SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Highly Commended

Scientific Inquiry

Year 9-10

Emily Weir

Walford Anglican School for Girls

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Australian Government Department of Defence

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OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☑ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: Emily Weir ID: 31882

SCHOOL: Walford Anglican School for Girls.

Activity: Give a brief outline of what you are planning to do.

I plan to grow 16 pots of radish, and split them into groups of 4. Each different group will be placed inside a large pot with holes covered with coloured cellophane (blue, yellow, red, clear). The holes will be cut out of the pot on the top and side. This will test the the effect of different coloured light on the growth of plants.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
Sharps risks: the large plant pots need to be cut with a handheld saw - there is a risk that I could cut myself.	Sharps risks: heavy duty gardening gloves will be worn when handling the saw. There will also be a adult present to assist and supervise.
Biological risks: when planting the radishes, potting mix will be used, a lot of bacteria can be found in this, particularily legionella longbeachae which can cause legionnaires' disease.	Biological risk: when planting the radishes in the potting mix, gloves will be worn and hands will be washed after to avoid any spread of bacteria from hand to mouth. The process will be performed in an outdoor area for constant airflow so there is a very low risk of inhaling any bacteria.

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Emily Weir

SIGNATURE(S): emily weir

☑ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Maria Caruso

SIGNATURE: MCaruso DATE: 16.06.23

29.05.2

Oliphant Science Awards Logbook

name brainstorm:

- Test the effect of different coloured light on the growth of plants
- The effect of different light filters on plant growth
- The effect of light filters on the growth of plants
- The effect of different coloured light on plant growth

final name: The Effect of Different Coloured Light on Plant Growth

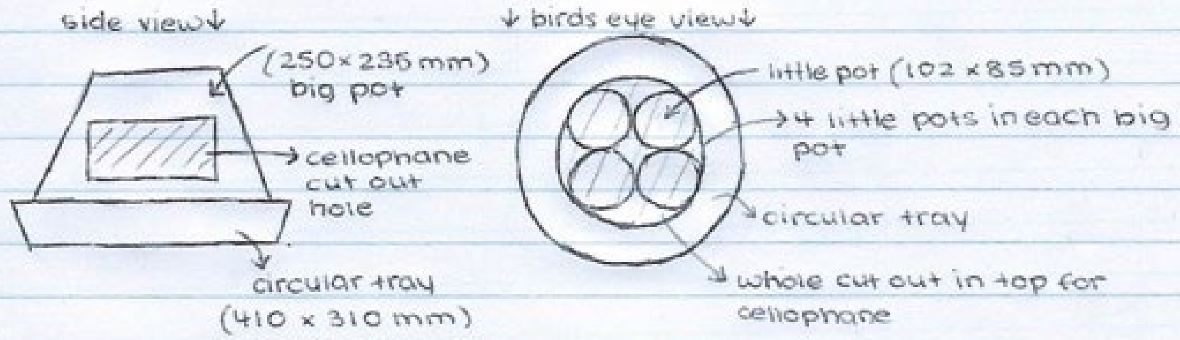
how pure is cellophane? can it be used for this experiment to mimic a light filter?

- cellophane is a polymeric (of or relating to a polymer) cellulose film made from the cellulose from wood, cotton, hemp or other sources.
- 92-96% cellulose
- research shows blue cellophane may not be pure and could have a small amount of yellow (30.05.23) preproom.org/cellophaneasalight filter.

how does this relate to real world scenarios?

- indoor plants/lighting can be manipulated to help the plants grow faster or to produce more food, aid population growth.
- possible improvements of growing enviroments.
- land / running out of space, indoor farms in cities / growing upwards

set-up diagram?



Oliphant Science Awards 2023
The Effect of Different Coloured Light on the Growth of Plants
Emily Weir

Introduction

Rapid urbanisation, which is fuelled by population expansion and industrial development, poses a danger to agricultural land because it causes fertile areas to be converted into urban infrastructure, which reduces the amount of land that can be devoted to farming.
The requirement to maximise food production within restricted resources of land is critical in areas with little agricultural land resources, such as China, India, and Brazil. Urbanisation and population increase put pressure on the amount of agricultural land that can be used, which reduces the capacity for food production. As light is the primary energy source for photosynthesis, the process by which plants convert light into chemical energy and support their growth, it is imperative to look at how light affects plant growth in order to overcome these obstacles and furthermore to explore the ideas of indoor farming and upwards farming.
Different coloured light, characterized by specific wavelengths, can have distinct affects on plant physiology and growth. The creation of customised lighting methods and cultivation practises that maximise production within confined land resources can be made possible by understanding how varied coloured light effects plant growth. Farmers and other agricultural stakeholders can increase crop output and ensure food security by designing lighting systems and glasshouse technologies, for the best light conditions for boosting plant growth.
Research into how different colours of light affect plant growth is significant to nations throughout the world that are losing agricultural land. We can create focused methods to optimise agricultural practises within constrained land resources by studying the connections between light and plant physiology. In the near future, companies can work towards sustainable agriculture, increasing food security, and lessening the difficulties brought on by agricultural land loss in certain countries by interdisciplinary study and the application of these discoveries.

Aim

The aim for this experiment is to test and observe the impact of different coloured light on stimulating the indoor growth of radish.

Hypothesis

It is hypothesised that the radishes exposed to red light will exhibit enhanced growth compared to those exposed to blue, green and white light. Plants contain photoreceptors called phytochromes which are sensitive to red and far-red light. Typically, plants react with red lights wavelength to produce a shade avoidance response called phototropism. When plants receive red photons, they respond by attempting to find additional light since they assume they are in the shade, resulting in taller plants. Although it isn't hypothesised that the plants will grow as tall as the red light, it is hypothesised however that the plants exposed to blue light will have a sturdier base as blue light helps to advance the stomatal opening which allows more CO_2, increasing plant quality. The radishes exposed to green light should have little difference to regular growth as the chlorophyll predominately reflects the green light instead of absorbing it. The radishes in white light should show similar growth patterns to those in natural sunlight as it contains all visible colours. Based on these hypotheses, graphs of plant height versus time are expected to have the highest gradient for red light.

Independent Variable
The independent variable will be the colour of cellophane covering the holes on the big pot The different cellophane colours will be green, red, clear and blue. Each different colour will be tested in four pots, each pot containing five seeds.

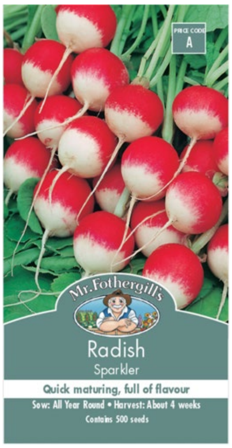
Dependent Variable
The dependent variable will be the height of the individual seedlings. This will be measured by measuring the height daily, and by looking at the overall height at the end of the test.

Controlled Variable and how it was controlled – table

Controlled variable	How it was controlled	Why it needed to be controlled
Type and amount of potting mix/soil.	The soil was used from the same pack of potting mix and measured accurately using a scale to ensure each pot received 150 g of soil each.	To ensure that plants have comparable fertiliser and water availability, soil will be used that has the same type and composition throughout all pots. Consistency in soil properties reduces the likelihood of confounding variables impacting plant growth. The amount of soil each pot received is important as variations in this factor could result in one pot accidently receiving more nutrients than the other.
Number of seeds planted in each pot.	The seeds were counted before distributed evenly within each pot. Five seeds were planted in each pot – one in the middle, 4 around the edges.	The results may only apply to the specific number of seedlings used in each treatment, making it challenging to draw broader conclusions about the effect of different colored light on plant growth.
Plant species.	It will be made sure that the plant planted for each pot will be the same species of radish from the same packet.	Using the same plant species and seeds for all the colours ensures that any observed differences can be attributed to the different light colours instead of variations between species.

Apparatus (refer to the images alongside).

- 80 sparkler radish seeds or a pack (aprox 500 per pack).
- 16 little clear plastic pots (102 x 85 mm). Can be obtained from bunnings. Must have small holes drilled into the bottom to allow drainage.
- 4 big black plastic pots (250 x 235 mm). Can be obtained from bunnings.
- 1 simple kitchen scale, measure in grams.
- 1 pack each of red, green, clear and blue cellophane.
- 1 hand saw.
- 1 pair of heavy-duty gardening gloves.
- Water to water the plants with.
- 4 black circular tray to put the big and little pots in.
- 1 low temp hot glue gun.
- 12 low temp hot glue sticks.
- 1 roll of black insulation tape.
- 1 ruler.
- 2400 g of simple potting mix, 150 g per little pot.

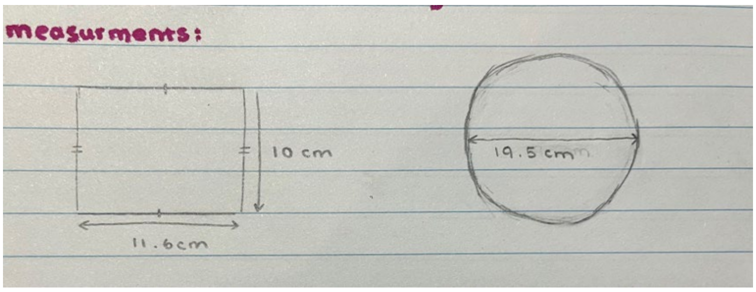





Method

1. 150 g of soil was measured into each little pot. The pots were separated into four groups of four and placed in the circular tray.

2. The large pots where then cut out. Each pot had three rectangles cut out around the sides with an equal distance apart with a width of 10 cm and length of 11.6 cm. The top of the pot was cut out as well, the diameter of the hole on top was 19.5 cm.



3. The holes in the large pots were then covered in cellophane. One pot was covered in each different colour, for example, one pot was covered in red, one in green etc. The

cellophane wasn't cut to a particular size, it was estimated what size would fit the hole the most accurately. The cellophane was glued on with the hot glue. The edges of the cellophane was then covered in black insulation tape.




4. The large pots were then placed over the little pots in the tray to simulate a green house. The pots were then placed outside in direct sunlight.

5. The plants were continuously watered over the week of growth. The plants were only watered when they felt dry to the touch.
6. The results were recorded, and a graph was made from the table of results.

Safety

The safety issue overcome in this experiment was handling and using the hand saw when cutting out the holes in the big pots. Heavy duty gloves were worn throughout this part of the experiment, this prevented any possibility of a saw-based injury. The utilisation of the saw was also heavily supervised by a responsible parent.

Results

The pots were observed each day from the 19th of June to the 25th of June. The plants were measured and recorded if they were above the datum. The height measurements were made relative to the datum, which consisted of a ruler laid across the top of the clear pot as a starting point for another ruler which measured the radish after it had grown about this first ruler. This information is presented in table 1.

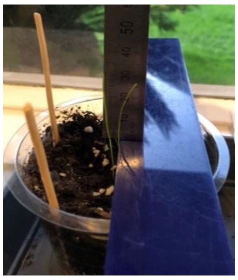


Figure showing datum method of measuring

Table 1: All observations.

Pot	Clear Cellophane							Red Cellophane						
	19/06	20/06	21/06	22/06	23/06	24/06	25/06	19/06	20/06	21/06	22/06	23/06	24/06	25/06
1a	8	13	20	25	32	38	44	25	33	40	45	53	59	65
1b	6	10	15	17	21	25	32	23	30	39	45	51	60	65
1c	-	5	8	10	13	18	27	7	14	20	24	30	34	38
1d	-	-	-	-	-	-		3	9	15	20	28	37	45
1e	-	-	-	-	-	-		-	-	-	-	2	8	15
2a	13	18	22	25	29	34	38	42	50	57	65	69	74	80
2b	9	13	16	22	25	28	34	23	32	40	45	53	58	65
2c	5	8	11	18	23	30	34	10	16	22	30	34	45	56
2d	2	7	9	17	20	24	29	4	11	18	24	33	40	51
2e	-	-	-	2	5	10	15	-	-	-	-	-	-	
3a	12	17	22	28	33	35	42	33	39	45	50	54	60	65
3b	6	10	14	20	25	30	38	27	34	38	48	53	57	
3c	-	-	-	-	-	-	5	8	12	18	25	29	35	45
3d	-	-	-	-	-	-		6	14	20	23	30	33	42
3e	-	-	-	-	-	-		-	-	-	5	9	14	23
4a	10	15	18	21	26	36	41	34	41	46	50	53	60	70
4b	7	11	15	18	24	34	40	29	36	40	45	49	54	62
4c	-	2	7	11	18	28	34	24	31	38	45	47	50	61
4d	1	7	12	15	23	32	37	16	21	28	35	39	45	52
4e	-	-	4	9	14	18	25	10	17	25	30	35	38	45

Pot	Green Cellophane							Blue Cellophane						
	19/06	20/06	21/06	22/06	23/06	24/06	25/06	19/06	20/06	21/06	22/06	23/06	24/06	25/06
1a	25	32	40	47	53	63	75	12	21	25	35	43	52	68
1b	18	28	35	45	51	58	70	9	16	22	32	35	43	60
1c	16	25	32	39	45	50	60	5	11	19	24	29	38	45
1d	12	23	30	37	43	48	55	3	8	14	20	28	38	
1e	4	12	20	28	32	43	50	-	-	-	-	3	9	17
2a	39	47	55	67	74	80	90	17	25	34	42	48	59	76
2b	17	23	30	38	44	50	60	12	18	25	32	39	51	63
2c	11	18	25	35	40	50	55	6	11	20	28	38	50	
2d	-	4	12	17	18	24	30	2	9	16	24	30	35	50
2e	-	-	-	-	-	2	10	-	-	-	4	10	16	24
3a	4	10	18	24	35	47	54	15	23	29	35	43	57	68
3b	9	12	20	26	33	48	57	9	16	25	30	35	37	45
3c	-	-	3	8	12	17	25	13	21	28	33	40	53	60
3d	-	-	-	-	-			8	15	22	26	30	33	45
3e	-	-	-	-	-	-		-	6	14	17	22	30	39
4a	35	42	50	60	63	72	80	32	39	45	50			
4b	31	44	50	60	65	70	76	22	28	36	42	50	62	70
4c	40	48	55	65	69	75		14	22	32	35	39	45	50
4d	32	37	45	50	55	58	65	6	11	17	26	31	37	45
4e	42	50	55	62	68			-	-	4	15	19	25	30

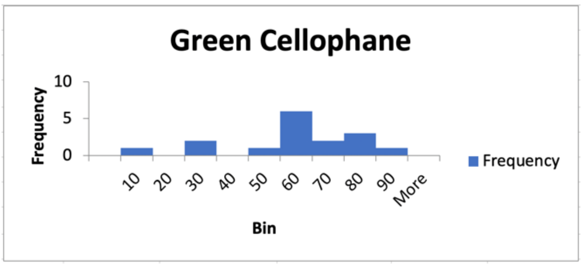
Above, we can see a table of results showing the growth of each seedling in each pot from the 19th to the 25th of June.

Table 2: Summary of Results

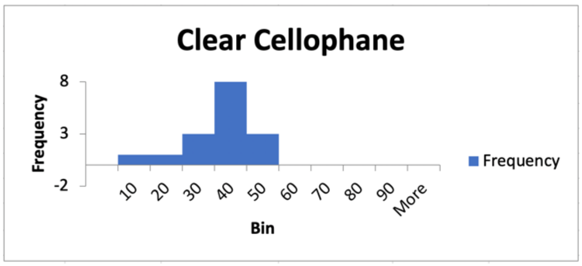
Cellophane	No. Plants	Max height	Average height	Average growth rate (mm/d)	No. > 50mm	No. >60mm
Clear	16	44	32.2	5	0	0
Red	18	80	52.5	6.3	11	8
Green	16	90	57	7.3	12	6
Blue	17	76	50.3	7.5	7	5

Table 2 shows the results summarised into the total number of plants sprouted in each colour, the height of the tallest plant in each colour, the average height of all the radishes that grew above the datum, the average growth rate in terms of mm per day for each colour, number of plants greater than 50 mm and number of plants greater than 60 mm. The table communicates the fact that radishes tested with green light grew the best by producing the tallest plant, however the red light grew more plants overall. The table demonstrates that the blue plants had the highest growth rate per day but a similar average height to red. The white light produced the same amount of light as the green light, however its tallest plant, average height and average growth rate were all lower in comparison to the other colours.

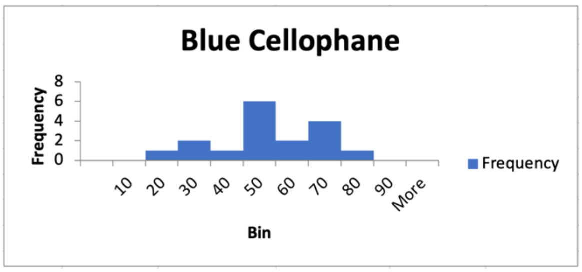
Graph 1



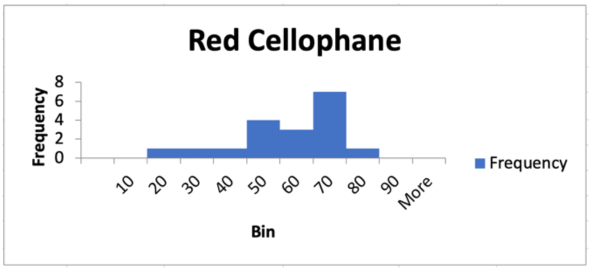
Graph 2



Graph 3



Graph 4



Interpretations
The graphs above represent the frequency of plant sizes in 10 mm range intervals for each colour.

Graph 1 shows results for the green cellophane pot. The height interval with the greatest number of seedlings is 60-70 mm. The green pot also has a wider spread of plant heights compared with the other colours. The green pots recorded the highest seedling of 90mm.

Graph 2 shows that the distribution of plant heights in the clear cellophane pot was almost symmetrical. The greatest number of seedlings occurred in the 30-40 mm range.

Graph 3 is also generally symmetrical, although there is a higher proportion of plants at the taller end of the scale. The greatest height population for the blue cellophane is in the range of 40-50 mm.

Graph 4 is negatively skewed with a higher population of taller plants. The greatest frequency of plants was in the 60-70mm range. Whilst not having the tallest seedling, the red cellophane pots had the greatest number of plants over 60mm in height.

The results have shown that overall the red plants had the highest amount of larger plants therefore demonstrating that the red cellophane was the most beneficial towards plants growth.

Evaluation
It was hypothesised that the radishes exposed to red light would exhibit enhanced growth compared to those exposed to blue, green and white light. This hypothesis was supported, although the green cellophane had the highest measurement for one plant, the red cellophane produced the most amount of taller plants in total compared to the other colours. It was also hypothesised that the plants exposed to blue light would have a sturdier bases due to blue lights stomatal qualities. This hypothesis is partly supported as the radishes exposed to blue light did grow consistently throughout the tests and it did not produce the tallest stalks, it was not possible to tell whether or not the bases were studier in comparison to the other colours, therefore this part of the hypothesis could not be verified. It was hypothesised that the green and white light should have similar growth patterns, due to white lights similarity to normal light and chlorophylls general inability to absorb green light.

The method was valid as it allowed adequate data collection and understanding, as well as being easy to follow. It allowed for the cellophane to be appropriately manipulated to simulate a green house. The datum measurement system introduced measurement inaccuracies as the plants had to moved around and manipulated to measure to the top of the leaf. This system would most likely not be used in a professional environment as the plant can only be measured once it has grown above it.

A source of error could be inaccuracies when measuring out the soil, although this factor shouldn't affect the end result to much.

Conclusion
The effect of different coloured light on the growth of plants has been demonstrated to have an impact on agricultural productivity. This experiment has shown that red light promotes photosynthesis which is an essential for the production of energy and the synthesis of vital plant compounds. Blue light was shown to be quite affective as well when manipulating the plant growth. By manipulating the plant growth under red and blue light, in the future, it is possible to optimize plant growth and enhance crop yields indoors.

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