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The Effects of Radiation on Plants and the Ecosystem

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Research Article

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ABSTRACT

The Sun emits all kinds of Electromagnetic waves, mostly Ultraviolet, Visible, and Infrared. The Earth's atmosphere blocks most of the high energy radiation, with the help of the ozone and other gaseous layers. However, with the emergence of industrial factories, power plants, and cars, the atmosphere is being polluted and depleted. As the production of chlorofluorocarbons continues to destroy the Ozone layer, greater amounts of the sun's radiation reach the earth and affect the plants. We believe that if plants are affected by the radiation, then they will grow abnormally due to denaturation of protein and DNA damage, thus resulting in a reduction in growth. To test the hypothesis, we irradiated the seeds of the plants with microwaves, infrared, ultraviolet, and x-ray light. In our data, the control group exposed to no radiation germinated the fastest. Therefore, we concluded that the radiation caused a mutation in plant's DNA, causing their growth and time to germinate to be affected negatively.

BACKGROUND RESEARCH

The sun emits all waves from the Electromagnetic Spectrum, from Gamma rays to Radio Waves. Luckily, our Earth's atmosphere protects the earth from 44% of the sun's radiation. 26% of the sun's energy is reflected or scattered back into space by clouds and particulates in the atmosphere and 18% of solar energy is absorbed in the atmosphere. In the atmosphere, the Ozone (O_3) layer absorbs ultraviolet radiation, while carbon dioxide and water vapor absorb infrared radiation [1]. The sun produces a huge amount of energy, 3.86 × 1026 watts, but only 1.74 × 1017 watts of energy strikes the earth at any moment of the day [2]. The earth's atmosphere protects the earth from the sun's harmful radiation.

Without the atmosphere, living things cannot live due to the overpowering radiation. The atmosphere has been protecting the earth from radiation, however, the recent increase in pollution weakens the atmosphere, allowing a greater portion of the sun's radiation to pass. As a result of the ozone layer depletion over the last couple of years, UV-B radiation is the most energetic radiation and will reach the troposphere, eventually, being absorbed by many biological substances [3]. The biggest cause of depletion is the production of Chlorofluorocarbons (CFCs), as one chlorine atom can destroy over 100,000 ozone molecules [4]. Countries have started to fix this issue by eliminating CFCs production and encouraged more environmental-friendly practices, however, the atmosphere has already been greatly affected, leading to a great increase in radiation exposure to plants.

During the process of seed dispersal, seeds are exposed to all types of radiation. Microwaves are not only used for heating food, but also for communication with satellites for weather forecasting. Due to their high wavelength, they are exposing seeds to microwave radiation. In fact, microwave radiation can penetrate through clouds, dust, smoke, snow, and rain. (NASA) Global positioning systems also use microwaves to transmit signals throughout the earth. 49.4 percent of the sun's radiation in infrared light. 42.3 percent of it is visible light [5]. And an additional, 7.3 percent of it is ultraviolet radiation. Therefore, there is a tremendous possibility that seeds are being subject to these radiation types during the process of seed dispersal. Cosmic objects such as the sun, supernova reminiscence, binary stars, and galaxy clusters all produce significant amounts of x-ray radiation (Britannica), enough to penetrate through the seed coat affect germination capabilities.

Plants rely on water to live, so exposure to radiation will heat the plant up causing negative effects [6]. The excess heat denatures the proteins and halts photosynthesis, thus creating several problems. Also, excess radiation has long-lasting effects on subsequent seedlings. Even if seeds germinate after being irradiated, they have a stronger likelihood of mortality after germination [7]. Gamma radiation on seeds decreases the percentage of seeds that actually germinate the plant's height, and the plant's total biomass. Radiation can have such a negative effect on plants that plants exposed to higher doses of gamma radiation (≤ 0.5 kGy)

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will not survive for more than 10 days Higher levels of radiation can lead to a higher percentage of aberrant cells chromosomal aberrations, DNA damage, growth reduction, detrimental reproduction effects, reduced seed germination, and reduced mortality, and direct burn damage to tissue [8-10]. Data from the Chernobyl incident suggests that adverse effects on individual organisms including plants were felt at doses between 5 and 400 rad/yr [11].

INTRODUCTION

Radiation comes in all forms and sizes ranging from radio waves to gamma rays. Not all waves are harmful; in fact, radio and visible light are not harmful to humans at all. Plants may not have the same response. They might be affected by certain types of light with certain frequencies and wavelengths such as microwaves, infrared, visible, and ultraviolet light. From out background research, gamma irradiation does affect not only the ability of a seed to germinate but also its success in being able to mature fully. The depletion of the ozone molecules and other gases prevents the reflection of the Sun's radiation from passing [12-14].

MATERIALS AND METHODS

Experiment 1 (Control)

1. Obtain 5 lima bean seeds.
2. Fill 3/4ths of a pot with soil. Label the pot as the control.
3. Plant the seeds 1 inch below the top layer of soil.
4. Leave the pot in the sun.
5. Water the plant twice a day (once at 7 AM, then at 4 PM).
6. Measure and take note how much plant has grown daily.
7. Repeat steps 1-6 two more times.

Experiment 2 (Irradiated Seeds with Microwave Light)

1. Obtain 5 lima bean seeds.
2. Place a glassful of water in a glass cup in the microwave.
3. Microwave the seeds in a glass bowl (microwave safe) for 1 second.
4. Fill 3/4ths of a pot with soil. Label the pot as microwave 1 sec.
5. Plant the irradiated seeds 1 inch below the top layer of soil.
6. Leave the pot in the sun.
7. Water the plant twice a day (once at 7 AM, then at 4 PM).
8. Measure and take note how much plant has grown daily.
9. Repeat steps 1-8 except with 8 seconds in the microwave.
10. Repeat steps 1-8 except with 24 seconds in the microwave.
11. Repeat steps 1-8 except with 48 seconds in the microwave.

Experiment 3 (Irradiated Seeds with Infrared Light Only)

1. Obtain 5 lima bean seeds.
2. Leave the seeds out in the sun in the morning with the infrared filter on top.
3. Remove them after 1 hour.
4. Fill 3/4ths of a pot with soil. Label the pot as infrared 1 hr.
5. Plant the irradiated seeds 1 inch below the top layer of soil.
6. Leave the pot in the sun.
7. Water the plant twice a day (once at 7 AM, then at 4 PM).
8. Measure and take note how much plant has grown daily.
9. Repeat steps 1-8 except with 8 hours under the infrared light.

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10. Repeat steps 1-8 except with 24 hours under the infrared light.
11. Repeat steps 1-8 except with 48 hours under the infrared light.

Experiment 4 (Irradiated Seeds with Sunlight-All Types Of Radiation Light)

1. Obtain 5 lima bean seeds.
2. Leave the seeds out in the sun in the morning.
3. Remove them after 1 hour 15 minutes.
4. Fill 3/4ths of a pot with soil. Label the pot as sun 1.25 hr.
5. Plant the irradiated seeds 1 inch below the top layer of soil.
6. Leave the pot in the sun.
7. Water the plant twice a day (once at 7 AM, then at 4 PM).
8. Measure and take note how much plant has grown daily.
9. Repeat steps 1-8 except with 10 hours under the sun.
10. Repeat steps 1-8 except with 30 hours under the sun.
11. Repeat steps 1-8 except with 60 hours under the sun.

Experiment 5 (Irradiated Seeds with Non-UV Light Only)

1. Obtain 5 lima bean seeds.
2. Leave the seeds out in the sun in the morning with the ultraviolet protection filter on top.
3. Remove them after 30 minutes.
4. Fill 3/4ths of a pot with soil. Label the pot as IR + visible 0.5 hr.
5. Plant the irradiated seeds 1 inch below the top layer of soil.
6. Leave the pot in the sun.
7. Water the plant twice a day (once at 7 AM, then at 4 PM).
8. Measure and take note how much plant has grown daily.
9. Repeat steps 1-8 except with 4 hours under the IR + visible light.
10. Repeat steps 1-8 except with 12 hours under the IR + visible light.
11. Repeat steps 1-8 except with 24 hours under the IR + visible light.

Experiment 6 (Irradiated Seeds with UV Light)

1. Obtain 5 lima bean seeds.
2. Put a new AA battery in the UV flashlight.
3. Place the seeds under the UV base with the UV flashlight on top.
4. Remove them after 75 seconds.
5. Fill 3/4ths of a pot with soil. Label the pot as UV 1.25 minutes.
6. Plant the irradiated seeds 1 inch below the top layer of soil.
7. Leave the pot in the sun.
8. Water the plant twice a day (once at 7 AM, then at 4 PM).
9. Measure and take note how much plant has grown daily.
10. Repeat steps 1-8 except with 10 minutes the UV light.
11. Repeat steps 1-8 except with 30 minutes under the UV light.
12. Repeat steps 1-8 except with 60 minutes under the UV light.

Experiment 7 (Irradiated Seeds with X-Ray Light)

1. Obtain 5 lima bean seeds.

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2. Place the seeds under the x-ray.
3. Start the X-ray machine for 2 seconds.
4. Fill 3/4ths of a pot with soil. Label the pot as x-ray 2 sec.
5. Plant the irradiated seeds 1 inch below the top layer of soil.
6. Leave the pot in the sun.
7. Water the plant twice a day (once at 7 AM, then at 4 PM).
8. Measure and take note how much plant has grown daily.
9. Repeat steps 1-8 except with 4 seconds under the x-ray.
10. Repeat steps 1-8 except with 8 seconds under the x-ray.
11. Repeat steps 1-8 except with 16 seconds under the x-ray.

DISCUSSION

All three control group plants experienced germination after 12-15 days. One of the five seeds microwaved for 1 second each germinated after 17 days. One of the five seeds exposed to UV light for 75 seconds germinated after 14 days. Additionally, one of the five seeds exposed to x-ray light for 2 seconds germinated after 2 days. In fact, after a couple days, most of the germinated seeds even started growing. The irradiated seeds grew at a delayed pace because it took more days for them to germinate. The rest of the irradiated seeds did not germinate at all, rendering the seeds unusable **(Figure 1)**.

Time became an issue because the lima bean seeds take a long time to grow. According to the seed packet, germination was to occur after 6-8 days, however, it took much longer. Due to faulty weather and inconsistent conditions, seed germination is prolonged and therefore may have needed more time to germinate. Natural issues, such as animals and weather, probably affected seed growth. Even though plants are supposed to be able to withstand natural issues, our small populations of 3 seeds in each pot may not have resulted in consistent precise results. We need bigger sample sizes to obtain more precise results.

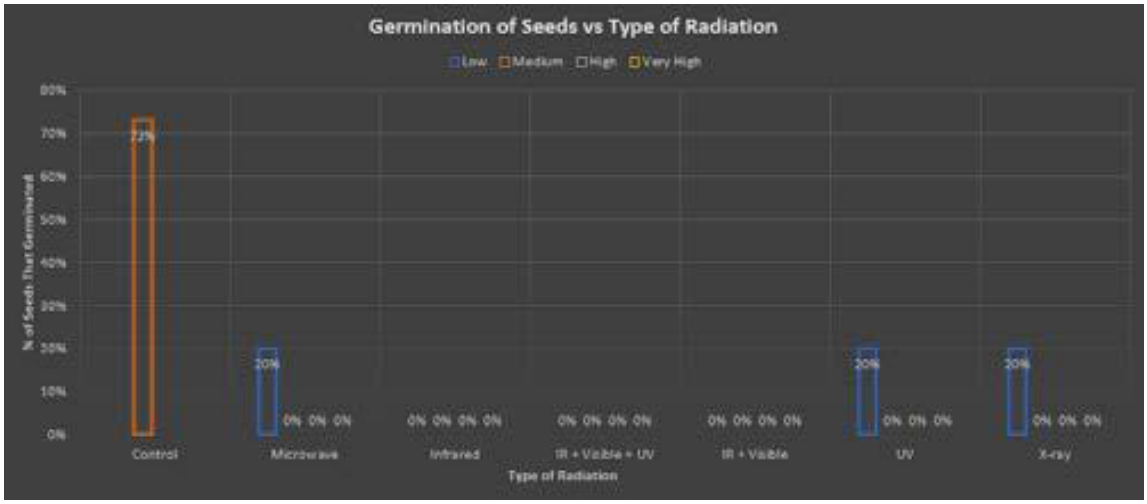

Figure 1. Seeds exposed under Radiation comes in all forms and sizes ranging from radio waves to gamma rays

CONCLUSION

Because the seeds that were irradiated with sunlight, infrared, or non-UV light did not experience any germination, we can certify that light (not just visible) does affect plant germination and growth. The control group seeds did experience germination and growth. Additionally, because the microwaved 1-second seed germinated, it is safe to say that in a time span of 1 sec, the seed was not affected greatly or at all. Additionally, the 75 second UV seed germinate, and 2-second x-ray seed germinated. Therefore, these small increments of radiation did not completely render the seed unusable but did delay the time required to germinate.

These results have great implications because, during the process of seed dispersal which lasts several days, the seed could be exposed to sunlight radiation which includes infrared, and visible spectrum, and ultraviolet light that are incredibly detrimental to the seed's ability to germinate. During the process from when a seed sprouts from a mature plant to seed dispersal, the seed can be exposed to much harmful radiation. Additionally, because of the wide presence of microwave radiation from weather

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satellites, seeds are being rendered unusable and unable to germinate. Furthermore, the x-ray light from cosmic objects can penetrate through the layers of the diminishing atmosphere and into the seed coat, impacting the ability of a seed to germinate.

In effect, all these types of radiation negatively impacted the ability of a seed to germinate. As the atmosphere is getting depleted, more radiation from the sun and from other objects in space in entering the tropospheric layer of the Earth. These greater forms of radiation are decreasing plant life, a primary producer in the food web of the ecosystem. Not only do plants provide oxygen to humans and other organisms, they also serve as a source of energy for all primary consumers. If there are fewer plants in our ecosystem because plants have a lower level of fitness due to increasing radiation levels, then all other living things' fitness is also diminished. In conclusion, many species of plants have the possibility of dying out if they are not able to disperse seeds without being affected by radiation. If consumers do not receive enough oxygen or energy from plants, consumer species also have the ability to go extinct. After all, plants which form the basis for food chains are necessary for the survival of all living organisms.

REFERENCES

1. Fondriest Environmental Inc. Solar radiation and photosynthetically active radiation. 2014.
2. Julian E. How much power does the sun give us? 2010.
3. Paul ND, Gwynn-Jones D. Ecological roles of solar UV radiation: Towards an integrated approach. Trends in Ecology & Evolution. 2003 Jan 1;18(1):48-55.
4. United States Environmental Protection Agency. Basic Ozone Layer Science. 2017.
5. Mardenkro P. Block infrared radiation to control plant temperature. 2014.
6. Fundamentals of Environment Measurements. Solar radiation and photosynthetically active radiation. 2016.
7. Xie S and Emily B. Effects of radiation on seed survival and germination. 2017.
8. Grover S and Khan AS. Effect of ionizing radiation on some characteristics of seeds of wheat. 2014.
9. Marcu D, et al. Gamma radiation effects on seed germination, growth and pigment content, and ESR study of induced free radicals in maize (*Zea mays*). Journal of biological physics. 2013 Sep 1;39(4):625-34.
10. Franco CH, et al. Mutagenic potential of lettuce grown from irradiated seeds. Scientia Horticulturae. 2015 Jan 23;182:27-30.
11. Miller S and Reed P. Effects of radiation on plants. 2015.
12. National Aeronautics and Space Administration. Science Mission Directorate. Microwaves. 2010.
13. Encyclopedia Britannica. X-ray source. 2018.
14. Bewley JD. Seed germination and dormancy. 1997.