Effect of induced mutations on the ability of rye grass to bind lead

SOUTHWESTERN MICHIGAN COLLEGE
HONORS PROGRAM

Audrey Bakerson, Douglas Schauer*

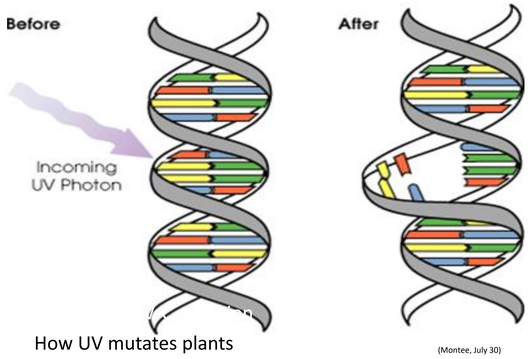
Southwestern Michigan College, 58900 Cherry Grove Road, Dowagiac, MI, USA 49047

ABSTRACT: The purpose of this research was to determine if starving rye grass seed and using ultraviolet C radiation could mutate plants to collect pollutants. Two different trials were conducted, both involved starving plants from cations and one also involved radiating with UV-C. The radiated samples had three different distances and three controls. The plants were each watered the same amount and were kept under the ultraviolet light at the same time intervals. The lead was added by putting 25 milliliters of 300ppm $Pb(NO_3)_2$ and 20 milliliters of buffer, de-ionized water, and tap water into separate containers of rye grass seed. The roots and shoots were tested separately to determine if different parts could collect significant amounts of the pollutant. The roots collected the most amounts of lead and the lead increased the further from the radiation it was until hitting 7.5 inches. Further research needs to be done at the different growing stages of the plant, along with using different types of ultraviolet light and continuing methods of starving the plants from cations. Growing amounts of toxins in the environment necessitate the need for an inexpensive, efficient, and reliable way to collect pollutants.

INTRODUCTION

Environmental pollutants have become an increasing dilemma and can be considered as one of humanities greatest rising problems (Muralikrishna & Manickam, 2017). Pollution unfortunately is all around us and its tiny particles are contaminating the air to a point where "…7 million people die…" each year from its dangerous effects. These particles cause lung and cardiovascular issues that lead to "…stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases and respiratory infections…" (World Health Organization, 2018).

Engineers and scientists have spent countless hours trying to invent something that would clean up toxins and pollutants. The globe spends about "$4.6 trillion" dollars annually trying to take care of pollutants (Cohen, 2017). Plants already do this to a certain extent, through phytoremediation. With the amount of toxins going into the environment increasing rapidly, there is a need for an inexpensive, efficient, and reliable way to collect pollutants. It is hypothesized that plants can be mutated by using radiation to collect these environmental hazards.



How UV mutates plants

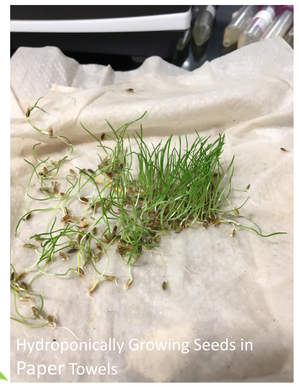
(Montee, July 30)

METHODS

The experiment included nine beaker grown seeds and twelve paper towel grown seeds. In each trial there were controls tested without being mutated. The plants were starved with a phosphate buffer solution and also tested in de-ionized water (DI). For the final solution they were grown in tap water. The plants that were radiated had three different heights and also one set that was not radiated. Data was collected by using a 4200-microwave plasma-atomic emission spectroscopy (MP-AES) System. The system detected the average intensity, which was used to calculate the known solutions. That information then helped determine the parts per million (PPM) of lead in each plant. All containers were put into nitric acid for two days after roots and shoots were separated.

RESULTS

Since plants are known to absorb pollutants in tissues (Bieby et al., 2011) multiple trials were conducted to determine if a mutation could induce increase absorbance in the tissues. The first mutation involved starving the plants from cations with a buffer solution. Also a set of buffer solution, de-ionized water, and tap water was tested. The roots seemed to collect the most pollutants and the buffer solution had the highest average for uptake. The ultraviolet C radiation did not kill the plants and neither did the 300ppm of lead. The methods of introducing the plants to the lead left some amounts of residue in the container (43-137ppm). The radiation worked best at the six inch distance and mainly increases until reaching 7.5 inches. The roots in the radiation trial also had the highest uptake. Compared to each of the controls the radiation increased the amount of lead in the plant for both the roots and the shoots.



Hydroponically Growing Seeds in Paper Towels

Rye Grass Seed Cation Starved			
Samples	Roots (PPM)	Shoots (PPM)	Remaining Solution (PPM)
DI 1	94.89	133.414	43.08
DI 2	180.98	118.017	43.19
DI 3	197.762	170.94	116.082
B1	411.349	102.086	137.001
B2	363.189	217.408	118.48
B3	500.808	221.62	51.313
W1	668.131	158.362	50.408
W2	316.894	182.732	46.776
W3	201.42	141.784	46.6

Grass in Lead Solution

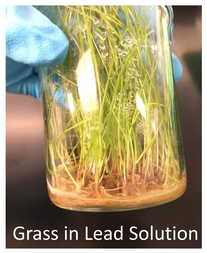
Rye Grass Seed Cation Starved

- **Part 1 -** Plants were grown in beakers with filtration paper
- **Part 2:** Buffer solution made out of K2HPO4, KH2PO4, & KNO3
- **Part 3:** 20mL of buffer, 20mL of DI, & 20mL of tap water add in separate containers
- **Part 4:** 25mL of 300ppm $Pb(NO_3)_2$ added to each container

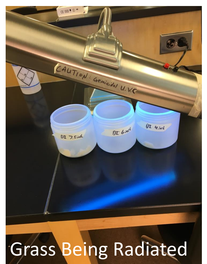
Samples

Rye Grass Seed Cation Starved & UV-C Radiation

- **Part 1:** Plants were grown in paper towels
- **Part 2:** UVC radiation three different days (two minute each time)
- **Part 3:** 20mL of buffer, 20mL of DI, & 20mL of tap water add in separate containers
- **Part 3:** 25mL of 300ppm $Pb(NO_3)_2$ added



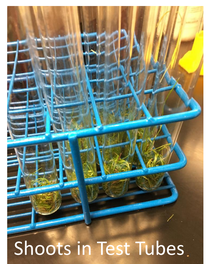
Grass in Lead Solution



Grass Being Radiated

Rye Grass Seed Cation Starved & UV-C Radiation			
Samples	Roots (PPM)	Shoots (PPM)	Remaining Solution (PPM)
B no UV-C	323.631	59.438	48.93
B 4inch	379.251	77.218	62.472
B 6inch	439.156	63.562	47.985
B 7.5inch	294.916	56.011	46.346
DI no UV-C	447.69	79.165	44.162
DI 4inch	406.334	66.823	51.329
DI 6inch	493.262	51.528	61.591
DI 7.5inch	335.68	50.8947	56.9
W no UV-C	231.202	55.755	54.055
W 4inch	327.851	66.387	48.079
W 6inch	322.952	40.1798	48.423
W 7.5inch	431.71	60.548	49.737

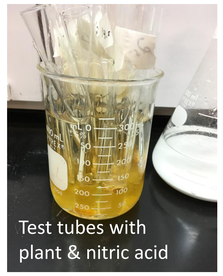
Grass Before Separated



Shoots in Test Tubes

FURTHER RESEARCH

- Test soil for lead
- Different plants types
- Different stages of the plant cycle
- Chemical mutations
- Radiating the seeds for mutations
- Changing the buffer solution
- Feed the plant cations
- Recycling the pollutants



Test tubes with plant & nitric acid

CONCLUSIONS

Phytoremediation has the chance to make a prominent impact on discovering alternatives for cleaning up pollution. There is a need for an inexpensive, efficient, and reliable way to collect pollutants to start decreasing the toxins in the environment. The trials conducted provide an insight on how different mutations can improve the uptake of the lead. The roots in these trials were the most efficient at collecting lead. The idea is that a super plant could be mutated to be used routinely, but for chemical spills and waste sites as well. With additional research this concept could turn into a quick, viable, reliable and environmentally friendly way to improve and save the environment.

Hydroponically Growing Grass Seed

REFERENCES

***Selected* references – the complete list in the accompanying report.**

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