The Dirty Water Dilemma: Which Laundry Detergent Is Best for Your Plants?

Unveiling the Effects of Different Laundry Detergent Greywater on Seed Germination

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Contents

Abstract

Did you know that an average Canadian household uses approximately 1000L of water on laundry per month (Statistics Canada, 2024)? What if all that “leftover” water could help your plants grow instead of going to waste? This experiment explored the surprising potential of laundry grey water — specifically from Tide, Gain, and Ecomax detergents — as a source of irrigation for seed germination and plant growth. Greywater has been re-used in some countries in order to conserve the freshwater during droughts and arid seasons. By testing how different types of greywater impacted seed growth, we aimed to uncover which detergent was most plant-friendly. In order to achieve this, pea seeds were grown over the course of three weeks using greywater from Tide, Ecomax, and Gain, with a control group watered with tap water for comparison. I hypothesized that Ecomax greywater, which contains eco-friendly ingredients, would best support seed growth out of the three detergents. My hypothesis was supported by the results. The greywater impacted the health of the plants, affecting their color, height, and germination rate with all three types of detergents. However, Ecomax greywater showed minimal impact on seed germination and growth as compared to Tide greywater and Gain greywater, making it most suitable for watering plants.

Purpose of the Experiment

The purpose of this experiment is to investigate the effects of laundry greywater - specifically from Tide, Gain, and Ecomax detergents - on germination and growth of pea seeds. Water scarcity is a growing global issue, and with laundry greywater making up a significant portion of household wastewater, finding ways to reuse it can help conserve precious resources. In June 2024, the City of Calgary recommended using greywater for watering plants due to the

Bearspaw Main Water Feeder break, which led to concerns about water scarcity. However, my mother expressed hesitation about using greywater in our garden. She was concerned about the impact of using water from household activities, such as laundry or showers, on plant health. This sparked my curiosity about the effects of greywater, particularly from laundry detergents, on plant growth. I decided to explore this topic further by investigating how different types of laundry detergent in greywater might affect seed germination. By understanding how different laundry detergents affect plant growth, this experiment can guide safer, eco-friendly practices for reusing grey water. This research could help reduce water waste, lower environmental footprint, and offer sustainable solutions for irrigation, especially in water-stressed areas.

Hypothesis

If pea seeds are watered with grey water from Tide, Gain, and Ecomax detergents, then the seeds watered with Ecomax greywater will show the highest germination rate and the healthiest plant growth in comparison to the seeds watered with Tide greywater and Gain greywater because it is marketed as being more eco-friendly and less harmful to the environment compared to the other detergents.

Background Research

Water is crucial for the wellbeing of all forms of life on earth. It is essential for agriculture, power plants and in the extraction of valuable minerals worldwide. However, water is a finite natural resource and only 0.5% of the earth's freshwater is available for our consumption (Bureau of Reclamation California-Great Basin, 2020). As a result, there has been a dramatic increase in the demand for water in the last few decades due to population growth and industrialization. An average Canadian utilizes approximately 223 liters of water everyday (Canadian government, 2024) which makes Canada one of the largest per capita water

consumers in today's world. If we continue using this valuable natural resource at the current rate, two-thirds of the world population will be forced to live under water-stressed conditions (United Nations, 2015).

Despite having the world's third largest freshwater resources, Canada is not immune to impacts of changing water supplies due to urbanization, forest fires, floods, drought, and climate change. Many parts of western Canada including British Columbia, Alberta and Saskatchewan are facing water shortages due to prolonged dry conditions. In fact, one of the CBC reports published in January 2024 (Bob Weber, 2024) has reported that some wells in Ponoka, a county in Southern Alberta, have already dried up due to climatic changes.

The aforementioned conditions of water scarcity in Canada and around the world make water conservation an extremely important practice. One of the most effective ways to conserve water is by reducing our daily water consumption. Reusing greywater produced in our homes to water indoor and outdoor plants is one effective way to achieve this. Greywater is the type of wastewater that comes out of washing machines, baths, showers, and bathroom sinks. It is important to note that greywater does not include sewage waste and wastewater from kitchen sinks. Wastewater is referred to as "blackwater" and cannot be reused to water plants as it is infected with bacteria. On the other hand, greywater can be safely used to meet the watering needs of plants without any major concerns as it is free from any disease causing pathogens.

Recycling greywater can help us in following ways:

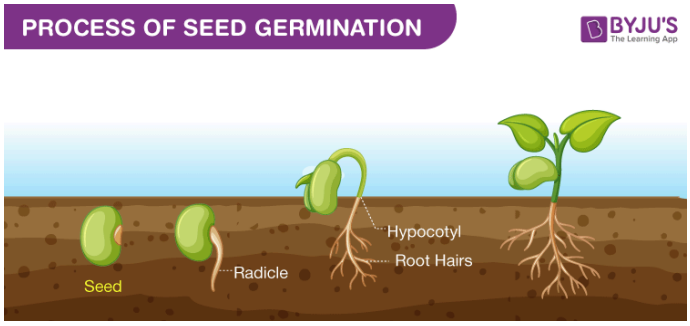
- Reduces the use of freshwater.
- Aids plant growth in areas with water scarcity
- It can also help in replenishing groundwater.

- ❖ Conserves energy to clean greywater and transport it to our homes.

Role of Water in Plants

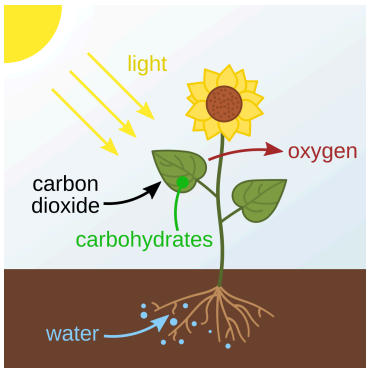
Water is an important nutrient for plants and makes up to 9.5% of plant tissues (Richmond, 2021). It plays a key role in the following plant functions:

Image 1: Process of Seed Germination (BYJU's, n.d.)



***Seed germination**:* When seeds absorb water,it softens the seed coat resulting in its opening and the emergence of the embryo. Water also activates the enzymes in the seed which are required for the growth of the embryo.

Image 2: Photosynthesis in Plants (Wikipedia, n.d.)



***Photosynthesis**:* Water plays a critical role in photosynthesis, a process through which plants manufacture their own food using carbon dioxide from the air, water from the soil and energy from the sunlight. During photosynthesis, the water loses electrons (oxidation) and is split into oxygen, hydrogen and electrons within the plant cells (National Geographic, n.d.). These electrons and hydrogen are used by the plant to make energy molecules ATP and NADPH, which are required by the plant to make food. Oxygen is released into the atmosphere through stomata (National Geographic, n.d.).

Transportation of nutrients*:* Plants transport the nutrients from one part to another through water.Water dissolves the nutrients present in the soil and transported them through the plant's vascular system to the leaves, where photosynthesis takes place. Once the leaves produce food through photosynthesis, water helps move this food to other parts of the plant, such as the stems, flowers, and roots, where food concentration is lower.

Transpiration*:*Water also helps to regulate the temperature of plants through a process called transpiration.Transpiration is the process of loss of water mainly through stomata present on leaves which results in lowering of plant temperature on hot sunny days.

Structural support*:* In order to generate a constant pressure on cell walls, known as turgor, for structural support, water is necessary. Turgor facilitates making plants flexible yet strong, enabling them to withstand strong wind currents or direct leaves towards sunlight for maximum photosynthesis.

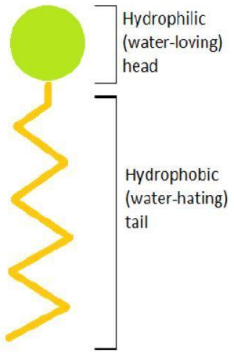
In the absence of sufficient amounts of water, plants will fail to transport the required nutrients across the different parts, which will eventually result in hindered growth. Water deficiency can also result in poor seed germination and can interfere with the process of photosynthesis. Laundry greywater contains the water, as well as detergents.

Detergents

Detergents are water-soluble cleansing agents that combine with dirt particles and increase their solubility in water. They are different from soaps as they do not form scum in water. Surfactants play a major role in detergents. Detergent manufacturers also use bleaches,

fluorescent whiteners, perfumes, stabilizers, enzymes, water softeners, and other processing aids to improve the effectiveness of detergents. Commonly used detergents are usually made up of sodium salts of sulfonic acids; however, eco-friendly detergents contain plant-based formulas to clean the dirt from clothes.

Image 3: Surfactant (Schneider, 2022)



Surfactants in detergents have water-loving (hydrophilic) heads and long water repelling (hydrophobic) hydrocarbon tails. During the washing of clothes, any grease or oil on the clothes' surface attracts the hydrophobic tails of surfactant. Eventually, a group of surfactant molecules surround the oil or grease droplets forming a sphere around it. These spheres are called micelles. After this, these micelles are lifted off the surface of cloth and get washed away.

Ingredients In Tide, Gain and Ecomax

Parts of Detergent	Gain	Tide	Ecomax
Water	✅	✅	✅
Surfactant (remove dirt and grease from surfaces)	sodium and MEA C10-16 alkyl benzene sulphonate,C10-16 pareth, sodium laureth sulphate;C10-16 alkyldimethylamine oxide,C10-16 dimethyl	sodium and MEA C10-16 alkyl benzene sulphonate , C10-16 pareth,sodium lauryl sulphate, C10-16 alkyl dimethyl amine oxide, C10-16 alkyldimethyl, monoethanolamine (MEA) citrate	decyl glucoside
Stabilizer (protects and maintain the effectiveness of other ingredients by preventing them from degradation or becoming inactive)	calcium formate,phenyl propyl ethyl methicone, trimethyl siloxysilicate,sodium and MEA citrate	sodium borate, sodium cumenesulphonate, calcium formate, hydrogenated castor oil,tetrasodium glutamate diacetate	Hydroxyethylcellulose
Cleaning Aid (prevent stains & soils from redositing onto garments after they are removed)	polyethylene imines Alkoxylated,tetrasodium glutamate	polyethylene imines alkoxylated,diethylene triamine	xanthum gum,cellulose
Process aid (Balances pH)	sodium formate	sodium cumene sulphonate, hydrogenated castor oil,salts of C12-18 sodium fatty acids,	Sodium carbonate, citric acid

Ingredients In Tide, Gain and Ecomax			
		alcohol, propylene glycol simethicone, dimethicone, ethanolamine	
Enzymes (targets specific stains and make them easy to wash)	**subtilisin,amylase, cellulase**	**subtilisin,amylase, mannanase**	
Preservatives (Prevent the growth of microorganisms)	**benzisothiazolinone**	**benzisothiazolinone**	
Whitening agent	✅	✅	
Colorants	✅	✅	
Fragrances	✅	✅	

Laundry greywater typically contains many substances that can impact plant health. Detergents, which contain surfactants, phosphates, and builders, are commonly found in greywater and can affect plants growth and seed germination. Soap residues in the water can modify the pH of the soil in which the plant is in and can cause damage to the roots of a plant. Fabric softeners contain salts, which impact the salinity of the soil and slow down plant development (International Product, 2022). Dirt and organic matter in the greywater may be beneficial to plants in small amounts; however,excess amounts of organic matter can lead to anaerobic conditions, which harm the plant's health. Additionally, bleach and other additives can

be toxic to plants when in high concentrations, hampering root growth and germination (Chan, n.d.).

Laundry Greywater and Seed Germination

Research on the suitability of greywater for plant growth has been a growing area of interest due to concerns about water conservation and sustainable agricultural practices. A study published in the *International Journal of Scientific & Engineering Research* (K.N., 2022) explored how detergents in laundry greywater impacted the soil properties and seed germination. The researchers used various concentrations of laundry greywater to grow mung beans and found out that the germination rate of mung beans was reduced due to the presence of detergents in the irrigation solutions. Another study by Jovanic, B.R., et al (2010). proved that the detergents in water used for watering bean seeds decreased the photosynthetic activity of plants due to decrease in the concentration of chlorophyll in plants. This occurred because surfactants present in detergents interfered with the plant's ability to absorb water and nutrients, leading to stress. Due to this stress, plants diverted energy to surviving rather than growing, which resulted in reduced chlorophyll production. However, one study carried out by Hung, A., et al (2021) concluded that the low concentration (0.0001%) of laundry greywater had minimal effect on the germination of mung beans and can be safely used to support plant growth.

Variables

Variable Type	What Is Included
Constant	- number of seeds for each pot - soil starter and same sized pots

	- Light exposure - Amount of greywater used on pots - Frequency of watering each pot - Data collected on the same day and time - Type of seeds - Type of water for preparing greywater
Independent	- The type of greywater used to water the plants. Ecomax greywater, Tide greywater, and Gain greywater.
Dependent	- height of the plants - width of the plants - colour of the plants - number of seeds germinated

Procedure

Step	Action
1.	Measure 50g of Miracle Grow seed starting potting mix using a scale and place it in a pot
2.	Repeat step one for the remaining empty three pots

3.	Preparation of simulated greywater:
a.	Measure 100 ml of tap water
b.	Take 1 mL of liquid Tide and dissolve it in the previously measured 100 mL
c.	Repeat step a and b for preparing simulated laundry greywater for Gain by using 1 ml of Gain in place of liquid Tide
d.	Repeat step a and b for preparing simulated laundry grey water for Ecomax by using 1 ml of Ecomax in place of liquid Tide
4.	Sow 3 pea seeds in each of the 4 soil pots, each approximately 1 cm deep
5.	Label and number each pot using the sticky notes and pen in the following order: 1. Gain (Pot 1) 2. Ecomax (Pot 2) 3. Tide (Pot 3) 4. Water (Pot 4) **These indicate which pot is watered by which greywater.**
6.	Measure 50 ml of Gain greywater and pour it slowly into pot 1.
7.	Measure 50 ml of Ecomax greywater and pour it slowly into pot 2.
8.	Measure 50 ml of Tide greywater and pour it slowly into pot 3.
9.	Measure 50 ml of tap water and pour it slowly into pot 4.

10.	Set the Root Farm- All Purpose LED Grow Light according to the instructions and place it in an untouched location.
11.	Place the 4 pots with seeds and water under the led light. Make sure to leave the lights on for 16 hours and turn lights off for 8 hours. Repeat for the course of three weeks.
12.	Water the seeds every second day for 3 weeks with the stimulated greywater or water (remake greywater per step 3 every time seeds are watered)
13.	After three weeks, measure the height and width of each individual sprout that has germinated and note both the height and width of the sprout in the notebook with the pen. The width should be measured from the tip of a leaf to the tip of the opposite leaf.
14.	Analyze the results
15.	Repeat steps 1 through 14 for the next 2 trials

Observations & Analysis

Trial 1: January 2 - 23, 2025

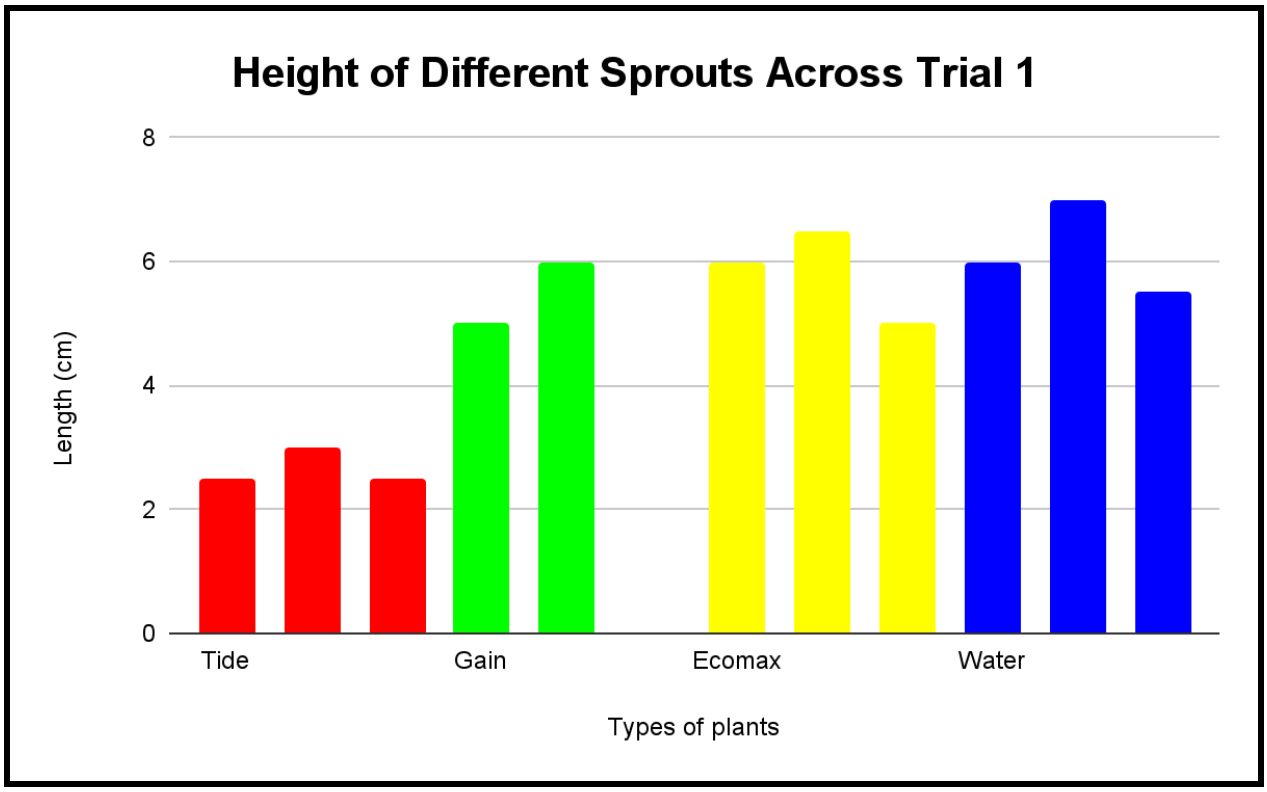
Greywater Type	Plant Number	Length (cm)	Width (cm)
Tide	#1	2.5	1.5
	#2	3	1.5
	#3	2.5	1
Gain	#1	5	2.5
	#2	6	3
	#3 (did not grow)	N/A	N/A
Ecomax	#1	6	3.5
	#2	6.5	4
	#3	5	3
Water (control group)	#1	6	4
	#2	7	4.5
	#3	5.5	4

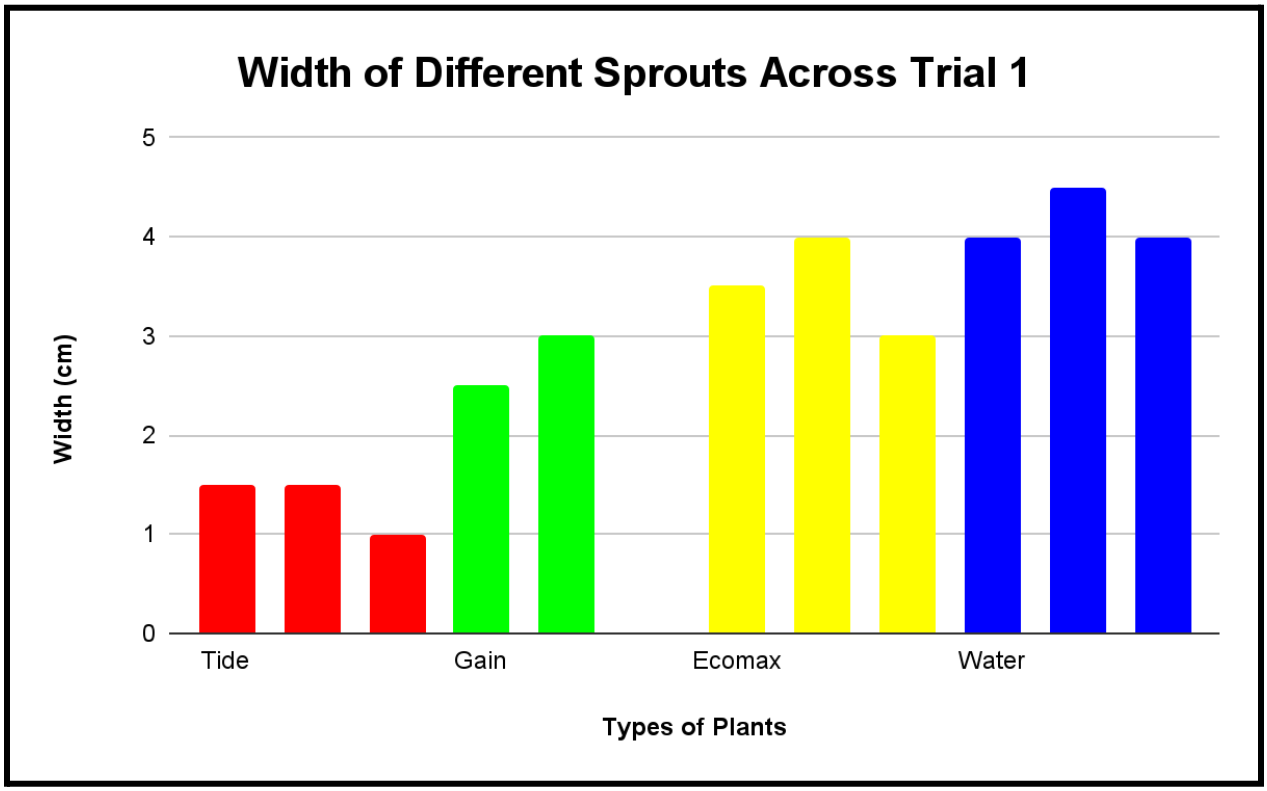
Trial 2: January 27, 2025 - February 17, 2025

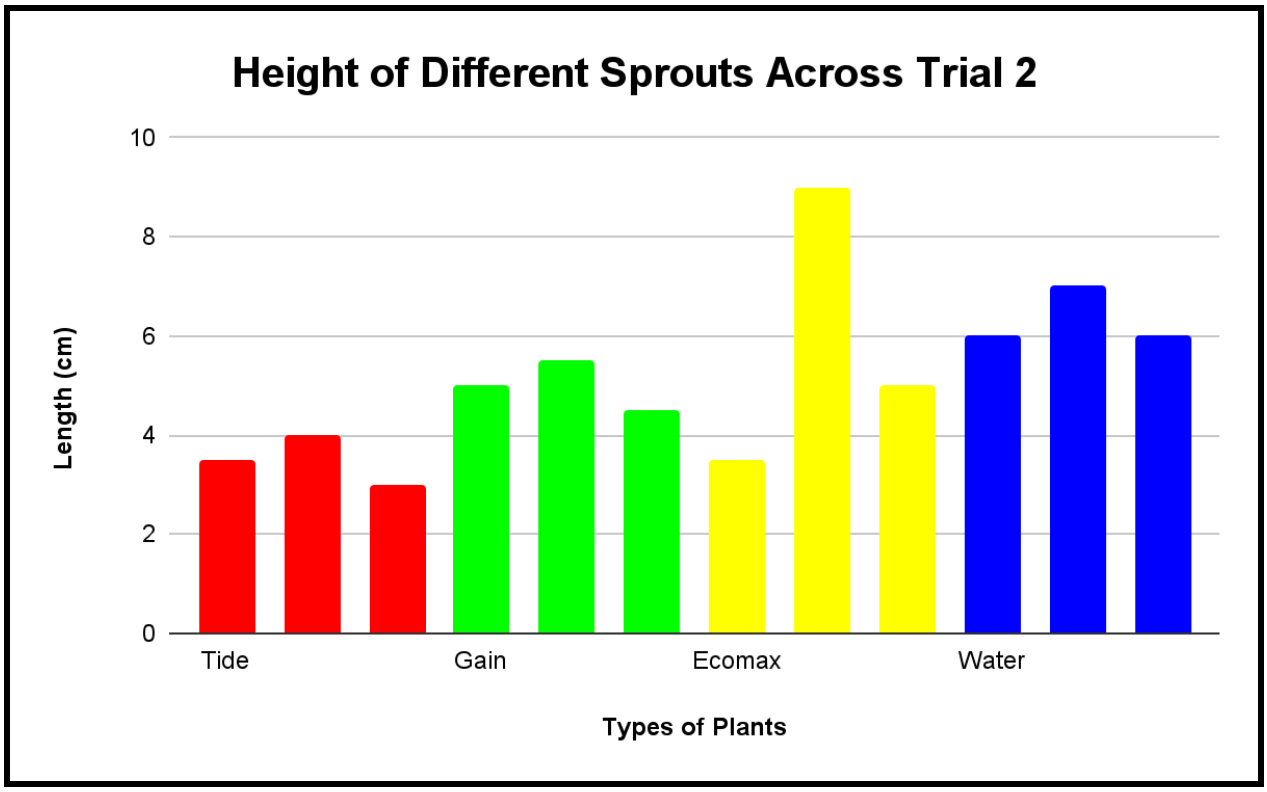
Greywater Type	Plant Number	Length (cm)	Width (cm)
Tide	#1	3.5	2
	#2	4	2.5
	#3	3	2
Gain	#1	5	2.5
	#2	5.5	3
	#3	4.5	2.5
Ecomax	#1	4.5	3
	#2	9	2.5
	#3	5	3.5
Water (control group)	#1	6	4
	#2	7	4.5
	#3	6	4

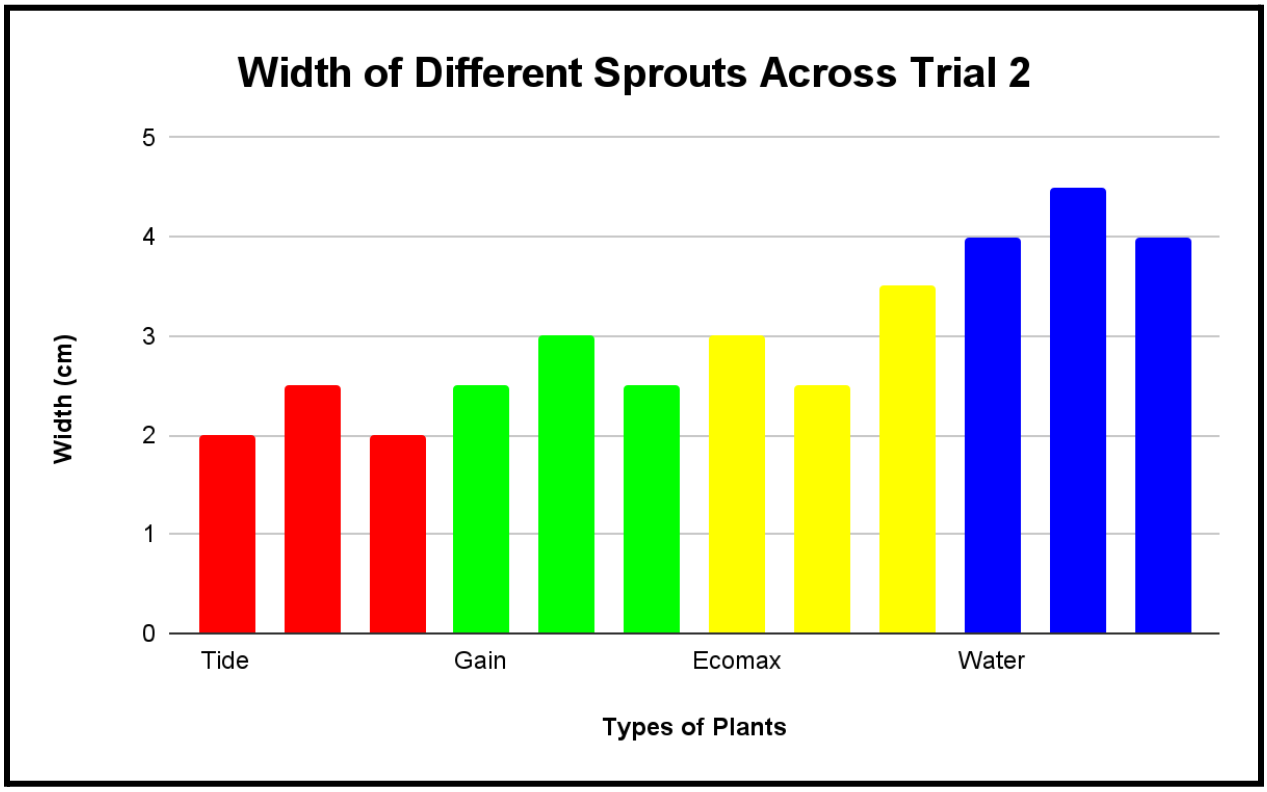
Trial 3: February 4- 25, 2025

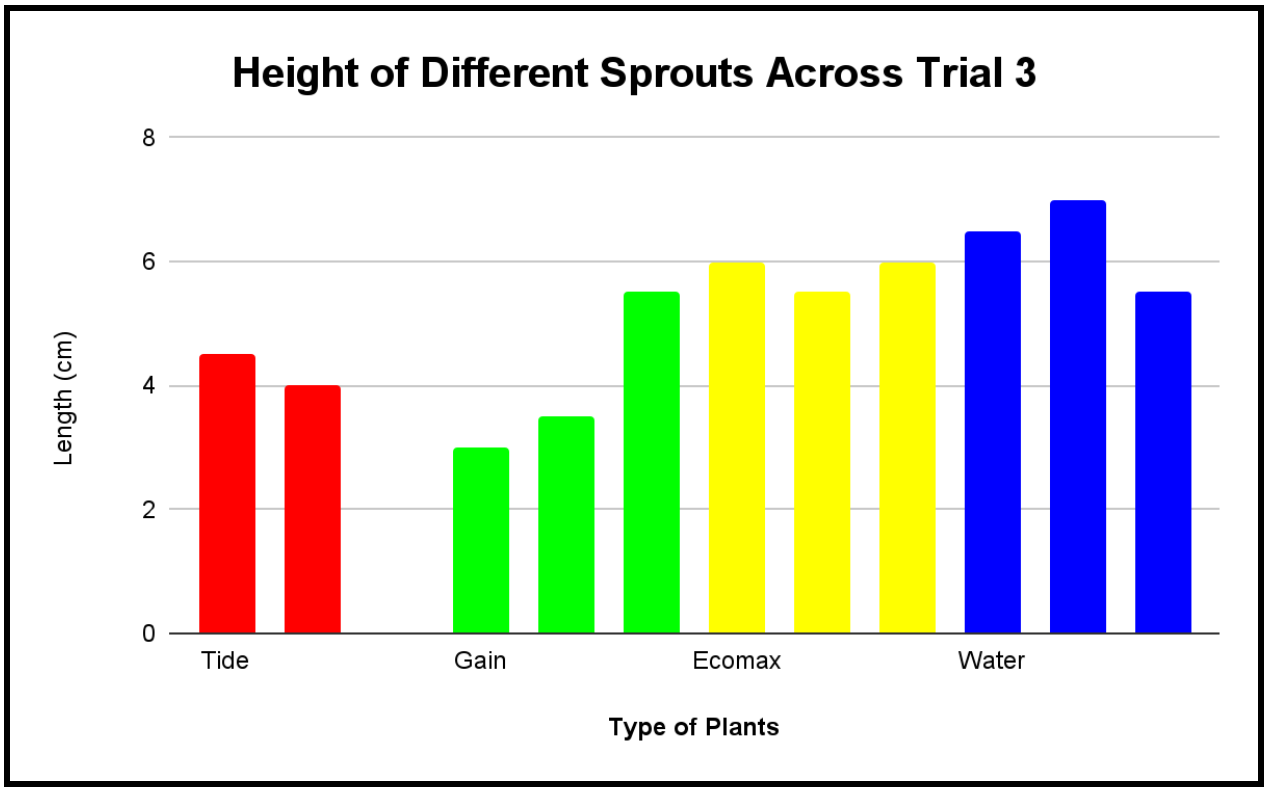
Greywater Type	Plant Number	Length (cm)	Width (cm)
Tide	#1	4.5	2.5
	#2	4	2.5
	#3 (did not grow)	N/A	N/A
Gain	#1	3	2
	#2	3.5	2
	#3	2	1.5
Ecomax	#1	6	4
	#2	5.5	3
	#3	5	3
Water (control group)	#1	6.5	4.5
	#2	7	4.5
	#3	5.5	3.5

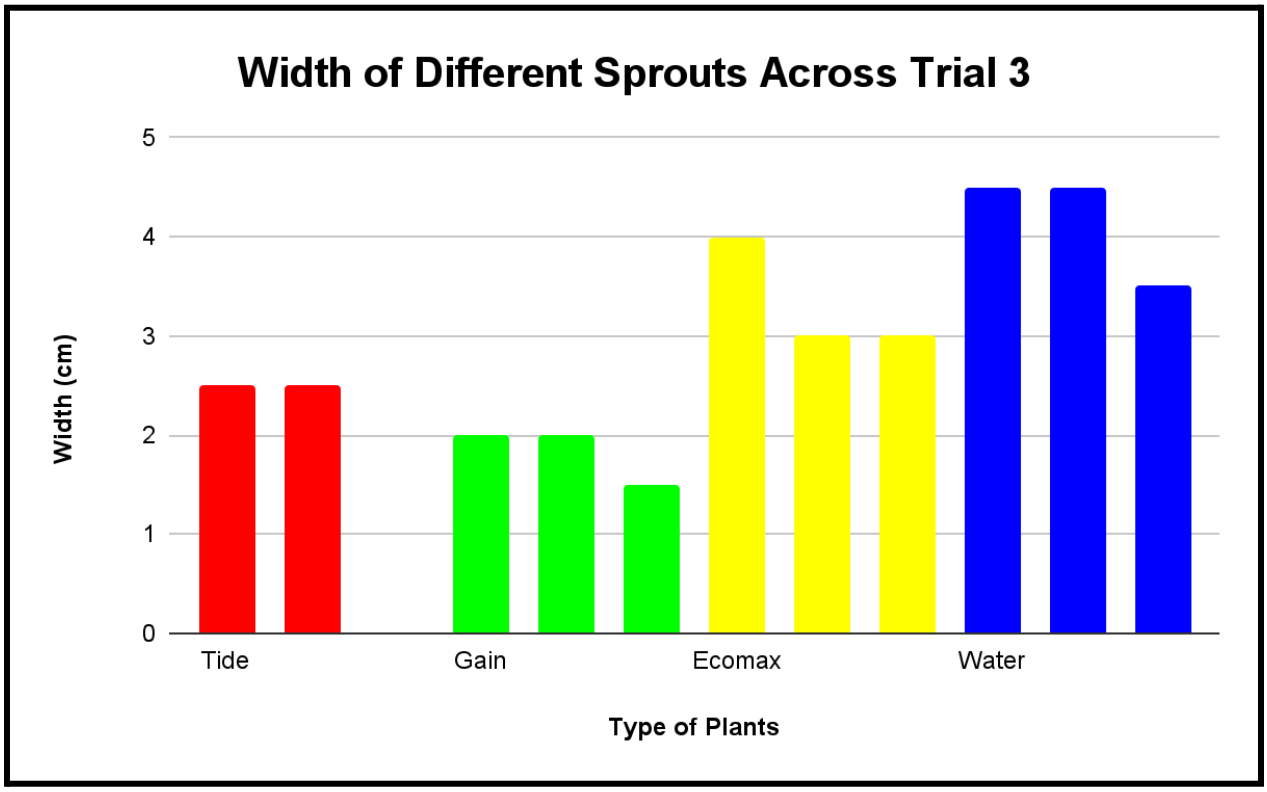

Height of Different Sprouts Across Trial 1
Length (cm)
8
6
4
2
0
Tide
Gain
Ecomax
Water
Types of plants


Width of Different Sprouts Across Trial 1
Width (cm)
5
4
3
2
1
0
Tide
Gain
Ecomax
Water
Types of Plants


Height of Different Sprouts Across Trial 2
10
8
6
4
2
0
Length (cm)
Tide
Gain
Ecomax
Water
Types of Plants


Width of Different Sprouts Across Trial 2
5
4
3
2
1
0
Width (cm)
Tide
Gain
Ecomax
Water
Types of Plants


Height of Different Sprouts Across Trial 3
Length (cm)
8
6
4
2
0
Tide
Gain
Ecomax
Water
Type of Plants


Width of Different Sprouts Across Trial 3
Width (cm)
5
4
3
2
1
0
Tide
Gain
Ecomax
Water
Type of Plants

Analysis

After carefully viewing my observation, I analyzed my work and noted the following:

Plant Height & Width

The above data explicitly depicts that plants in the control group (tap water) grew the tallest (5.5 - 7 cm) and widest (3.5 - 4.5 cm) with healthy leaves and no visible signs of stress in all three trials. Plants watered with tide greywater experienced the smallest growth both length (2.5 - 4 cm) and width (1 - 2.5 cm) in all the trials. The seeds watered with Gain greywater also exhibited stunted growth (length 3.5 - 6 cm & width 1.5 - 2.5 cm) compared to the control group, although their growth was more pronounced than that of the seeds watered with Tide greywater. On the other hand, seeds watered with Ecomax greywater experience the plant growth most similar to the control group with the length between 5 cm to 9 cm and width between 2.5 cm to 4 cm.

Seed Germination

Another factor observed was the rate at which the seeds had started to sprout above the surface of the soil. Generally, the seeds watered with Gain-infused water had come up first, but did not grow much in height afterward. In the second trial, one of the Ecomax sprouts had reached the height of 9 cm, yet bore very few leaves in comparison to the other sprouts in the same pot.

Qualitative

Through all three trials, I observed a difference in the colour of the plants in comparison to each other. The seeds watered with Tide and Gain infused water were often a greyish green in comparison to the Ecomax sprouts, which had a brighter green.

Conclusion

The purpose of my experiment was to investigate what type of laundry greywater produced from Gain, Tide, and Ecomax was suitable for seed germination and plant growth of pea seeds. For this, pea seeds were grown over the course of three weeks with different laundry greywaters. The data gathered after three weeks supported my hypothesis and seeds grown by using Ecomax laundry greywater demonstrated optimal growth which was similar to the control group. On the other hand, the plants watered with Tide exhibited the most stunted growth followed by Gain. This has occurred because there are high concentrations of chemicals in Tide, such as surfactants and phosphates, which are toxic to plants. These chemicals appear to inhibit the plant's ability to absorb nutrients and water, leading to reduced chlorophyll production and overall plant health.On the other hand, ingredients in Ecomax are plant-based which do not interfere with absorption of nutrients from the soil. Future studies could explore different plant species, additional types of greywater, or methods of greywater treatment to further refine safe practices for using greywater in gardening and agriculture.

Applications

The experiment shows that eco-friendly detergents, like Ecomax, have a less detrimental impact on plant health compared to average detergents. This suggests that eco-friendly products, which typically contain fewer harmful chemicals, may be a better choice for those looking to reuse water in gardening or farming. For urban gardeners or those in areas with limited water supply, the results suggest that laundry greywater from Ecomax can be a valuable resource for keeping gardens thriving while reducing dependence on freshwater sources. In other words, this experiment underscores the potential of recycling water and managing resources more efficiently, contributing to the broader goal of water conservation. By reusing laundry greywater

in a controlled way, households and communities can reduce water waste, helping to mitigate the challenges posed by water scarcity in many parts of the world.

Sources of Error

One of the potential errors that may have occurred during the experiment includes variations in light exposure intensity and the amount of detergent concentration that the plants received. Although 1 mL of detergent was equally added to 100 mL of water, small differences in measurement might have made some detergent mixtures more or less concentrated than intended. Also, the Root Farm All-Purpose LED Grow Light was intended to be operated for 16 hours daily; however, there could have been instances when the light was turned on for one extra hour.

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I would like to express my gratitude to my mentor, Ms. Haney, for her guidance throughout the science fair process and for providing the Root Farm All Purpose LED Grow Light, which was essential for germinating the sprouts within the trial period. I also appreciate Ms. Adrienne, my English teacher, for reviewing my paper and helping me correct any grammatical errors. Lastly, I would like to thank my parents for their continuous support during the experiment and for purchasing the necessary supplies for the project. Last but not least, I would like to thank Dr. Shahin and Dr. Soares for organising CYSF at Renert School and giving me this opportunity.

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