SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Scientific Inquiry

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OLIPHANT SCIENCE AWARDS 2020

The effect of nuclear radiation on plant growth.

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Background information:

I went to the supermarket and I wanted to buy salad in pre-packed plastic bags. I discovered that they were treated with nuclear radiation. When I investigated further, I discovered that radiation is not always dangerous if it is in low levels.

We are exposed to nuclear radiation all the time. It is released from soil, building materials and is in the air around us. This is called background radiation and the levels are low.

There are three types of nuclear radiation, alpha, beta and gamma decay. Radiation is emitted from atoms (the nucleus) when they are not stable. They break down and change into different atoms by emitting the radiation.

The radiation can penetrate living matter and change, damage or kill the cells that make up the material. Radiation is therefore called ionising radiation. The most ionising radiation is alpha followed by beta and then gamma. In terms of penetrating power, gamma is the most penetrating followed by beta and finally alpha. Alpha radiation is blocked easily by paper, beta needs thin foil to be blocked and gamma needs lead to be blocked.

Food irradiation uses radioactive materials to steralise food. It kills microorganisms such as insects, mould and bacteria so that the food lasts longer before it rots. The radiation does effect the food in a small way. The chemical composition can change. Gamma and beta radiation is often used. It cannot be used for dairy products and eggs because it does effect the flavour. I wondered if radiation could help plants grow or whether it would harm their growth.

Questioning and predicting

Question: How do different types the radiation (alpha, beta and gamma decay) affect the growth of a plant?

Prediction:

Gamma radiation is the most penetrating and can cause damage to cells, alpha is the least penetrating and beta is in between. Therefore, I predict that more gamma radiation will penetrate the soil easily and kill some or all of the seeds (as well as microorganisms) before they have a chance to grow, followed by beta and lastly alpha. The seeds grown in soil with no radiation should grow the best. The seeds grown with gamma radiation should grow the least. Seeds grown alpha and beta decay will probably grow, those grown with alpha will probably grow better than those grown with beta decay.

Planning and conducting:

I tried to buy radioactive samples but this was difficult. I was only able to find Uranium ore samples on eBay. The samples varied in size and I couldn't find alpha, beta and gamma samples. I asked whether school has radioactive materials and discovered that they had circular disks of alpha, beta and gamma decay.

I was also shown a device called a Geiger Counter. It measures the level of radioactivity by beeping and counting the number of alpha, beta and gamma radiations.

I also needed to work safely by making sure I grew my plants in a place that was not close to the main house. When not in use for the experiment, the radioactive samples were stored in a locked metal box and were wrapped with lead.

Gamma decay sample

Locked metal box for storing the radioactive samples

To grow the plants, I thought of using plastic take away containers and I bought some potting soil so that all the plants would be grown in the same soil.

Next I had to think of a fast growing plant. I did some research and discovered that there were some vegetables such as radish and celery that grew quite quickly. I decided on radish because they are smaller plants than celery and germinate in 5 to 8 days and grow to maturity in 4 to 8 weeks.

Just in case some seeds did not germinate naturally, I decided to grow six plants in each plastic container. The packet indicated that the seeds needed to be buried 6 mm under the soil and spaced 3 to 5 centimetres apart.

Variables:

The variable that I will change is the type of radiation (alpha, beta and gamma decay).

The variable that I will measure is the height of the plants.

A fair test:

- The same type of seed (radish) was used for all the tests.
- Some plants had to be grown without any radiation to check whether the radiation was affecting their growth or not.
- The same number of seeds (two) were placed in each position of the plastic container.
- The same amount soil was placed in each container to grow the seeds.
- The same amount of water was used to water the plants each time. Two teaspoons per plant.
- The plants were all watered at the same time, every two days.
- The seeds were placed the same distance apart and in the same position in each container.
- The plants were all grown in the same environmental conditions – room temperature and sunlight were the same. They were all grown in a back unused room which had a large glass window.

Materials:

- Radish seeds – one packet
- 4 plastic take away containers.
- New potting soil
- Alpha, beta and gamma decay discs – one of each – low levels
- Cup and water
- Geiger counter
- Ruler
- Glad wrap
- toothpick

Method:

1 Each radiation disc was covered in gladwrap so that they wouldn't get dirty from the soil.
2 The Geiger counter was turned on using the switch at the back. The tube was placed 2 cm above each radiation disc (the position of the seeds above the radiation discs when placed in the containers).
3 Each radiation disc was tested for radiation levels using the Geiger counter. The number displayed on the Geiger counter after one minute was recorded. This indicated the amount of radiation present.

4 Each disc was placed in the centre of a container and covered with potting mix. The depth of the potting mix was 3 cm in each container.
5 The Geiger counter was used to see whether the radiation was penetrating the soil. The number on the display after one minute was recorded.
6 One container was left without a label. One container was labelled with alpha, one with beta and one with gamma.
7 The Geiger counter was used to see whether the radiation was penetrating the soil. The number on the display after one minute was recorded.

Checking if radiation passes through the soil

8 A mark was drawn on a toothpick 6 mm from the bottom.
9 The toothpick was used to make a hole 6 mm deep in the soil using the mark on the toothpick.
10 Two seeds were placed in every hole and the seeds were covered with soil.
11 The seeds were moisten with watered as indicated in the instructions on the packet. Two teaspoons of water were used for each of the seed positions.
12 The containers were placed in a back room of the home that was not used, near a large window.
13 The containers were checked every day.

The planted seeds ready to grow

Processing and analysing data/results:

The plants were viewed and measured every day. All the results were recorded in the journal. The results table show the average height of the plants every third day.

The average was found by adding up the height of the plants that grew in each container and dividing by the number of plants that grew.

The height was measured to the top of the plants. If more than one seed germinated in a position, the average height was taken.

Not all the seeds germinated. Some of the plants started to wilt after 15 days. The plants grow with alpha decay wilted first followed by alpha and then no radiation and finally gamma.

Five of the six positions for gamma showed growth. Four positions showed growth for alpha (one plant taking 13 days to germinate and another 24) and only two positions showed growth for no radiation and beta.

Some yellow leaves started to appear by day 32.

Even though there were two seeds placed at every position, position 5 for beta and positions 2 and 5 for gamma grew three plants.

It was surprising to see the plants shot up in height after they germinated. For example the height of no radiation position 6 and alpha position 6 on the first day of visible growth was 1.4 cm.

15 May

19 May

The yellow circles indicates that 3 plants grew.

4 June

The orange circle shows a third plant that germinated after 13 days.

18 June

The blue circle shows some yellow leaves that formed.

Results table

	Average height of radish plants every three days (centimetres)																			
Day	*0*	*3*	*6*	*9*	*12*	*15*	*18*	*21*	*24*	*27*	*30*	*33*	*36*	*39*	*42*	*45*	*48*	*51*	*54*	*57*
No radiation	0	0	1.8	5.2	6.2	6.8	7.2	7.5	8.1	8.4	8.5	8.7	8.8	9.0	9.1	9.1	9.2	9.2	9.3	9.3
alpha	0	0	0.6	5.0	6.1	4.7	5.1	5.3	4.5	5.5	6.2	6.6	6.9	7.1	7.2	7.2	7.3	7.3	7.4	7.4
beta	0	0	1.9	5.3	6.2	6.9	7.3	7.7	8.6	9.0	9.3	9.5	9.6	9.8	9.9	10.0	10.0	10.1	10.2	10.2
gamma	0	0	2.4	5.0	6.0	6.3	6.6	7.1	7.3	7.5	7.8	8.0	8.2	8.4	8.6	8.7	8.8	8.9	9.0	9.0

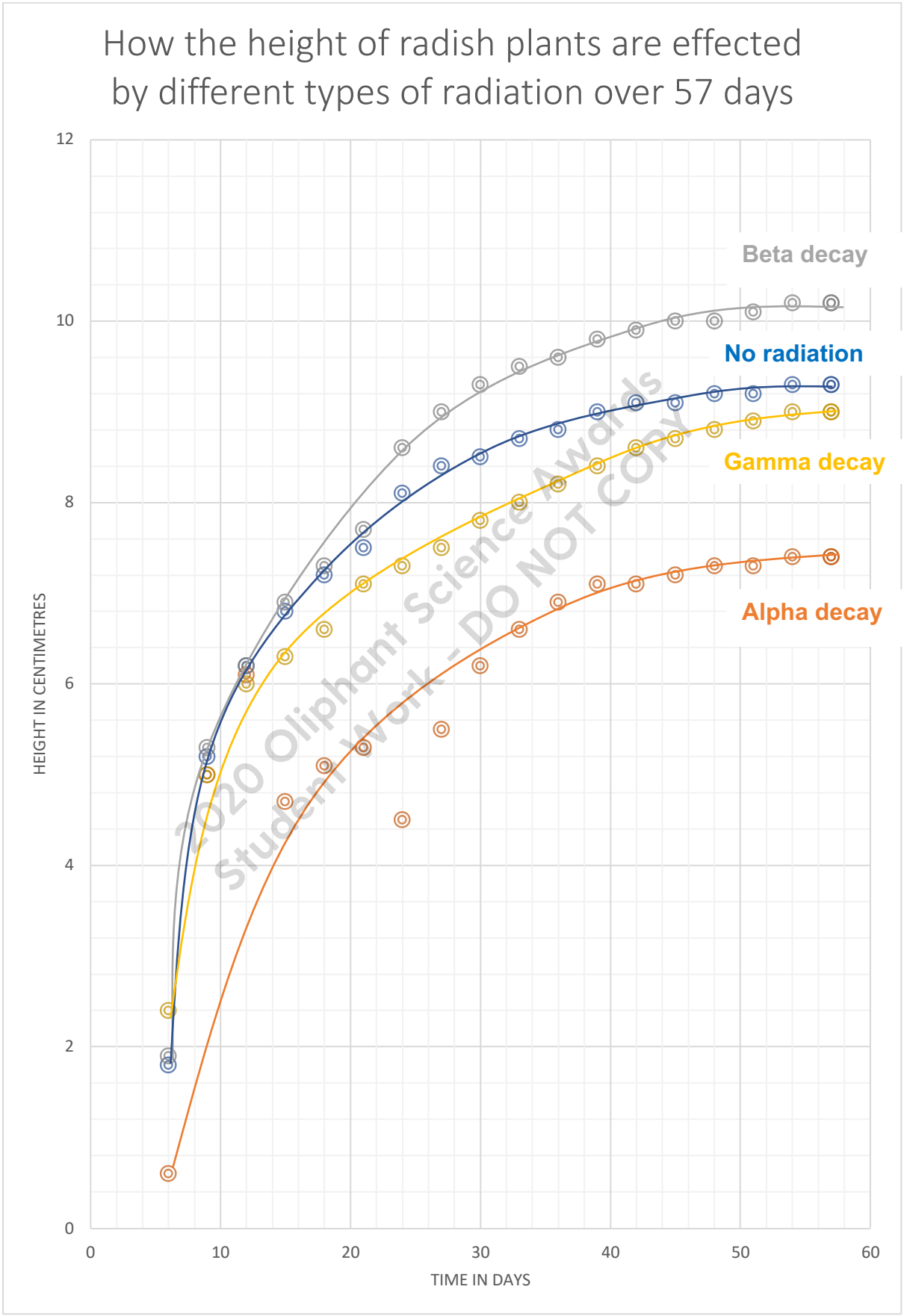
Radiation levels

Background	28
Alpha	238
Beta	3671
Gamma	1790

Radiation passing through the soil

Alpha	55
Beta	173
Gamma	677

Graph


How the height of radish plants are effected by different types of radiation over 57 days
HEIGHT IN CENTIMETRES
TIME IN DAYS
0
2
4
6
8
10
12
0
10
20
30
40
50
60
Beta decay
No radiation
Gamma decay
Alpha decay
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The plants grown with beta decay grew the tallest. This was followed by the plants grown with no radiation, gamma and lastly alpha. The difference in height was around 3.0 cm.

The trend is very clear. All the plants grew quickly at the start and then their growth slowed down. Beta grew 1.9 cm in the first 3 days, them 3.4 cm in the next 3 days, then 0.9 cm in the next 3 days. The average height grown got smaller and smaller until it was around 1 to 2 mm towards 39 days. The growth stopped after that. The growth slowed down considerably by about day 21. The pattern was similar for all the plants but the growth slowed down quicker for the other radiations. For example, average growth in the three days slowed down by day 9 for gamma and day 12 for no radiation. The trend for alpha is similar but there is a dip in the results at day 21. This is because a seed germinated in position 4 and the plant remained very small. This decreased the average. The seed in position 3 that germinated on day 13 grew quite well and did not effect the average as much.

The plants grown all slowed down and showed little growth at the end of the 39 days. They would have been ready to plant in soil. After some research, I discovered radish plants grow to an average height of 15 cm to 40 cm by maturity. This is quite a large difference. Some of the radish plants grew to a height of 13 cm (even though the average was around 9 or 10 cm) so it seems the plant growth may have slowed down as the plants were reaching their maximum height.

What the graph does not show is that five out of the six seed positions germinated with gamma while only two plants germinated without radiation and three with beta. It appears that overall, the plants germinated and grew best with gamma with their average height only being 1 cm smaller than the plants grown with beta decay.

Before I stared, I predicted that gamma radiation will penetrate the soil easily and kill some or all of the seeds before they have a chance to germinate and grow, followed by beta and lastly alpha. I based this on penetration power rather than ionising power. I thought the plants grown without radiation should grow best. I was partly correct. Plants grown without radiation did grow well but only two seeds germinated.

Conclusion:

Based on my experiment, I conclude that plants grow best when grown with gamma radiation. While the average height of the plants was slightly less than those grown without radiation, more seed germinated and grew into plants using gamma radiation. When tested for radioactivity, the plants did not seem to give off any radiation.

It is possible that the gamma radiation killed harmful microorganisms (germs and bacteria) on the seeds and in the soil and allowed the plants to grow better. Assuming the radiation is too strong was incorrect. The gamma radiation did not seem to ionise/damage the cells of the seeds while the alpha and beta decay seemed to affect the germination of the seeds.

Beta decay helped the plants grow well but only three plant positions grew. The plants did not grow well with alpha. Some seeds germinated after a long period and did not grow that well. This indicates that both of these radiations damaged or killed the seeds due to their ionising ability.

Evaluating:

Radish seeds were a good choice of plant for this experiment because they grew fast and enough plants grew to see a clear pattern in the results.

It was hard to measure the height of the plants especially once they were taller because they curled up after about 15 days and the plants started to wilt.

The main thing I could not control was the amount of radiation each plant received. All three types of radiation passed through the soil but the levels of radiation reaching the plant were different. 55 alpha reached the top of the soil, 173 beta reached the top of the soil and 677 gamma reached the top of the soil.

To make the radiation levels the same, I would have to get sources that produce the same level of radiation or bury the radiation at different depths. This is something I could investigate next time.

Potting mix was used to grow the plants. Soil in the garden may absorb different amounts of radiation depending on whether it is sandy like our garden or rocky like other gardens.

The investigation could be improved by growing more plants, for longer. For example I could have had three trays with six positions (18 plants) for each of the radiations to see if the pattern was the same for more plants. I was surprised that the plants with no radiation did not grow as well as those with radiation. It is possible that I was unlucky in choosing bad seeds for the plants with no radiation. The soil could have been deeper and this may have allowed the roots to grow deeper and hold up the plants better as they only wilted once the plants grew fairly tall after. More water at

the start of the experiment may have helped more seeds germinate. Some seeds may need more water than others although the pattern is clear that more plants germinated with gamma decay.

It would be interesting to investigate the long term effect of the radiation on the plants once radishes were produced. Would the radishes contain radiation? Would they taste the same?

Other questions that could be investigated include

- Does radiation effect other plants that grow larger in the same way?
- Does the fruit of the plant contain radiation if the plant is grown with low levels of radiation.
- Does a plant grow better if radiation is used to germinate the seeds before they are placed in soil and then grown without radiation.

The information gained from this experiment is useful to others to increase awareness of radiation and its uses. It isn't always harmful and may have potential benefits. This experiment shows that radiation is beneficial in germinating seeds successfully and in growing plants. This could be beneficial to agriculture and farming. More plants can be grown quick. This would help farmers and the economy. It could also be useful in helping grow crops in underdeveloped countries that need food to feed large populations or countries with limited space. Alternatively, a country like Australia may be able to produce more crops and donate or sell the produce. Crops could be removed and regrown more often (for example twice in a season instead of only once).

Reference list:

Free reference generator used - Cite This For Me: Harvard

Websites:

Chemistry LibreTexts. 2020. *17.2: Types Of Radioactivity- Alpha, Beta, And Gamma Decay*. [online] Available at: <https://chem.libretexts.org/Bookshelves/Introductory_Chemistry/Map%3A_Introductory_Chemistry_(Tro)/17%3A_Radioactivity_and_Nuclear_Chemistry/17.02%3A_Types_of_Radioactivity-_Alpha%2C_Beta%2C_and_Gamma_Decay> [Accessed 15 April 2020].

Touran, N., 2020. *What Is Radioactivity?*. [online] What is nuclear?. Available at: <https://whatisnuclear.com/radioactivity.html> [Accessed 17 April 2020].

Videos:

2020. [online] Available at: <https://www.youtube.com/watch?v=zI2vRwFKnHQ> [Accessed 17 June 2020].

Acknowledgements:

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