average of each treatment we performed
16. After the information was collected, we entered the final information into an ANOVA test
17. Lastly, we put that information into a graph to find if there was a real difference in the mung bean sprouts' height when monosaccharides were added into the soil

Results:

Summary Table (Round 1):

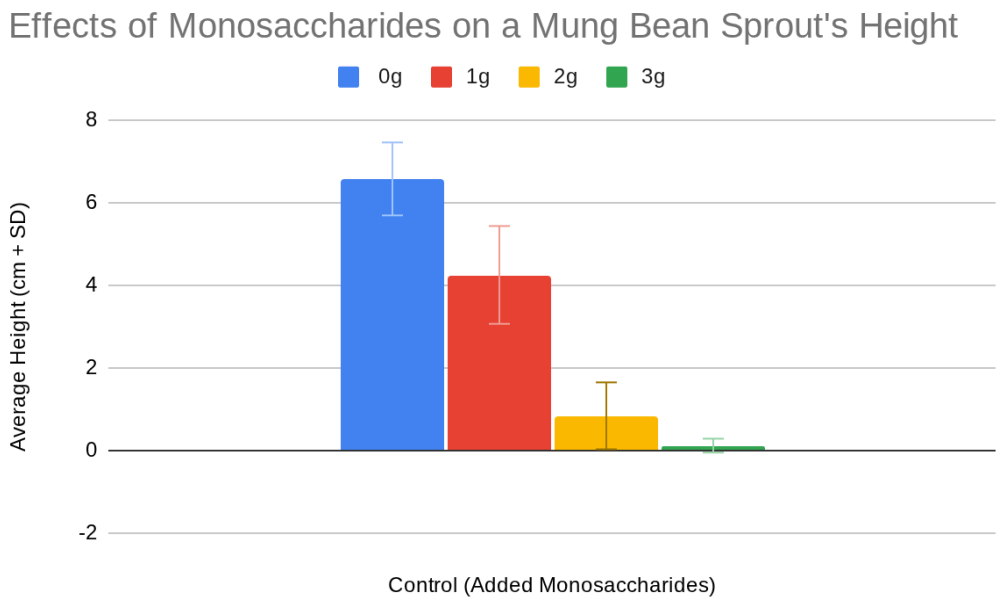
Summary Table

Grams of Monosaccharides	Average Height (in centimeters)	Standard Dev.
0	6.57	0.883
1	4.25	1.182
2	0.84	0.809
3	0.12	0.168

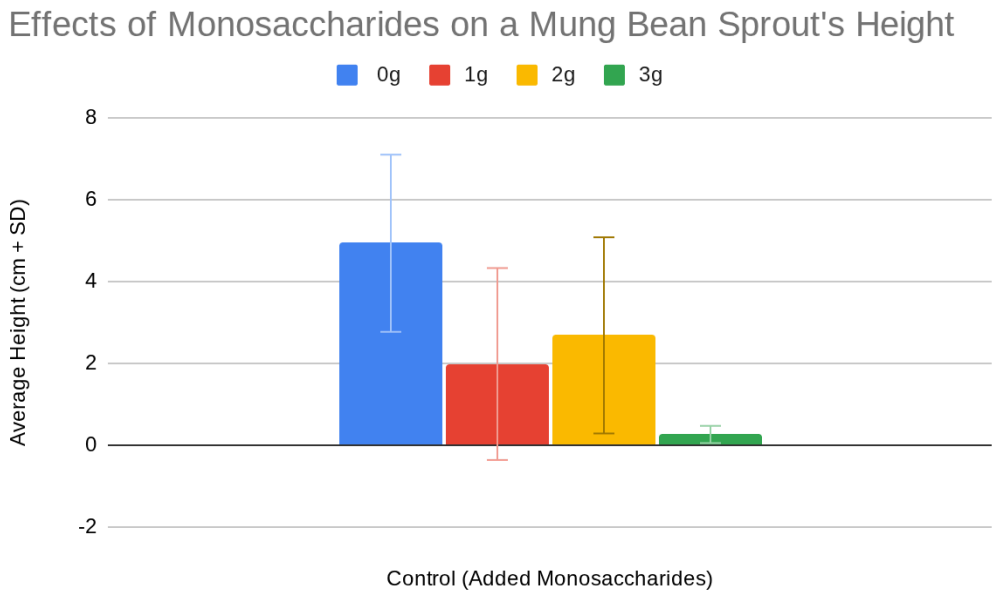
Summary Table (Round 2):

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

Graph of Average Height of *Vigna radiata* at 14 days of Growth (Round 1):



Graph of Average Height of *Vigna radiata* at 14 days of Growth (Round 2):



One Way ANOVA Test and Tukey HSD Test (Round 1):

Input Data (Round 1):

Treatment →	A	B	C	D
Input Data →	9.5	8.0	0.75	0.25
	5.0	0.5	4.5	0.75
	5.75	4.5	7.0	0.75
	6.75	0.75	6.25	0.25
	3.0	1.75	0.75	0.25
	1.5	0.5	1.5	0.25
	1.75	0.5	0.25	0.25
	5.5	1.5	0.25	0.0
	4.75	0.0	1.75	0.0
	5.75	1.75	3.75	0.0
	4.93	1.98	2.68	0.26
	2.164	2.344	2.395	0.261

ANOVA Test Results (Round 1):

source	sum of squares SS	degrees of freedom ν	mean square MS	F statistic	p-value
treatment	120.1552	3	40.0517	10.2645	3.0349e-05
error	171.6872	44	3.9020		
total	291.8424	47			

Tukey HSD Test Results (Round 1):

treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inferfence
A vs B	4.7159	0.0091033	** p<0.01
A vs C	3.5832	0.0685634	insignificant
A vs D	7.7560	0.0010053	** p<0.01
B vs C	1.1327	0.8369464	insignificant
B vs D	3.0401	0.1536887	insignificant
C vs D	4.1729	0.0251731	* p<0.05

One Way ANOVA Test and Tukey HSD Test (Round 2):

Input Data (Round 2):

Treatment →	A	B	C	D
Input Data →	9.5	8.0	0.75	0.25
	5.0	0.5	4.5	0.75
	5.75	4.5	7.0	0.75
	6.75	0.75	6.25	0.25
	3.0	1.75	0.75	0.25
	1.5	0.5	1.5	0.25
	1.75	0.5	0.25	0.25
	5.5	1.5	0.25	0.0
	4.75	0.0	1.75	0.0
	5.75	1.75	3.75	0.0

ANOVA Test Results (Round 2):

source	sum of squares SS	degrees of freedom ν	mean square MS	F statistic	p-value
treatment	111.3187	3	37.1062	8.1205	0.0003
error	164.5000	36	4.5694		
total	275.8188	39			

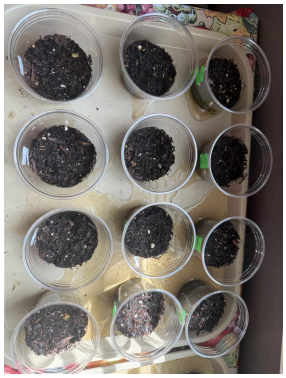
Tukey HSD Test Results (Round 2):

treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inferfence
A vs B	4.3641	0.0194495	* p<0.05
A vs C	3.3285	0.1049027	insignificant
A vs D	6.8789	0.0010053	** p<0.01
B vs C	1.0355	0.8755419	insignificant
B vs D	2.5149	0.3003222	insignificant
C vs D	3.5504	0.0753027	insignificant

Photos of Experiment (Round 1):

Pictures taken right after we planted the seeds into the soil and watered according to their treatments:

0g: **1g:**

2g: **3g:** 

Pictures taken after 14 days of growth and our experiment ended:

0g: **1g:**

2g: **3g:**

Photos of Experiment (Round 2):

First day of second experiment after we placed the seeds on top of the soil this time:

0g: **1g:**

2g: **3g:**

Two weeks of plant growth when our experiment was finished:

g: **1g:**

2g: **3g:**

Conclusion:

In our first experiment, we watered each of our Mung Bean Sprouts (*Vigna radiata*) with 60ml of water per gram of monosaccharides depending on how much monosaccharides each plant required. We continuously watered our plants once everyday with 60ml of water for 14 days. Every two days we would use a measuring tape to measure how tall each plant was in centimeters. After two weeks we collected all the data and found the average each plant grew in height every two days. The data we collected was organized into a graph to see if the dependent variable changed from the independent variable. In our graph, we can see a trend that when the more monosaccharides added into 60ml of water per plant a day grew the least in height. Our control treatment with no added monosaccharides grew the most in height. The error bars did not overlap between any of our treatments except for the 2 and 3 grams of added monosaccharides. Which doesn't show support for there to be a significant change from each of our treatments except the 2 and 3 grams of added monosaccharides.

The graph pulled from the data of our second experiment was from the average height the plants grew from the entire 14 days, and not every 2 days. Our control treatment still grew the most in height, and still the treatment with the most added monosaccharides grew the least in height. This time the treatment with 2 grams of added monosaccharides had an average that most of them grew taller than the treatment with 1 grams of added monosaccharides. Showing that there wasn't a significant change between those treatments when we did the experiment the second time. The error bars overlap between all the treatments except for the treatment with 3 grams of added monosaccharides. This also shows there was not really a huge difference between the treatments when we did our experiment for a second time.

The data we collected in our first and second does not support our hypothesis. At first we thought the more monosaccharides added would make the plants grow taller in height because of the extra glucose there is for the *Vigna radiata* to grow and repair cells. Although our data from our graphs show that the more monosaccharides added, the less they grew in height. Looking at our ANOVA statistical test in our first experiment, we got a p-value of 3.0349e-05, which is significantly lower than 0.05. Meaning that there was a significant change between our treatments and that the independent variable did impact the dependent variable. The ANOVA statistical test for our second experiment also had a significant change between our treatments with a p-value of 0.0003, which is also lower than 0.05. The Tukey HSD test from our first and second experiment shows there was not much of a significant change between all of our treatments. In our second experiment the only two treatments that showed a significant change from the Tukey HSD Test were 0g vs 1g added monosaccharides (p-value: 0.0194495) and 1g vs 2g added monosaccharides (p-value: 0.0010053). Although in our first experiment, the three treatments with significant change between each other were 0g vs 1g added monosaccharides (p-value: 0.0091033), 0g and 2g added monosaccharides (p-value: 0.010053), and 2g and 3g added monosaccharides (p-value: 0.02511731). Overall, our hypothesis is unsupported from our data because the graph shows our control treatment with the greatest height out of all the other treatments, when we expected the opposite to happen. Although our p-value showed that there was a difference between our treatments, it wasn't in the way we expected.

Our original hypothesis was "If the amount of monosaccharides in a *Vigna radiata* are increased then the height of the mung bean sprout will increase because the added glucose will provide a source of energy and building blocks for its rapidly developing cells." Now that we

saw that our hypothesis is not supported by our data, we think the added glucose is harming the mung bean sprouts growth. We believe the added monosaccharides could be disrupting osmosis in the mung bean sprouts roots because the higher sugar concentrations are drawing water out of the plants roots causing damage to them. Since plant cells usually are able to manage better in hypotonic conditions because of their thick cell wall and central vacuole instead of hypertonic conditions. Which could be the reason the more monosaccharides the mung bean sprouts had, the less they grew in height and in general overall. Our revised hypothesis with help from the data we collected from our experiments is "If the amount of monosaccharides in a *Vigna* Radiata is increased then the height of of the *Vigna radiata w*ill decrease because the higher sugar concentration is drawing water out of the *Vigna radiata's* roots, causing damage."

Sources of Error and Improvements:

Some possible sources of error were in our second experiment, where we placed the seeds on top of the soil instead of planting them in the soil. Which could have caused the mung bean sprouts to not grow as tall in height the first time we did the experiment. We believed that placing the seeds on top of the soil would cause the plants to grow quicker because mung bean sprouts germinate into the soil. Which could have given us better data between the treatments. Another possible source of error in our second experiment could have been the amount of water we gave each mung bean sprout compared to the first experiment. The first time we did the experiment we watered each plant with 60ml of water once per day with the amount of added monosaccharides they needed. The second time we did the experiment, we used a spray bottle to water the mung bean sprouts, and each plant received 5 sprays of water from the spray bottle which is 20ml of water. We believe the less water given could have also caused the plants to

grow less in height compared to the first experiment. The weather conditions could have also affected how much the mung bean sprouts grew in height in the second experiment since most days were more cloudy and less sunny than they were the first time we did the experiment.

Some possible errors could have occurred, from the weather, the way the seeds were planted, and the amount of water given to each mung bean sprout. The results from this experiment has taught us that the more monosaccharides added to the water given to each mung bean sprout usually grew less in height than the control treatment with no added monosaccharides. We also learned how osmosis can play a role in how the plant grows if the concentration of sugar is higher than it is inside the plant roots. Since beforehand we didn't know much about osmosis and what osmotic conditions plant cells can maintain and do best in. An improvement for this experiment is to extend the amount of time the plants had to grow. So, instead of 14 days of growth and then finding the average height of each mung bean sprout, we could do 28 days of growth. Which gives plenty of time for the mung bean sprouts to grow even more. Another improvement from the last experiment we did, would be to definitely give the mung bean sprouts more water and planting the seeds in the soil, instead of on top of the soil. For future experiments with our revised hypothesis we could have even more treatments to see if there is a trendline between the dependent variable and the independent variable. For example, we could have treatments for every 0.5 grams of added monosaccharides up to 4 grams of added monosaccharides. We would also research more about the maintenance of mung bean sprouts to see how much water and sunlight they need so they aren't impacted by variables we cannot control.

Work cited:

Abdelrahman, Hamada, et al. “Carbohydrates and Amino Compounds as Short‐Term Indicators of Soil Management.” *CLEAN - Soil Air Water*, vol. 45, no. 1, 23 Nov. 2016, https://doi.org/10.1002/clen.201600076. Accessed 23 Aug. 2025.

Basler, A., and J. Dyckmans. “Compound-Specific Δ13C Analysis of Monosaccharides from Soil Extracts by High-Performance Liquid Chromatography/Isotope Ratio Mass Spectrometry.” *Rapid Communications in Mass Spectrometry*, vol. 27, no. 22, 7 Oct. 2013, pp. 2546–2550, https://doi.org/10.1002/rcm.6717. Accessed 23 Aug. 2025.

Dormaar, Johan F., and Walter D. Willms. “Effect of Grazing and Cultivation on Some Chemical Properties of Soils in the Mixed Prairie.” *Journal of Range Management*, vol. 43, no. 5, Sept. 1990, p. 456, https://doi.org/10.2307/3899012. Accessed 20 Aug. 2025.

Lima, Diana L.D., et al. “Effects of Organic and Inorganic Amendments on Soil Organic Matter Properties.” *Geoderma*, vol. 150, no. 1-2, Apr. 2009, pp. 38–45, https://doi.org/10.1016/j.geoderma.2009.01.009. Accessed 20 Aug. 2025.

Randhir, Reena, and Kalidas Shetty. “Elicitation of the Proline-Linked Pentose Phosphate Pathway Metabolites and Antioxidant Enzyme Response by Ascorbic Acid in Dark Germinated Fava Bean Sprouts.” *Journal of Food Biochemistry*, vol. 31, no. 4, 5 July 2007, pp. 485–508, https://doi.org/10.1111/j.1745-4514.2007.00126.x. Accessed 30 Aug. 2025

Sadava, D, Hillis, D, Heller, H, Berenbaum, M.(Eds). “Life: The Science Of Biology,” 9th ed.,

Freeman & Company, 2009.

Wang, Huibo, et al. “Carbon Dots Promote the Growth and Photosynthesis of Mung Bean Sprouts.” *Carbon*, vol. 136, 1 Sept. 2018, pp. 94–102, www.sciencedirect.com/science/article/abs/pii/S0008622318304123?via%3Dihub, https://doi.org/10.1016/j.carbon.2018.04.051. Accessed 20 Aug. 2025.

Yan, Xiaoxia, et al. “Formation and Properties of Mung Bean Resistant Starch Nanoparticles.” *International Journal of Food Science & Technology*, vol. 58, no. 12, 9 Sept. 2023, pp. 6234–6242, https://doi.org/10.1111/ijfs.16710. Accessed 31 Aug. 2025.

Appendix:

Round 1:

	Trial	Amount of Monosaccharides (Control) 0g	1g	2g	3g
Height of Plants in Centimeters	1	6.4	1.6	0.1	0
	2	7.6	4.7	1.5	0
	3	7.3	3.9	1.5	0
	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