Forest Fire Frenzy

Research Ideas: Forest fire impacts on soils (organisms and plant flora)

- Want to stick with fire
- Thinking about environmental impacts of Forest Fires

Possible research questions

1. What kind of fire extinguisher chemicals could help grow back plants faster after a forest fire?
2. How does using fire extinguisher chemicals affect soil pH before and after using it?
3. How can we reduce the amount of pollution created by forest fires?

Research Question

What kind of fire extinguisher chemicals could help grow back plants faster after a forest fire?

- Water
- Fire extinguisher

Research

1. What causes Forest Fires?
   - Hot, dry weather and lightning strikes
   - fuel, ignition and weather
   - Climate change is predicted to worsen all three ingredients across most of Canada
   - global warming is a threat to our forest
   - The cloud that the lightning is in has a negative charge and the surface of the Earth has a positive charge therefore the two connect making a lightning strike

2. What chemicals are used to put out fire? Government of BC - Wildfire
   - Main focus in putting out fire: oxygen
   - Water: evaporates quickly but not effective
     (How does water put out fire?) Water puts out fire by absorbing heat to make the fuel cooler. If the flame cannot heat up the fuel it cannot be vaporized, so you cannot create a flame. They also add alkaline salt to water as a new anti-freezing agent. Class A fires (natural fires, paper plastics, cloth) use only water to put it out (Firefighting Canada)
   - Foam: better than water but not so efficient
     (How does foam put out fire?) Foam puts out fire by putting a "blanket" over the fire blocking all flammable vapors to escape from the fuel. The aqueous film-forming foams (AFFFs) have Perfluoroalkyl substances (
     PFAS). PFAS also acts as a blanket. PFAS foams are more effective than fluorine free foams. Water based foam extinguishers put out Class B fires (kitchen fires, flammable liquid)

     How does the fluorine in the PFAS affect plants?
     The fluorine is absorbed by the plants and it takes up the place of other nutrients. It affects the process of photosynthesis and respiration.
   - Fire retardants: best option of all of these but can degrade or break down due to the heat

     Fire retardants used in BC have Phos-check or diammonium sulfate. Diammonium sulfate puts out fire by releasing carbon dioxide that cools and suffocates the fire. This ingredient is safe for agriculture fertilizers.

     (BC Fire Retardant) BC crew uses a red dye in their retardants called Red Iron Oxide to see where the retardant landed. The red iron oxide is good for soil because it helps improve soil quality and gives nutrients to the plants.

     How does diammonium sulfate affect Albertan soil?
     - What pH level do most plants prefer?
       Plants prefer 6.2-6.8 of a pH
     - What is the general pH level of the soils in Alberta?
       6 or less.

- How does diammonium sulfate affect soil pH?
  (NH4)2SO4 is the chemical formula for diammonium sulfate and when mixed with soil forms an acid that helps put out the fire. The diammonium sulfate + soil produces alkaline ammonia and neutral calcium sulfate. The ammonia then reacts with hydronium ions to make nitric acid. So the soil that has around 6 pH now reduces to 5.5 pH.

- How does fire fighting chemicals sometimes help plants grow?
- In a study they found out that the firefighting chemical ammonium polyphosphate helped the plants grow taller and it made twice as many plants as the unburned area. This acted as a fertilizer to help the plants grow. They also found that FFCs with phosphorus helped with shoot growth.

- https://www.amerex-fire.com/upl/downloads/library/fire-extinguisher-product-catalog-english.pdf

- What are the ingredients in the fire extinguisher we used?
- It has mono ammonium phosphate. Having phosphate will affect plant growth by increasing shoøt growth.

3. Alternatives/ Better Methods:
   - Fire Extinguisher Powder: Fire extinguisher powder can be used as an effective fertilizer to help plants grow.
   - Preventing Environmental Impacts:
     - Learning how to control toxic firefighting trash and discuss with the firefighting rescue team
     - Stop firewater from leaving by temporarily creating a barrier for drains or using a toxic blocker or firewater containment facilities.
     - Ensure that the fire resistant chemicals comply with ozone depleting liquids and fluorinated gas regulations.

4. Effects of forest fire on the ecosystem (soil, plants, animals) Forest Fire Ecology
   - How do boreal forests form after a forest fire? Write the sequence of events
   - A fire, regrowth (1 year), burnt tree with black bat woodpecker(1 year after fire), few more plants grow after 50 years, in 100 years trees grow taller, within 200 years it forms the boreal forest.
   - Write 3 different ways that forest fire affects the health of an ecosystem?
     (https://parks.canada.ca/nature/science/conservation/feu-fire/feuveg-fireveg/dirige-prescribed/role)
   - Wood boring insect's population increases because of the fire. They eat the wood on the dead trees. Fungi and parasitic plants population decreases since they are temporarily removed. Diseases and insects are reduced because their shelter is gone.
   - Fire releases nutrients to help plants grow which means fire is sometimes good
   - plants can adapt to fire in 4 ways, one is increased seed release, two is increased flowering and fruiting, third is some plants have fire resistant bark and buds, and fourth is plants sprout from undisturbed root systems.
   - Fire releases nutrients like nitrogen which helps grass grow.
   - How does heating affect the chemical properties of the soil?
     (https://www2.nau.edu/~gaud/bio300w/frsl.htm#:~:text=By%20altering%20soil%20physical%20properties,moisture%20and%20lower%20soil%20porosity.)
   - If hydrophobic polymers are in the soil water is blocked from getting in because of high temperatures.
   - How does it affect the physical properties of the soil?
   - The fire causes loss of soil structure and soil porosity. This is bad since water and minerals can't get through.

5. How do different species react and adapt to the forest fire?
   Forest Fire Ecology
   After forest fires the first few plants and trees that grow are aspen and birch grow within the first year because the trees are gone so nothing is blocking the sun. Jack pine and lodgepole pine have cones which involve seeds. These seeds come out by having the heat of the fire open the cone to release the seeds. The fire's heat is what is required to open the cones to free the seeds. The fire gets rid of all competition. When the fire burns trees and plants, the nutrients go into the soil. Black spruce takes a long time to grow. White cedar and white spruce takes 150 years to grow back. They are rare in areas with multiple forest fires.

6. Humans and Animals™- https://greensciencepolicy.org/harmful-chemicals/flame-retardants/wildlife-map
   https://www.theguardian.com/environment/2023/oct/18/flame-retardant-pollution-endangered-wildlife#:~:text=The%20chemicals%20were%20found%20at,distances%20through%20water%20and%20air.

7. Lodgepole pine seeds
https://www.awes-ab.ca/species/lodgepole-pine/#:~:text=To%20achieve%20this%20lifespan%2C%20lodgepole,but%20more%20competitive%20white%20spruce.
    - They are called pioneer trees because they are important and because they're fast growing and easily grow back after a forest fire.
    - What are the best growing conditions for these seeds? Sandy, lots of sun, loamy soil
    - It does not tolerate flooding so you should not overwater them

8. Why do lodgepole pine trees grow better after a forest fire?
(https://natural-resources.canada.ca/our-natural-resources/forests/wildland-fires-insects-disturbances/forest-fires/fire-ecology/13149)
    - All the big plants fell so there is room for the little ones to get sunlight without the big ones blocking it.
    - The forest fire gets rid of their competition so they don't have to fight for nutrients.
    - they need fire to release the seeds because their seeds are covered in a thick skin
    - Flame retardant chemicals can affect aquatic animals because animals get these chemicals and then more animals eat the other animals passing on the chemicals. This is bioaccumulation. Chemicals get into the water by rain and soil erosion.
    - Humans are affected by flame retardant chemicals…
9. Types of extinguishers:
    - We used a class ABC dry chemical extinguisher for all the treatments that needed the extinguisher. Other types of extinguishers include: Class D, Class K, Carbon dioxide extinguisher. Class ABC can put out paper, cloths, oil, paint, and electrical equipment. Class K extinguishers can put out cooking oils and fats. Class D extinguishers can put out metal fires such as magnesium, sodium & potassium.Carbon dioxide extinguishers are usually used for putting out class B & C fires and can replace oxygen which makes the fire gone.

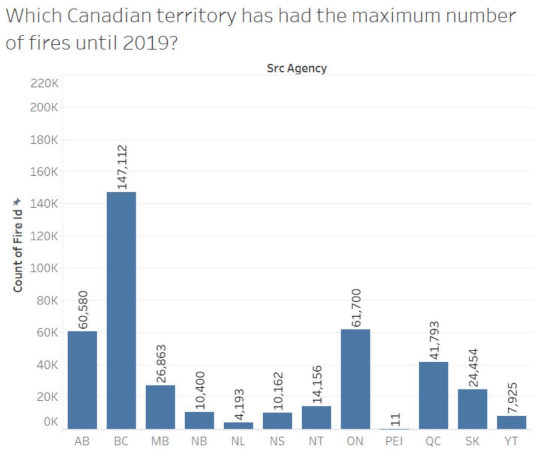


Fig. 13: Determining the region with largest number of fires

Fig. 14: Using area marks for forest area and line marks for average number of fires.

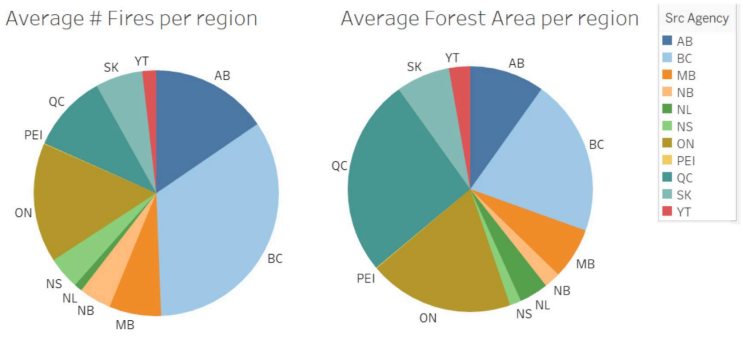


Fig. 15: Using a pie chart to represent forest area and average number of fires.

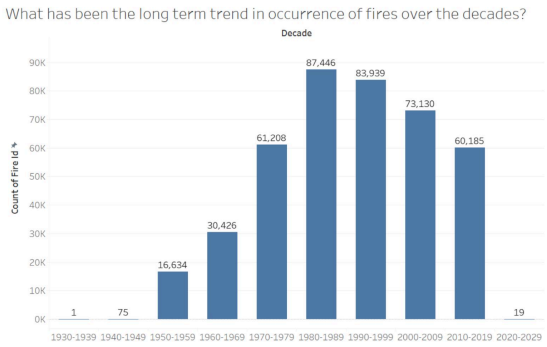


Fig. 18: Design choice for analysis of trends in occurrence of fires over the decades

Hypothesis

I think that water would be the best option for putting out the fire and not harming the plants in the forest because water does not have any harmful chemicals. The reason I did not pick the fire retardants/extinguisher is because I learned from research that it has diammonium sulfate which reduces the pH of the soil which is not good for the plants. Most plants prefer a pH of 6.2-6.8. But water helps plants grow and it puts out fire efficiently.

Materials

- Lodgepole pine (9)
- Spruce trees (6 for each test) (old trees that were 2 years old that were given to us)
- Grass seeds
- Plant pots
- Soil
- Water
- Fire extinguisher (2 kinds - water, Class ABC dry chemical chemical extinguisher)
- Gloves
- Goggles
- Mask
- Measuring spoons/cups
- Masking tape and a sharpie/marker
- Measuring tape
- Ziplock bag
- pH meter

Variables

Controlled:

- Amount of fire extinguisher
- Temperature (Room temperature)
- Watering schedule

- pH meter
- Amount of soil

Manipulated: Chemicals used on plants (3 kinds - water, Class ABC dry chemical extinguisher, 1/2 concentration of extinguisher))

Responding: Growth of plants

Procedure

1. Get the soil and pots. Label each pot with the type of chemicals/treatment used
2. Use a measuring cup and put 4 cups of soil to each pot

For grass seeds and spruce tree seeds:

3. There are 9 grass seed pots (3 for each treatment - Water ½ extinguisher and extinguisher)
4. There are 9 spruce tree pots (3 for each treatment - Water, ½ extinguisher and extinguisher)
   **Note: Realized that the foam spray was the same as the extinguisher. Changed the treatment to ½ extinguisher instead.
5. ½ extinguisher treatment: Add ½ tbsp of extinguisher then mix with 4 teaspoon water (labeled F1, F2, F3). This was done on August 18, 2024
6. For extinguisher treatment: Measure equal amount (15ml/1 tablespoon) of fire extinguisher powder and add to the grass seed pots (E1, E2, E3)
7. Water treatment: Add same amount of water to each pot (30-80mL)
8. After sowing, plant the seeds regularly for all pots
9. Sow the seeds about 6mm deep in the soil
10. Plant the seeds and place it near a window
11. Water the grass seed approximately every 3-4 days till the end of the experiment
12. Start recording the height of the sprouted plant and pH about every week
13. Make observations about the health/color of the plant and any other changes

Lodgepole pine seeds (See Appendix for full instructions)

14. Soak the lodgepole pine seeds for 10 mins
15. Put the seeds on a wet paper towel in a ziplock bag and store them in the fridge for 21 days.
16. Place a peat pellet in a deep dish filled with water
17. Wait for 20 mins
18. Put the peat pellet in the plant pot
19. Dig holes in the peat and plant the lodgepole seeds in the pots. Spread evenly.
20. Add the lodgepole pine to medium size pots and replant with more soil.
21. Fill with soil to the line on the pot, then add 30 ml of water to the soil. (12 pots)
22. Then after planting, add 60 ml of water to each plant.

23. For extinguisher treatment: Measure equal amount (15ml/1 tablespoon) of fire extinguisher powder and add to the lodgepole pine pots (E1 (T), E2 (T), E3 (T))
24. For ½ extinguisher treatment: Add ½ tbsp of extinguisher then mix with 4 teaspoon water (labeled ½ E1 (T), ½ E2 (T), ½ E3 (T))
25. Water treatment: Add same amount of water to each pot (30-80mL)




June 22 2024

Observations

Watering schedule

- 150ml each time (too much water, so lower for next day) - June 22, 2024
- June 22, 2024 watered with 150 mL (too much)
- June 23rd - 70 mL
- June 24th - 100mL for seeds and 150mL for trees
- June 26 - 60 mL for both
- June 28 - 60 for both
- July 1 - 80 for both

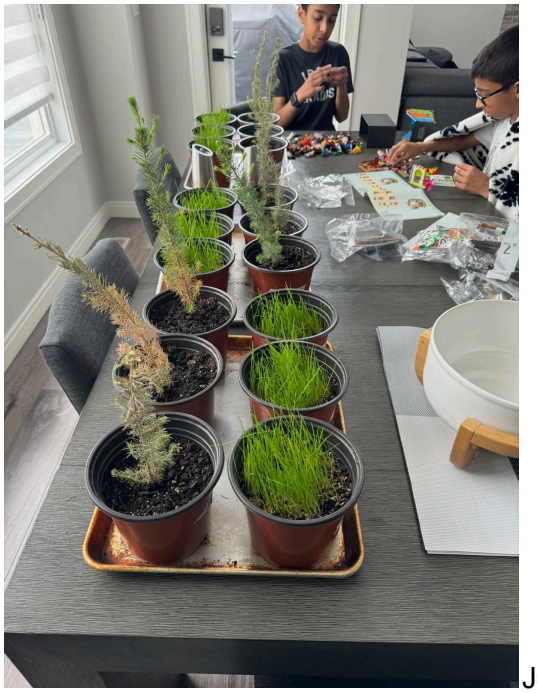
Update: July 8, 2024

- All extinguisher plants died and foam 1 and 2 died and water 2 and 3 died. Water 1 and foam 3 stayed alive. We knew others were dead because they were the color of brownish yellow instead of green.

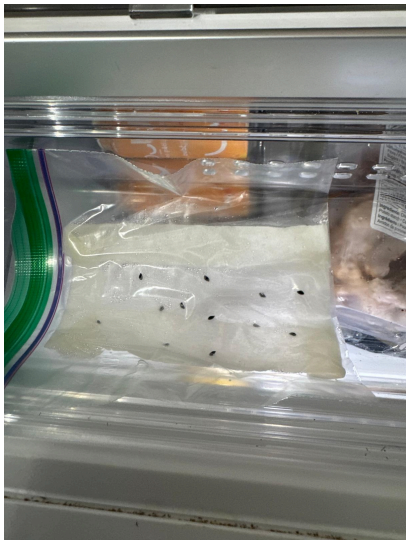
Table 0: The amount of water added to spruce trees and grass seeds (mL)

Date	All 9 Spruce trees (mL)	All 9 Grass seeds (mL)
June 22, 2024	150	150
June 23, 2024	70	70
June 24, 2024	100	150
June 26, 2024	60	60
June 28, 2024	60	60
July 1, 2024	80	80
July 4, 2024	80	80
July 7, 2024	80	80
July 9, 2024	80	80
July 10, 2024	80	80
July 11, 2024	160	80
July 13, 2024	80	80
July 18, 2024	80	80
July 20, 2024	60	60
July 22, 2024	60	60
July 24, 2024	80	80
July 26, 2024	0	80
July 28, 2024	80	80
July 30, 2024	80	80
Aug 1, 2024	0	80
Aug 4, 2024	80	80
Aug 7, 2024	80	80
Aug 11, 2024	80	80
Aug 15, 2024	80	80

Aug 18, 2024	1 tbsp+7.5 mL	1 tbsp+7.5 ml
August 23	80	80
Aug 26, 2024	80	80
August 29, 2024	80	80
Sept 2, 2024	80	80
Sept 5, 2024	80	80
Sept 8, 2024	80	80
Sept 11, 2024	80	80
Sept 14, 2024	80	80
Sept 27, 2024	80	80
Sept 30, 2024	80	80
Oct 4, 2024	80	80
Oct 7, 2024	80	80
Oct 10 , 2024	80	80
Oct 13, 2024	80	80
Oct 16 , 2024	80	80
oct 20, 2024	80	80
Oct 23, 2024	80	80
Oct 27, 2024	80	80
Oct 31, 2024	80	80
Nov 3, 2024	80	80
Nov 6, 2024	80	80
Nov 10, 2024	80	80
Nov 14, 2024	80	80
Nov 21, 2024	80	80
Nov 26, 2024	80	80
Nov 30, 2024	80	80
	80	80


July 1 2024


July 9, 2024


July 26, 2024


August 1, 2024

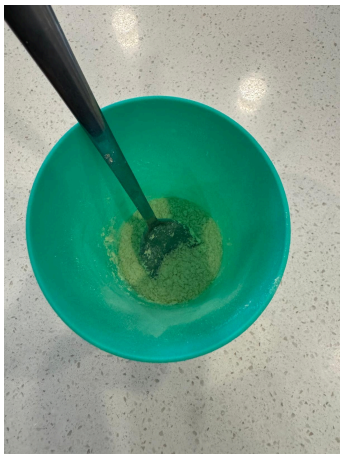





August 2, 2024

August 9, 2024


August 16, 2024



August 18, 2024

Sept 25, 2024

Nov 10, 2024

December 1, 2024

Dec 9, 2024


Dec 18, 2024


Jan 5, 2025


Jan 19, 2025


Jan 26, 2025


Feb 2, 2025

DATA FOR GRASS SEEDS AND WHITE SPRUCE TREES

Table 1A: Information for spruce trees and grass seeds treated with ½ Extinguisher (instead of foam because extinguisher and foam were the same) measuring growth and pH. NOTE: Measured plants treated with ½ extinguisher treatment until August, because all trees had died on July 24, 2024.

Date		Foam 1	Foam 2	Foam 3	Tree Foam 1	Tree Foam 2	Tree Foam 3
June 22, 2024	Height				26.7 cm	26.6 cm	29.3 cm
June 23, 2024	Growth						
	pH	8	8	8	8	8	8
July 1, 2024	Growth	8.6cm	7cm	7.8cm	26.7cm	28.3cm	32.2cm

	pH						
July 24, 2024	Growth	24.1cm	24.7cm	24.9cm		-	35.6cm
	pH	8	8	8	die	die	8 Brown needles-die ?
Aug 1, 2024	Growth	30.2	29.5cm	35			37
	pH	8	8	8			8

Table 1. Weekly record of plant height (cm) for grass seeds and white spruce trees and their pH (old data)

***Note: Tree Water 2 and 3 died on July 24, 2024 so we only tracked Tree water 1**

***Note: Extinguisher Tree all died July 1, 2024**

	W1 (grass)	**W2 (grass)**	**W3 (grass)**	**W(tree) T1**	**E1 (Grass)**	**E2 (grass)**	**E3 (grass)**	**E (tree)**
Height June 22	seeds	seeds	seeds	T1 - 26 cm T2 - 20.3 cm T3 - 24.3cm	seeds	seeds	seeds	E1-29.6 cm E2-29.8 cm E3-27.5 cm
pH June 23	7	7-8	7-8	-	8	8	8	-
Height July 1	9cm	10.3cm	10.4cm	T1 - 27.6cm T2 - 21.1 cm T3 - 25.3cm	7cm	8.5cm	7.5cm	E1-30.5cm E2-29.8cm E3-27.8cm
pH July 1	8	8	8	8	8	8	8	-
Height July 4	27.3cm	26.3cm	27cm	T1-31.1cm T2-dead T3-dead	25.1	28.1	25.8	dead
pH July 4	8	8	8	8	8	8	8	-
Height Aug 1	32.3	37.9cm	30.8cm	T1-31.1cm	28.1cm	32.1cm	33cm	dead
pH Aug 1	8	8	8	8	8	8	8	-
Height Aug 9	8.1cm	9.8cm	10.6cm	T1-37cm	5.2 cm	7.8cm	7.7 cm	31 cm
pH Aug 9	8	8	8	8	8	8	8	8

Height Aug 16	12 cm	18.5cm	17.5cm	T1-35.5cm	8.5 cm	7.9cm	7.9 cm	31 cm
pH Aug 16	8	8	8	8	8	8	8	8
Height Aug 23	17.5 cm	22.6cm	23.2 cm	T1-36.5cm	6.3 cm	9.8 cm	13.7 cm	29 cm
pH Aug 23	8	8	8	8	7	7-8	7-8	7
Height Aug 30	18.7 cm	23.5cm	27.1 cm	T1-36.6cm	3.6 cm*	4cm**	14.8 cm	29.6 cm ***
pH Aug 30	8	8	8	8	7	7-8	7	7
Height Sep 7	19.8cm	26.6cm	26.6 cm	T1-36.8cm	5.2 cm	dead	14.7 cm	27 cm
pH Sep 7	8 healthy	8	8 healthy	8	8	8	8 mostly dead	8 dying
Height Sep 14	22.2 cm	26.3cm	27.4 cm	T1-36.3cm	dead	dead	14 cm	26 cm
pH Sept 14	8	8	8	8	8	8	8	8

Table 2. Total growth of grass seeds in cm .
Note: Only includes data from August 9th onwards, as all the plants died on July 24th, 2024

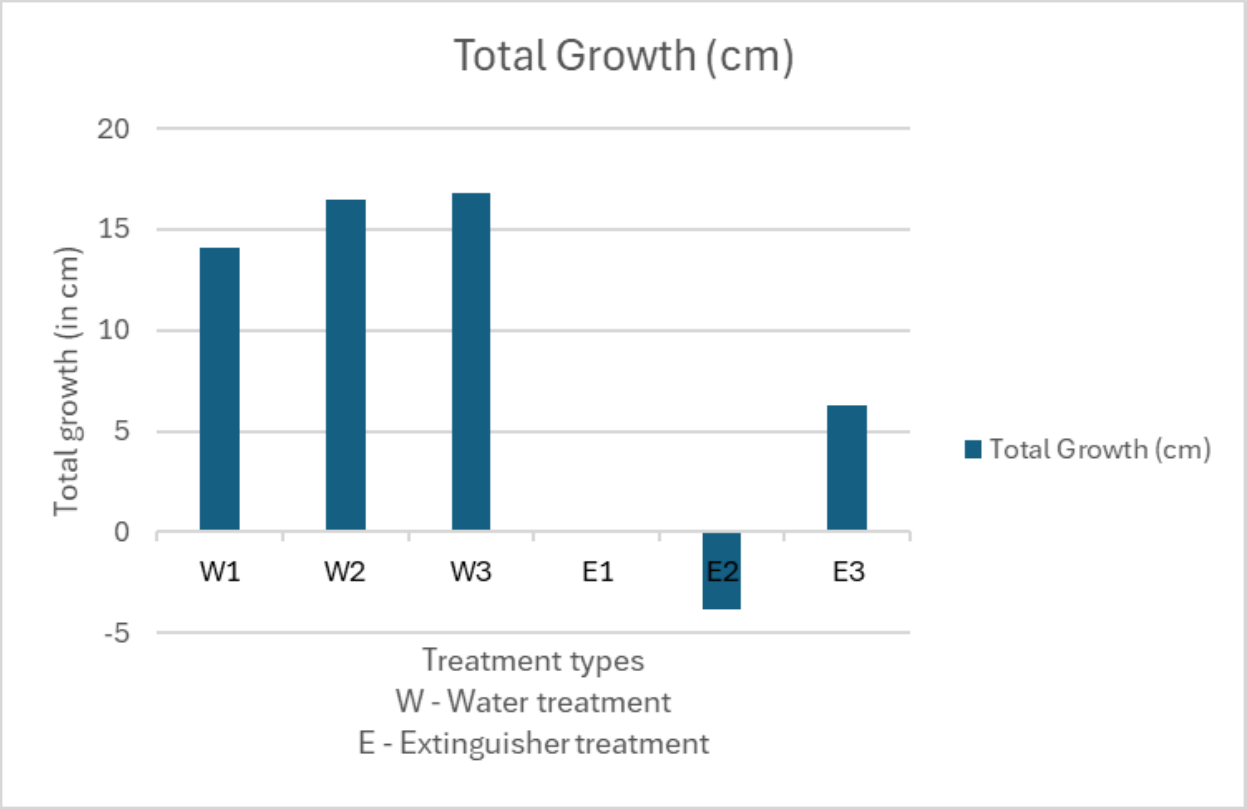
Treatment type	Final height of the plants (cm)	Initial height of the plants (cm)	Total Growth (subtract the final height from original height) (cm)
W1	22.2	8.1	14.1
W2	26.3	9.8	16.5
W3	27.4	10.6	16.8
E1	5.2	5.2	0
E2	4	7.8	-3.8
E3	14	7.7	6.3

Table 3. Average growth (in cm) of grass seeds for water and extinguisher treatments.

Treatment type	Mean growth of plants (cm)
Water	25.8
Extinguisher	2.5

Graph 1.

Note: Only includes data from August 9th onwards, as all the plants died on July 24th, 2024



Observations:

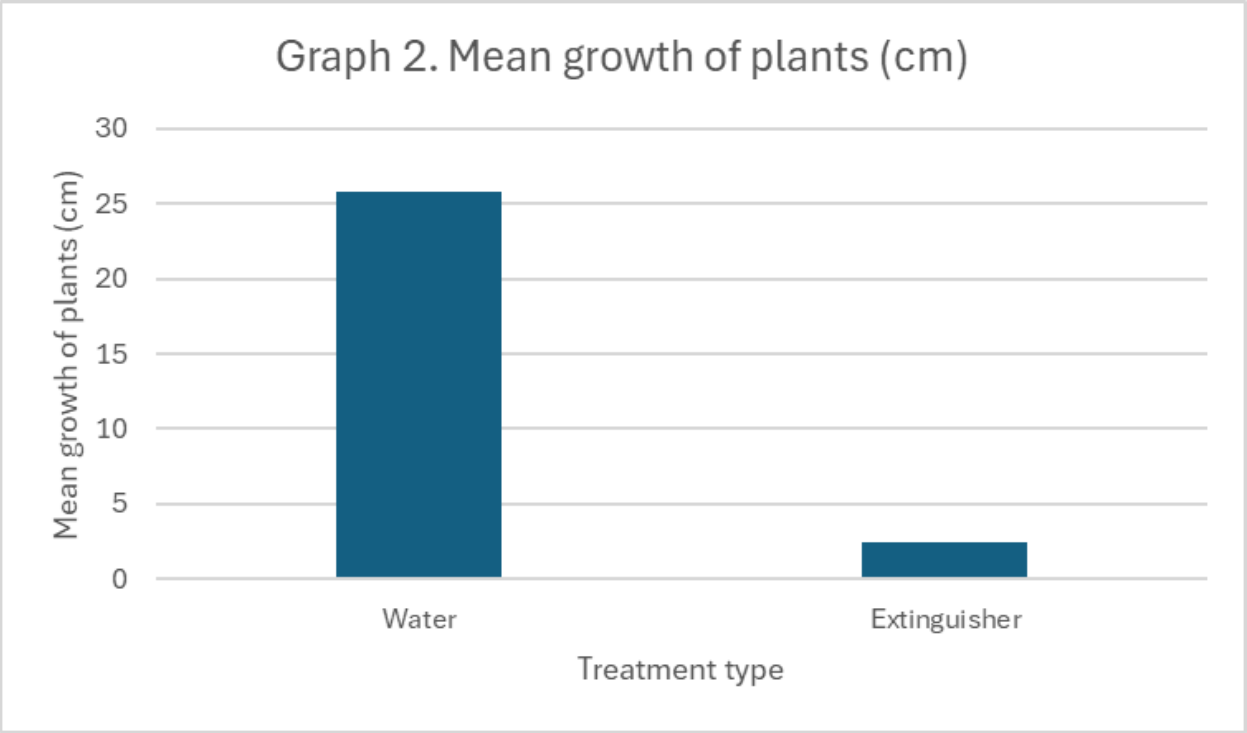
- W3 grew the most. W3 stands for a plant that was treated with water. The 3 is what number/trial it is.
- E2 grew the least. E2 means it was treated with an extinguisher. The 2 means what number/trial it is
- Overall, water treatment did the best and extinguisher treatment did the worst.

Analysis for Graph 1:

The plant that grew the most was W3. This result was expected because water is healthy for plants and extinguishers are not. So it makes sense for a water treatment to do good.

The plant that grew the least was E2. This was expected since extinguisher is not good for since it reduces the plants pH by 0.5 and it hurts the plants. They prefer a pH of 6.5 to 6.8 and reducing it by putting an extinguisher on is not healthy for the plants

Graph 2



Observations: The best growth was for water treatment. The least growth was extinguisher treatment.

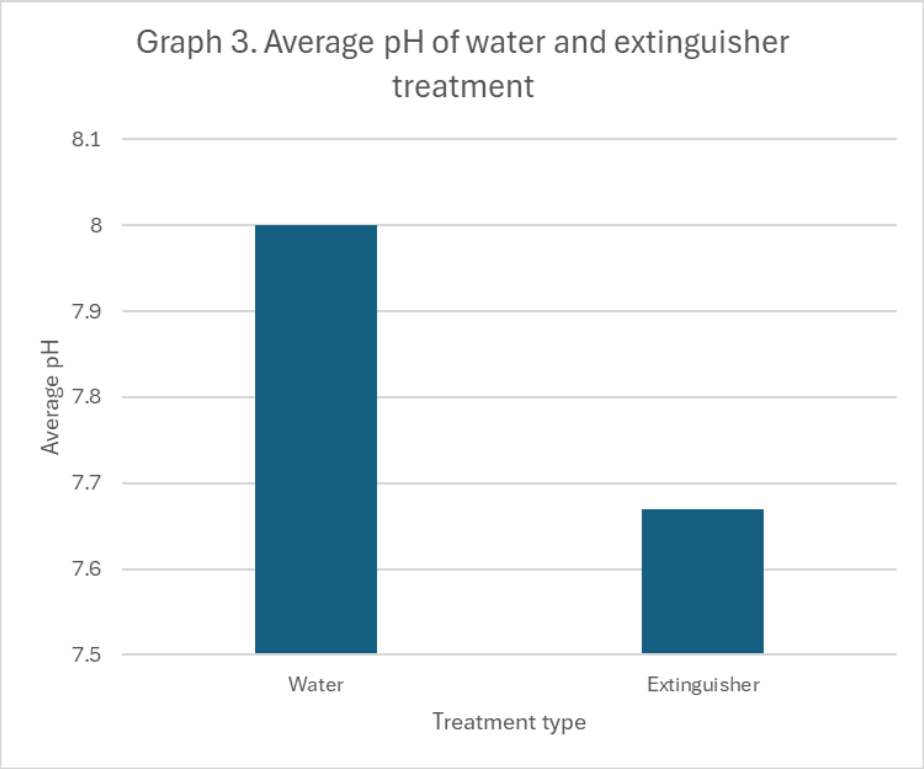
Analysis for Graph 2:

- The best treatment was water. The results are not surprising since it didn't have any harmful chemicals. Extinguisher is not good for the plants since it reduces the plants pH by 0.5 and it hurts the plants. They prefer a pH of 6.5 to 6.8 and reducing it by putting an extinguisher on is not healthy for the plants.
- The treatment with the least growth was the extinguisher treatment plant. This makes sense because an extinguisher is not a good idea to have on your plants. It is harmful to them and water works better. This makes sense why extinguisher treatment is lower than the water treatment in growth.

Table 4. Average pH of plants

Treatment type	Average pH
Water	8
Extinguisher	7.67

Graph 3:

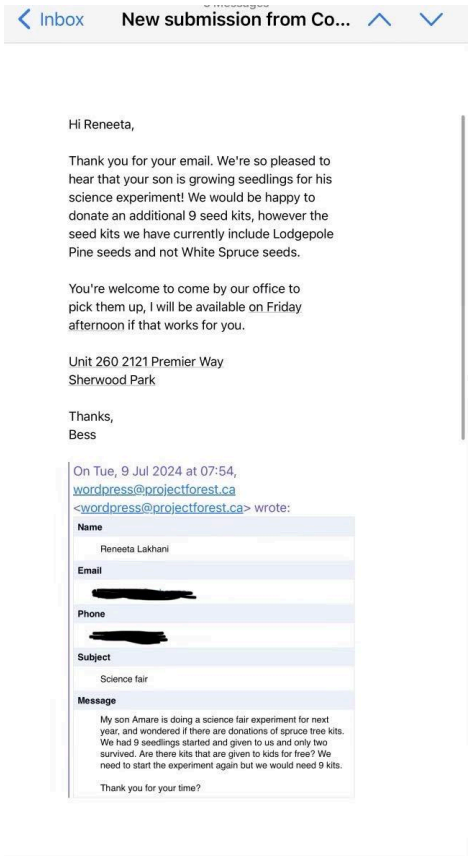


- Observations: Highest average was the water treatment. The lowest pH was extinguisher treatment.
- Analysis: Highest average of pH was for water treatment. This is expected because we used tap water. Tap water has chemicals that can affect the pH of the plants. Some chemicals include chlorine, arsenic, nitrates, and fluoride.
- The lowest average of pH was for extinguisher treatment. This is expected because of how it does not help plants grow. The chemicals affect plants by burning plant tissue and blocking the pores for gas exchange.

DATA FOR LODGEPOLE PINE TREES

Updates:
Added the lodgepole pine to med size pots and replanted with more soil. Filled soil to line the pot, added 30 ml of water to the soil. THen after planting add 60 ml of water to each plant.

New Lodgepole Pine Seeds - July 9, 2024



Inbox New submission from Co...

Hi Reneeta,

Thank you for your email. We're so pleased to hear that your son is growing seedlings for his science experiment! We would be happy to donate an additional 9 seed kits, however the seed kits we have currently include Lodgepole Pine seeds and not White Spruce seeds.

You're welcome to come by our office to pick them up, I will be available on Friday afternoon if that works for you.

Unit 260 2121 Premier Way
Sherwood Park

Thanks,
Bess

On Tue, 9 Jul 2024 at 07:54, wordpress@projectforest.ca <wordpress@projectforest.ca> wrote:

Name
Reneeta Lakhani

Email
[redacted]

Phone
[redacted]

Subject
Science fair

Message
My son Amare is doing a science fair experiment for next year, and wondered if there are donations of spruce tree kits. We had 9 seedlings started and given to us and only two survived. Are there kits that are given to kids for free? We need to start the experiment again but we would need 9 kits.

Thank you for your time?

Table 5. Weekly watering log for lodgepole pine seeds

Date	Lodgepole pine
Aug 18, 2024	15mL
Aug 19, 2024	15mL
Aug 20, 2024	15
Aug 21, 2024	15
Aug 22, 2024	30
Aug 23, 2024	30
Aug 24, 2024	15
Aug 25, 2024	30
Aug 26, 2024	30
Aug 27, 2024	30
Aug 28, 2024	15

Aug 29, 2024	15
Aug 30, 2024	30
Aug 31, 2024	30
Sept 1, 2024	15
Sept 2, 2024	30
Sept 3, 2024	30
Sept 5, 2024	30
Sept 6, 2024	30
Sept 7, 2024	30
Sept 8, 2024	30
Sept 10, 2024	80
Sept 16, 2024	30
Sept 17, 2024	30
Sept 18, 2024	30
Sept 19, 2024	30
Sept 20, 2024	30
Sept 21, 2024	30
Sept 22, 2024	30
Sept 23, 2024	30
Sept 24, 2024	30
Sept 25, 2024	Replanted lodgepole pine to pots - added 15 mL to soil and watered 60 mL
Sept 27, 2024	80
Sept 30, 2024	80
Oct 4, 2024	80
Oct 7, 2024	80
Oct 10, 2024	80
Oct 13, 2024	80
Oct 16, 2024	80
Oct 20, 2024	80

Oct 23, 2024	80
Oct 27, 2024	80
Oct 31, 2024	80
Nov 3, 2024	80
Nov 6, 2024	80
Nov 10, 2024	80
Nov 14, 2024	80 (Added fire extinguisher chemicals)
Nov 21, 2024	80
Nov 26, 2024	80
Nov 30, 2024	80
Dec 1, 2024	80
Dec 4, 2024	80
Dec 8, 2024	80
Dec 13, 2024	80
Dec 20, 2024	80
Dec 25. 2024	80
Dec 28, 2024	80
Jan 1, 2025	80
Jan 5, 2025	80
Jan 8, 2025	80
Jan 10, 2025	80
Jan 14, 2025	80
Jan 17, 2025	80
Jan 21, 2025	80
Jan 25, 2025	80
Jan 30, 2025	80
Feb 2, 2025	80

Table 6. Weekly record of plant growth (cm) for lodgepole pine seeds and their pH (new data). (W= Water treatment, 1/2 E = 1/2 tbsp extinguisher powder, E = 1 tbsp of extinguisher powder)

	W1	W2	W3	W4	½ E1	½ E2	½ E3	½ E4	E1	E2	E3	E4
Height Nov 10	5 cm	3.7 cm	3 cm	4.6cm (wilted)	3cm	3.2cm	4.9cm	4cm	3.8cm	4.3cm	3.3cm	4.6cm
pH Nov 10	8	8	8	8	8	8	8	8	8	8	8	8
height Nov 17	5	4	3.4	5.1 (wilted)	3.5	3.2	5.4	4	4.3	4.5 (wilted)	3.6	4.7
pH Nov 17	8	8	8	8	8	8	8	8	8	8	8	8
Height Dec 1	4.8	3.6	3	4.7 (wilted)	3.5	3.4	4.7 (wilted)	3.9 (wilted)	4.5	4.2 (wilted)	3.5	4.6 (wilted)
pH Dec 1	8	8	8	8	8	8	8	8	8	8	8	8
Height Dec 8	4.7	3.5	2.6	3.8 (wilted)	3.1	3.3	4.2 (wilted)	3.2 (wilted)	3.3	3.5 (wilted)	3.5	2.6 (wilted)
pH	8	8	8	8	8	8	8	8	8	8	8	8
Height dec 17	4.9	3.8	3.3	4.5 (wilted)	3.3	3.9	4.8 (wilted)	3.6 (wilted)	4	4	3.5	3 (wilted)
pH	8	8	8	8	8	8	8	8	8	8	8	8
Height Dec 22	5.1	3.8	3.2	4.5 (wilted)	3.3	3.9	4 (wilted)	4 (wilted)	4	5 (wilted)	3.4	3.5 (wilted)
pH	8	8	8	8	8	8	8	8	8	8	8	8
Height Dec 29	5.1	3.5	3.4	5.4	3.3	4	5	4.4	4	4.8	3.5	3.5
pH	8	8	8	8	8	8	8	8	7-8	7-8	7-8	7-8
Height Jan 5	5	3.3	4.6	4.9	3	4.4	5	4	4.1	4.6	3.3	5.3
pH	7-8	7-8	7-8	7-8	8	8	8	8	7-8	7-8	7-8	7-8
Height Jan 12	4.8 (wilte)	3.6	3.5	5	3 (wilted)	3.8	4.5	4.1	3.5	3.7	3.6	3.6
pH	8	8	8	8	7-8	7-8	7-8	7-8	7-8	7-8	7-8	7-8

Height Jan 19	3.8	4	3.5	4.7	4.5	3.5	4.9	4.2	4.2	4.6	3.8	4.1
pH	8	8	8	8	7-8	7-8	7-8	7-8	7-8	7-8	7-8	7-8
Height Jan 25	3.8	4	3.8	3.5	4.9	3.5	4.6	4.2	4.2	4.6	3.6	4.5
pH	8	8	8	8	7-8	7-8	7-8	7-8	7-8	7-8	7-8	7-8
Height Feb 2	5	4.8	3.9	3.1	4.4	3.8	5.2	4.3	4.4	4.5	3.7	4.5
pH	8	8	8	8	7-8	7-8	7-8	7-8	7-8	7-8	7-8	7-8

Note: * mostly dead, only one very small green piece
** mostly dead one green piece
*** pines falling off very easily

Procedure update (August 2):

- Trimmed the plants because we needed a good starting point for measuring the size.
- Shortened the grass by trimming it down to the edges of the pot (recorded in table).
- Used gloves, goggles and mask while using the fire extinguisher. Collected the fire extinguisher by spraying it into a bucket. We used a 15 mL (1 tablespoon) measuring spoon to collect the extinguisher and spread it into the plant pots (E1, E2, E3, and W1)
- Added ½ tbsp of extinguisher mixed with 4 teaspoon water (didn't mix well) on August 18th (labeled F1,2,3) Then added 1 tbsp water more to plant

Procedure update (August 23)

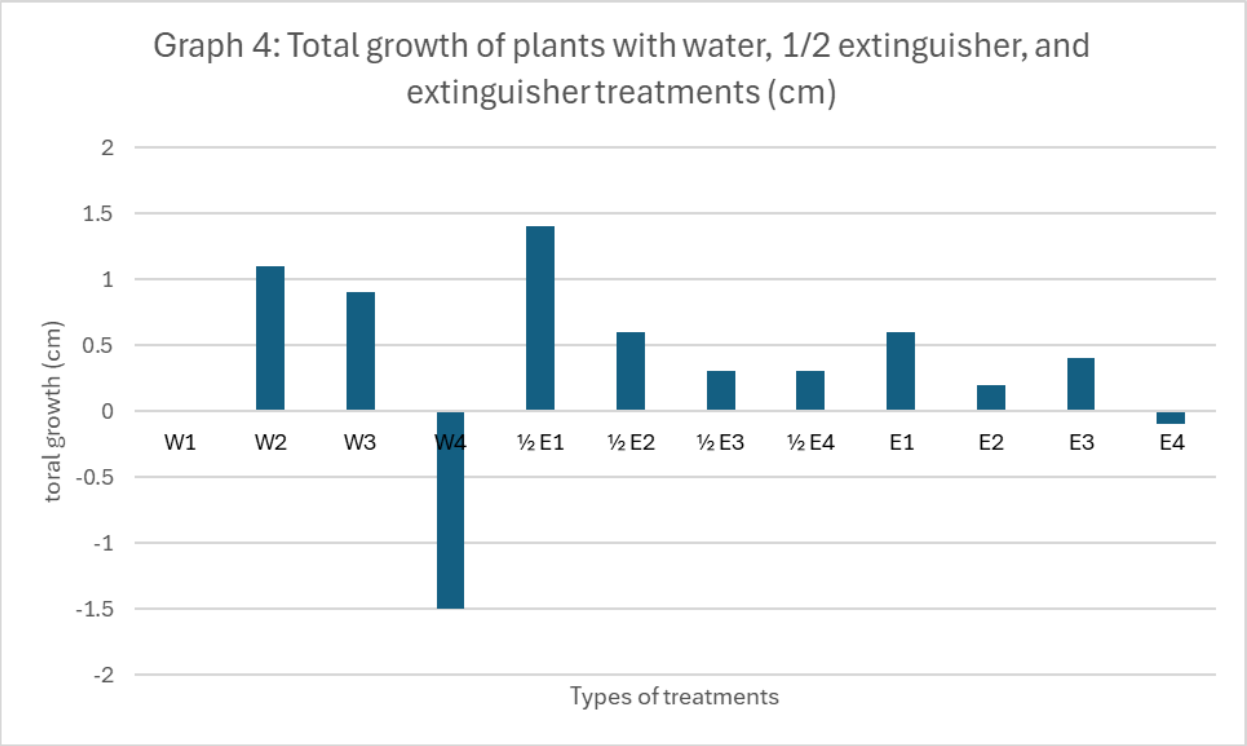
- Extinguisher plants look very dead with only a few strands of green grass. Only 1-3 strands of green. Needles on the trees are flaky and falling off.

Table 7. Record of plant growth with the different treatments

Treatment type	Final height of the plants (cm)	Initial height of the plants (cm)	Total Growth (subtract the final height from original height) (cm)
W1	5	5	0
W2	4.8	3.7	1.1
W3	3.9	3	0.9
W4	3.1	4.6	**-1.5**

½ E1	4.4	3	1.4
½ E2	3.8	3.2	0.6
½ E3	5.2	4.9	0.3
½ E4	4.3	4	0.3
E1	4.4	3.8	0.6
E2	4.5	4.3	0.2
E3	3.7	3.3	0.4
E4	4.5	4.6	**-0.1**

Graph 4:



Observations: The best growth was ½ E1 at 1.4 cm. The least growth was W4 at -1.5 cm.

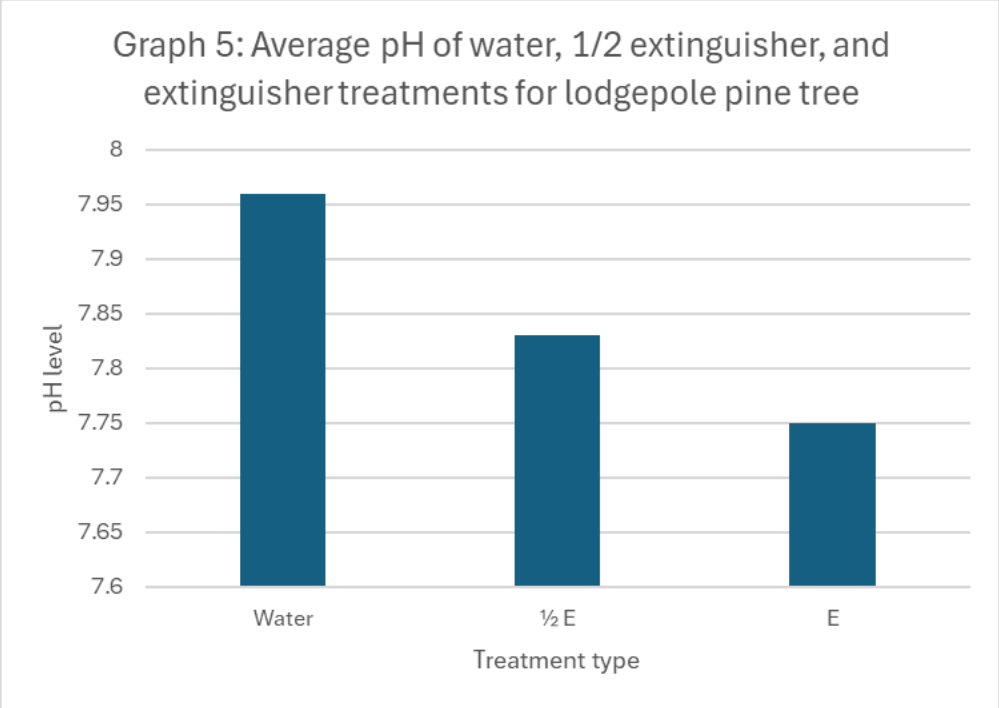
Analysis: The best growth was ½ E1 at 1.4 cm. This result is a bit surprising since I expected water to do the best. Maybe ½ E1 did best because it didn't have a lot of extinguisher chemicals on it. Also, the ABC extinguisher is an approved NPK fertilizer. ½ extinguisher treatment probably did better than water and extinguisher treatments because it was balanced between no fertilizer and too much fertilizer.

The lowest growth was W4 and maybe since water is not a NPK approved fertilizer, it doesn't have some helpful chemicals for plants. NPK stands for nitrogen, phosphate and potassium. These are the three main nutrients plaNts need.

Table 8: Average pH of water, ½ extinguisher and extinguisher treatments for lodgepole pine tree

Treatment type	Average pH
Water	7.96
½ E	7.83
E	7.75

Graph 5



Observations: The plant type that had the highest pH was the water treatment. The lowest pH was the extinguisher treatment.

Analysis: The preferred pH of lodgepole pine trees is 5 to 7.5. All the treatments gave a pH higher than this value range. This tells me that the plant did not grow in their preferred pH environment. The water treatment plants had the highest pH of all. The extinguisher treatment had the lowest pH of all. The results for the water treatment are unexpected because water is

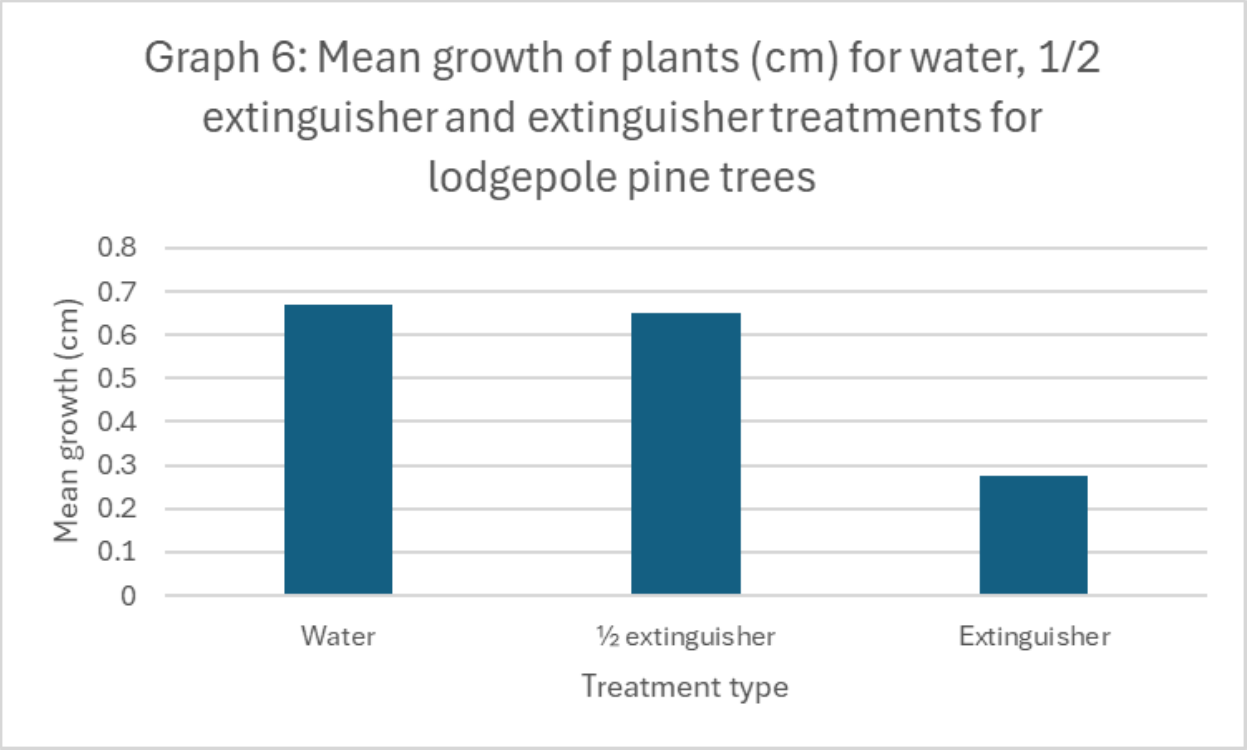
usually good for plants so I expected them to grow better. Maybe this happened because the tap water we used has chemicals that harm the plant.

Table 9. Average growth of water, ½ extinguisher and extinguisher treatments for lodgepole pine tree

Treatment type	**Mean growth of plants (cm)**
Water	0.67*
½ extinguisher	0.65
Extinguisher	0.275

***When I took the mean growth I got rid of the negative height of W (Tree) because it didn't make sense. Water should make plants grow, not shrink.

Graph 6:



Observation: The highest mean growth was at 0.67 cm for water treatment. The lowest mean growth was at 0.275 cm for extinguisher treatment.
Analysis: The results are expected since water did the best. Why I expected water to do the best was since plants need water to grow. Water does not have a monoammonium sulfate like

extinguisher so it doesn't give plants ammonium toxicity. I know that extinguishers reduce the pH of the soil. It has chemicals like monoammonium sulfate. Too much ammonium sulfate will make it experience ammonium toxicity which can cause leaves to burn, plant leaves to turn yellow, root damage and death. When the plant leaves turn yellow it means that the chloroplast is not turning the energy of the sunlight into nutrients. So the growth of the plants will stay the same or reduce. Maybe this is why the plants with extinguisher treatment grew the least.

Sources of error

Measuring plants: This was a source of error because when we were measuring the height of the plants some were drooped down. We lifted them up so that the plant was as tall as possible. We measured it using measuring tape. Sometimes I measured by myself. This might have affected the results because I had to lift and measure at the same time. Maybe when I am looking at the measurement my hand might droop along with the plant so that could be a source of error. When we lifted them up we can't get the exact height so results may be slightly different.

Plants were dead soon into the experiment: I knew the plants were dead because of their yellow color and they were drooped down. For example the W4 lodgepole pine plant wilted right after starting the water treatment. The E2 plant wilted in week 2. This made it harder to measure because they were dropped down and I had to lift them up. If I added an extinguisher to a healthy plant it would most likely end up growing a bit before dying. We should have changed our procedure to let the plants grow for longer before adding the treatment.

Watering for lodgepole pine: The watering started at 15mL and then went to 80mL.
This could be an error because I might have watered too much and too much of anything is bad. Too much water could cause the plant to flood or lack of oxygen which suffocates them. When too much water comes onto the plants it carries nutrients to the bottom of the pot so the plant can't get the required nutrients. It causes root damage and it can affect how much water and nutrients the plant absorbs.

Conclusion

I thought that water would be the best option for putting out the fire and not harming the plants in the forest because water does not have any harmful chemicals.

For the spruce tree and grass seeds experiment, for the water treatment the total average growth was 25.8 cm and for the extinguisher treatment it was 2.5 cm. The best treatment was water. The results are not surprising since it didn't have any extinguisher. Extinguisher is not good for the plants since it reduces the plants pH by 0.5 and it hurts the plants. They prefer a pH of 6.5 to 6.8 and reducing it by putting an extinguisher on is not healthy for the plants.

For the half extinguisher in the lodgepole pine tree, the average growth was 0.65cm. For water treatment, the average growth was 0.67cm and the extinguisher treatment was the lowest at

0.275 cm. The result for water treatment was expected since water doesn't have harmful chemicals added to plants. The result for ½ extinguisher was about 0.65 and this was expected since I didn't think extinguisher would help the plants grow because they have monoammonium sulfate which can kill the plants by burning leaves. And the result for extinguisher treatment was about 0.275 and this was expected. I would expect the same results, but with this treatment having a lower growth. I say this since ½ extinguisher added half a tablespoon and extinguisher had a full tablespoon.

These are the things I would fix if I repeated the experiment again. when we were measuring the height of the plants some were drooped down. We lifted them up so that the plant was as tall as possible. Add a column in the weekly record of plant growth that is titled drooped and the purpose of that would say if the plants were drooped down or not and we could say how we were going to lift them up to measure more accurately.

The plants were dead soon into the experiment. We Should have given the plants more time to grow before adding the treatment because most plants seemed dead when we were doing the experiment. This may have affected the results since some may have died before adding the extinguisher but I didn't realize till after.

We may have overwatered the plants. We were watering 15mL then turned to 80mL. Overwatering could cause plants to suffocate and die. This could have been reverted by watering 30-50mL instead of 80mL.

We used a class ABC dry chemical extinguisher for all the treatments that needed the extinguisher. Other types of extinguishers include: Class D, Class K, Carbon dioxide extinguisher. Class ABC can put out paper, cloths, oil, paint, and electrical equipment. Class K extinguishers can put out cooking oils and fats. Class D extinguishers can put out metal fires such as magnesium, sodium & potassium.Carbon dioxide extinguishers are usually used for putting out class B & C fires and can replace oxygen which makes the fire gone.

References

https://www.cs.ubc.ca/~tmm/courses/547-20/projects/hannah-preeti-roopal-rubia/update.pdf

https://climateatlas.ca/forest-fires-and-climate-change

Government of BC - Wildfire

Firefighting Canada

How does foam put out fire?

BC Fire Extinguishing Process

Fire Extinguisher Powder

Preventing Environmental Impacts
Forest Fire Ecology

https://parks.canada.ca/nature/science/conservation/feu-fire/feuveg-fireveg/dirige-prescribed/role

https://www.ccohs.ca/oshanswers/safety_haz/fire_extinguishers.html

https://www2.nau.edu/~gaud/bio300w/frsl.htm#:~:text=By%20altering%20soil%20physical%20properties,moisture%20and%20lower%20soil%20porosity.

https://greensciencepolicy.org/harmful-chemicals/flame-retardants/wildlife-map

https://www.theguardian.com/environment/2023/oct/18/flame-retardant-pollution-endangered-wildlife#:~:text=The%20chemicals%20were%20found%20at,distances%20through%20water%20and%20air.

https://projectforest.ca/lodgepole-pine-seed-kit/

https://www.awes-ab.ca/species/lodgepole-pine/#:~:text=To%20achieve%20this%20lifespan%2C%20lodgepole,but%20more%20competitive%20white%20spruce.

https://www.midwesternbioag.com/products/map-monoammonium-phosphate/#:~:text=Monoammonium%20phosphate%20(MAP)%20is%20Midwestern,pH%20of%204%20to%204.5.

Procedure for Lodgepole pine taken from https://projectforest.ca/lodgepole-pine-seed-kit/

https://www.researchgate.net/publication/233413286_Long-term_effects_of_fire_and_three_firefighting_chemicals_on_a_soil-plant_system

https://sequoiavalleyfarms.com.au/lodgepole-pine/

https://www.pthorticulture.com/en-us/training-center/ammonium-toxicity#:~:text=Symptoms%20start%20in%20the%20newest,cases%2C%20root%20tips%20may%20die .

Appendix

Table 2. Measuring growth and pH for water treatment for both grass seeds and spruce trees.

Date		Grass Water 1	Grass Water 2	Grass Water 3	Tree Water 1	Tree Water 2	Tree Water 3
June 22, 2024	Height				26 cm	20.3 cm	24.8 cm
June 23, 2024	Growth						
	pH	7	7.5	7.5	7	7	7.5
July 1, 2024	Growth	9cm	10.3cm	10.4cm	27.6 cm	21.1cm	25.3cm
	pH	8	8	8	8	die	die
July 4, 2024	Growth	27.3cm	26.3cm	27cm	31.1cm	-	-
	pH					-	-
Aug 1 2024	Growth	32.3	37.9cm	30.8cm	31.1cm		
	pH	8	8	8	8		

Table 4. Information for spruce trees and grass seeds treated with an extinguisher measuring growth and pH. NO EXTINGUISHER YET

Date		Extinguisher 1	Extinguisher 2	Extinguisher 3	Tree Extinguisher 1	Tree Extinguisher 2	Tree Extinguisher 3
June 22, 2024	Height				29.6 cm	29.8 cm	27.5 cm
June 23	Growth						
	pH	8	7.5	8	8	8	8
July 1	Growth	7cm	8.5cm	7.5cm	30.5	29.8cm	27.8cm
	pH	8	8	8	die	die	die
July 4, 2024	Growth	25.1	28.1	25.8		-	-
	pH					-	-
Aug 1, 2024	Growth	28.1	32.1	33			
	pH	8	8	8			

Lodgepole Pine Seeds Instructions

Included in your Seed Kit:

- 1 paper envelope containing 4 lodgepole pine (*Pinus contorta*) seeds
- 1 dehydrated peat pellet
- 1 biodegradable peat pot

Breaking Seed Dormancy (Stratification):

We're going to simulate natural germination conditions for our pine seeds, ie., the cold, wet spring.

1. Soak the seeds in water at room temperature for 24 hours.
   (July 25 at 6 pm)
2. Place them on a wet paper towel inside a plastic bag and store them in your fridge for 21 days. It is important to pay attention to potential mold development. You can protect your seeds against mold by changing the moist paper towel regularly.
   (July 26-Day 1 - August 15-Day 21)
   - changed paper towel on Aug.2

Hydrate Your Peat Pellet

After stratification, the 21 days your seeds spent in the fridge, it's time to prepare your growing materials. (Aug 16)

1. Place your peat pellet in a dish deep enough to allow it to be submerged in water.
2. Pour warm water over top of your pellet so that it is submerged.
3. The peat pellet will take about 10 minutes to fully expand, though it may take a bit longer depending on the temperature of the water. Add more water if needed.
4. After expansion, place your peat pellet into the peat pot provided.
5. Once placed in the pot, tear the mesh wrapping at the top slightly to create a larger opening. You may need to squeeze the peat pellet to encourage full expansion.

Planting Your Pine Seeds

1. Use a pencil, toothpick or your baby finger to dig four wells in the peat pellet where your seeds will be planted. (August 16)
2. Place each seed in a well and lightly cover it with the peat in the pellet.
3. Place the pot in a warm and sunny place, like on a window sill.
4. Make sure the peat stays moist; not too much or too little water.

Pine Seedlings

1. Once the seedlings have sprouted and are 8-9 cm tall, you can transplant the seedling(s) in the peat pot into a larger pot to create more soil volume. If you have more than one seedling, separate them to ensure enough room for them to grow. The additional soil volume (add potting soil) will ensure that the plants stay moist.
2. Seedlings are ready to be transplanted outdoors in the spring when the risk of frost is over (after May long weekend in Alberta). Alternatively, you can keep growing your seedling in a larger pot and transplant it in September.

Share Your Seedling Journey With Us!

We would love to see your growing journey in action. Include the **#MyProjectForestSeedling** hashtag and tag @ProjectForest when posting your planting pics on social media!

Table 1: The amount of water added to spruce trees and grass seeds (mL)

Date	Spruce trees (mL)	Grass seeds (mL)
June 22, 2024	150	150
June 23, 2024	70	70
June 24, 2024	100	150
June 26, 2024	60	60

June 28, 2024	60	60
July 1, 2024	80	80
July 4, 2024	80	80
July 7, 2024	80	80
July 9, 2024	80	80
July 10, 2024	80	80
July 11, 2024	160	80
July 13, 2024	80	80
July 18, 2024	80	80
July 20, 2024	60	60
July 22, 2024	60	60
July 24, 2024	80	80
July 26, 2024	0	80
July 28, 2024	80	80
July 30, 2024	80	80
Aug 1, 2024	0	80
Aug 4, 2024	80	80
Aug 7, 2024	80	80
Aug 11, 2024	80	80
Aug 15, 2024	80	80
Aug 18, 2024	1 tbsp+15 mL	1 tbsp+15 ml
August 23	80	80
Aug 26, 2024	80	80
August 29, 2024	80	80
Sept 2, 2024		80
Sept 5, 2024		80
Sept 8, 2024		80
Sept 11, 2024		80

Table 2. Measuring growth and pH for water treatment for both grass seeds and spruce trees.

Date		Grass Water 1	Grass Water 2	Grass Water 3	Tree Water 1	Tree Water 2	Tree Water 3
June 22, 2024	Height				26 cm	20.3 cm	24.8 cm
June 23, 2024	Growth						
	pH	7	7.5	7.5	7	7	7.5
July 24, 2024	Growth	9cm	10.3cm	10.4cm	27.6 cm	21.1cm	25.3cm
	pH	8	8	8	8	die	die
July 4, 2024	Growth	27.3cm	26.3cm	27cm	31.1cm	-	-
	pH					-	-
Aug 1 2024	Growth	32.3	37.9cm	30.8cm	31.1cm		
	pH	8	8	8	8		

Table 3: Information for spruce trees and grass seeds treated with foam measuring growth and pH. NO EXTINGUISHER YET

Date		Foam 1	Foam 2	Foam 3	Tree Foam 1	Tree Foam 2	Tree Foam 3
June 22, 2024	Height				26.7 cm	26.6 cm	29.3 cm
June 23, 2024	Growth						
	pH	8	8	8	8	8	8
July 1, 2024	Growth	8.6cm	7cm	7.8cm	26.7cm	28.3cm	32.2cm
	pH						
July 24, 2024	Growth	24.1cm	24.7cm	24.9cm		-	35.6cm
	pH	8	8	8	die	die	8 Brown needles-die ?
Aug 1, 2024	Growth	30.2	29.5cm	35			37
	pH	8	8	8			8

Table 4. Information for spruce trees and grass seeds treated with an extinguisher measuring growth and pH. NO EXTINGUISHER YET

Date		Extinguisher 1	Extinguisher 2	Extinguisher 3	Tree Extinguisher 1	Tree Extinguisher 2	Tree Extinguisher 3
June 22, 2024	Height				29.6 cm	29.8 cm	27.5 cm
June 23	Growth						
	pH	8	7.5	8	8	8	8
July 1	Growth	7cm	8.5cm	7.5cm	30.5	29.8cm	27.8cm
	pH	8	8	8	die	die	die
July 4, 2024	Growth	25.1	28.1	25.8		-	-
	pH					-	-
Aug 1, 2024	Growth	28.1	32.1	33			
	pH	8	8	8			

Date	Lodgepole pine
Aug 18, 2024	15mL
Aug 19, 2024	15mL
Aug 20, 2024	15
Aug 21, 2024	15
Aug 22, 2024	30
Aug 23, 2024	30
Aug 24, 2024	15
Aug 25, 2024	30
Aug 26, 2024	30
Aug 27, 2024	30
Aug 28, 2024	15
Aug 29, 2024	15
Aug 30, 2024	30
Aug 31, 2024	30

Sept 1, 2024	30
Sept 2, 2024	30
Sept 3, 2024	30