1. Title

Effect of manure fertilizer, white sugar and molasses on soil's PH and arugula's growth rate.

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2. Abstract

Using manure compost in agriculture has numerous benefits. It contains nitrogen, phosphorus, potassium and other nutrients which are essentials for plants growth. It also adds organic matter to the soil which may improve soil structure, aeration, soil moisture-holding capacity, and water infiltration. On the other hand, many researches claim sugar to be a good fertilizer improving plants growth. The hydroscopicity of sugar will absorb and retain water longer after watering, which will make the plant remain moist, giving an optimal chance at successfully growing.

The purpose of our experiment was first to investigate the effect of molasses and sugar on soil's PH, and second to study whether molasses or white sugar could be used as a source of nutrients for plants. To that end, soil's PH, plant growth rate, taste and color were examined.

Arugula seeds were planted in four pots. Each pot had the same amount of loam soil. Pot A was chosen as a controller, pot B, C and D contained molasses, white sugar, and manure fertilizer, respectively. PH of the soil was measured in each pot after adding the fertilizers. Samples were exposed to direct sunlight during four weeks.

Results showed that the pot containing manure fertilizer displayed the fastest plant growth, while the other samples (A, C and D) had a lower growth rate.
None of the samples showed any significant decrease in the soil's PH or plant colour change.
As for the taste, plants placed with molasses and manure fertilizer exhibited greater tart flavour among the rest of the samples.
Results indicate the PH of the soil was not affected by any of the fertilizers. However, manure fertilizer increased significantly the growth rate of arugula plant. Moreover, it also increased the tart taste of the plant, making it more appealing to the consumer.

Key word: manure fertilizer, soil PH, molasses, arugula growth rate, arugula taste, arugula flavour.

3. Research Questions

How does adding manure fertilizer, molasses (brown sugar), and white sugar affect the soil's PH?
How does adding manure fertilizer, white sugar, molasses affect plants growth, taste, and color?

4. Introduction

People have been using fertilizers for centuries to boost plants growth. The most popular and easier way to get fertilizer is manure. Manure is supposed to be a natural source of fertilizers as it is the waste that animals discharge out of their bodies.

However, the way people started to feed animals affected the composition of animals' excrements. Animals are nowadays provided with food containing chemicals and hormones to enhance their growth.
To perform our experiment, manure free from chemicals and hormones was obtained to study its effect in the acidity of the soil (PH).

On the other hand, many researches (1,2) claim sugars to be a good fertilizer option.
Sugar is extremely hygroscopic. The hydroscopicity of sugar will absorb and retain water longer after watering, which will make the plant remain moist, giving an optimal chance at successfully growing. Also, the idea behind using sugar to help aid in plant growth comes from observing plants' natural process of photosynthesis. Since plants use photosynthesis to create sugars and starches for food, then it can be logically assumed that if more sugar is added to a plant, then it will be provided with additional food, and thereby boosting growth as a result (2).
In the present experiment, the effect of adding manure fertilizer, molasses (brown sugar) and white sugar to the soil on the soil's PH and plant's growth, taste, and color were studied.

Our hypothesis is that adding manure, molasses and white sugar to the soil with PH 7.5 will decrease it to less than 7 which is the best value to enhance arugula growth (3). Adding white sugar, molasses or manure fertilizer will cause the arugula plant to have stronger taste (tart), and will cause the leaves to have greener color.

The variables :
-controlled variable: the same amount and type of soil (loam), same amount of water, same amount and type of seeds, same place (direct sunlight) under the same conditions (temperature, humidity…).

-Independent variable : the type of fertilizer added to each pot (molasses , manure, white sugar)
-Dependent variables : growth rate of arugula, the taste and color of arugula, the PH of the soil

5. Research Methods*

To perform the present investigation arugula seeds were germinated using wet cotton for 3 days. Samples were then planted in four identical pots labelled as A, B, C, and D. All pots contained 500 g of soil.
Plants were watered daily with 40 ml of tap water. Once a week, control sample (A) was watered with tap water only, while sample B, C and D were watered dissolving 20 g of molasses, white sugar, and manure fertilizer in 40 ml of water, respectively.
All samples were located in the same place in direct sunlight.
Samples were observed for 5 weeks.
Each week the length of each plant was measured, leaves color was examined, and the PH of the soil was checked.

1. The *globe protocols* used are :

The PH of the soil as dependent variable

6. Results

Week 1				
	Pot A (control: only water added to the soil)	Pot B (molasses)	Pot C (white sugar)	Pot C (manure)
The average length of the plant	1.1 cm	1.2 cm	1.0 cm	2.0 cm
PH of the soil	7.3	7.1	7.3	7.5
The taste of the leaves (tart)	It was not tasted it as it was very small			
The color of the leaves	The same color (bright green)			
Week2				
	Pot A (control: only water added to the soil)	Pot B (molasses)	Pot C (white sugar)	Pot C (manure)
The average length of the plant	2.3 cm	2.1 cm	2.2 cm	3.5 cm
PH of the soil	7.1	7.1	7.2	7.2
The taste of the leaves (tart)	It was not tasted it as it was very small			
The color of the leaves	The same color (bright green)			

Week 3				
	Pot A (control: only water added to the soil)	Pot B (molasses)	Pot C (white sugar)	Pot C (manure)
Length of the plant	4.0	4.1	4.0	5.2
PH of the soil	7.2	7.0	7.1	7.0
The taste of the leaves (tart)	It was not tasted it as it was very small			
The color of the leaves	The same color (bright green)			

Week 4				
	Pot A (control: only water added to the soil)	Pot B (molasses)	Pot C (white sugar)	Pot D (manure)
Length of the plant	5.1	5.2	5.0 cm	7.0 cm
PH of the soil	7.2	6.8	7.1	7.0
The taste of the leaves (tart)	Moderate tart flavour	Strong tart flavour	Moderate tart flavour	Strong tart flavour
The color of the leaves	The same color (bright green)			

As shown in tables 1, 2 3, 4 and 5, growth rates of samples A, B and C were similar and no significant difference among the samples were observed. However, sample D exhibited higher growth rate presenting a length of 7 cm at the end of the

experiment, while the length of the rest of the samples were 5 cm.
The soil's PH remained unchanged throughout the experiment.
The taste in the fourth week was strong tart for the sample plants in Pot B and D.
The color was the same for the plants for all samples.

7. Discussion

As previously reported (3) arugula seeds grow properly in loam soil. Arugula prefers humus-rich, well-drained soil, but also tolerates a wide variety of conditions. Arugula plant was also chosen for its fast germination (3 days).
The pot sample that contained manure fertilizer (D) displayed the higher growth rate. These finding agreed with previous works (4, 5) which also studied the effect manure fertilizers on arugula plants.
On other hand, samples watered with water and molasses and sugar (pots B and C), did not enhance the plant growth rate (5.2 cm and 5.0 cm), as they had same length as control sample (5.1 cm). These findings were unexpected, since many researches claim sugar to be good fertilizer, enhancing the plants growth (1, 2). Some researchers (9) suggest is that depending on which microbes are present in the soil adding sugar can have beneficial or harmful effects on the plant. Beneficial effects include all the activity that goes on in hot compost: nitrogen fixation, toxin decomposition and nutrient production. These desired effects are the reason for adding sugar to a fertilizing agent.
Moreover, after 6 weeks approximately samples watered with sugar fertilizers presented signs of wilting. These results

also do not agree with other findings (6, 7) which found that watering plants with sugar had a good impact on flower blooming.
Some researchers suggest (9), the sugar that we typically eat is mostly polysaccharides, which are much more complex types of sugars that plants are not able to break down as easily. In other words, sugar can, in fact, aid in plant growth, but only through the plant's own self-production of sugars; not through sugar additives, also, other works did not find any influence of adding sugar on plants growth (7, 8).
As for the PH measurements, it was expected that fertilizers would decrease the PH of the soil. However, none of the samples had any impact on the soil's PH. Nevertheless, that not affected the plants growth since the optimum PH range for arugula plants (PH 6 to 7) was already reached from the beginning of the experiment.
The taste of arugula differed among the samples, having the greater tart taste those samples watered with molasses and manure fertilizers. Arugula is habitual in culinary uses, i.e salads, pizza, etc. This tart taste will make it more appealing to the consumer.

8. Conclusion*

The PH of the soil was not affected by adding manure, sugar, or molasses.

Manure is a good choice to increase the length of the plants as plants growth rate was between 1.5-2.5.

Manure and molasses fertilizers enhance the tart taste of plants.
None of the fertilizers had an impact on leaves' color.

9. GLOBE Badges

*Be a **Collaborator***
The work conducted by Toleen Mira and Lujain Alomeri . We thank our Globe teacher Mrs. Sana Sabra and Mrs.Dania Qabani for guiding us in the experiment steps , collecting information, and writing the research. We thank our school which made it easier for us to find do the experiments by providing all the material and resources.
Be a Data Scientist
The report includes in-depth analysis of students' own data as well as other data sources. Students discuss limitations of these data, make inferences about past, present, or future events, or use data to answer questions or solve problems in the represented system. Consider data from other schools or data available from other databases.
Make an Impact
The local issue that led us to conduct our research is that our dream is to make Jeddah green, so we were thinking of a way to make modify the soil in order to make it more suitable for the plant.
Be a STEM Professional
Knight of Knowledge STEM Coordinator Mrs.Abeer Qenawi, who is STEM certified professional , guided us to use ***Technology*** (by using digital tools such as a digital balance and PH meter), ***Math*** (by measuring the length of plants, the

weight of soil and fertilizers , and the volume of water) , ***Science*** (by studying the features of soil, fertilizers, molasses, manure, and sugar), and ***Engineering*** Process Steps to solve the problem that we conducted our experiment to solve. in our experiment.

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