FIRAS EL-HAWAT 10B

SCIENCE: ASSIGNMENT TASK 1

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I hereby state the contents of this assignment was completed and edited by Firas El-Hawat and any information that had been taken from supplementary sources has been acknowledged.
STUDENT RESEARCH PROJECT

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The title of this Student Research Project is “The effectiveness of different greenhouse materials on the growth of wheat grass”.

**INTRODUCTION**

The Student research project selected is “The effectiveness of different greenhouse materials on the growth of wheat grass”. A greenhouse, also habitually denoted to as a glasshouse or hothouse, is a structure that has its walls and roof primarily made of transparent material, such as glass or certain types of plastics, in which plants requiring regulated climatic conditions are grown in, such as in the Botanical Gardens. This enables a vast number of plants to be grown in virtually any climate as greenhouses can be tampered with to create optimal climatic conditions for certain plants to be grown in. Moreover, greenhouses are also capable of enhancing the sun’s beneficial impacts on plants, via light diffusion, substantially aiding photosynthesis, whilst also preventing the majority of the sun’s radiation from escaping the structure, maintaining a warm, moist and/or tropical environment, if required. The concept and aim of this experiment is to determine which material used on a greenhouse provides the optimal climatic conditions for plant growth and quality, taking into account each material’s composition and properties. {Greenhouses online, 2016}

Vinyl is of the most recommended greenhouse materials in ensuring efficient plant growth. This is as vinyl is highly tolerant to moisture and humidity whilst also being outstandingly strong and durable. Such qualities are vital for greenhouse coverings as greenhouses are habitually placed under exceptionally moist and humid temperatures, meaning that the greenhouse covering used is required to be capable of withstanding such climatic conditions. Moreover, vinyl is capable of slight light diffusion, aiding in plant photosynthesis and ensuring efficient plant growth, whilst is additionally a remarkably low cost material that is recyclable and environmentally friendly, thus furthering its beneficial factors. {Jezek, G, 2015}

Moreover, a remarkable greenhouse material in ensuring efficient plant growth, yet, habitually used for insulation, is Fiberglass. Fiberglass, unlike other greenhouse materials, has a low electrical and thermal conductivity rate, ensuring that there is a minimal chance of unwanted electrical and thermal energy traveling through the material contributing unwanted heat into the atmosphere, which may disturb the present climatic conditions. However, fiberglass is mostly incapable of light diffusion, and as such is usually not recommended for greenhouse coverings. {InterActiveCorp, 2016}

Moreover, polycarbonate is the highest recommended greenhouse material, due to the exceptional qualities it possesses that supplementary materials simply lack. Polycarbonate is naturally transparent and has the ability to transmit light nearly that of glass, whilst being exceptionally sturdier and resilient towards harsh weathers, making it far more desirable over glass. In addition, polycarbonate has substantially high heat resistance, as well as exceptional
light diffusion, significantly aiding plant photosynthesis as well as ensuring that the greenhouse covering does not contribute unwanted thermal energy into the atmosphere which may disturb the present climatic conditions. {Polymer technology and services, 2015}

Furthermore, Acrylic is an exceptional greenhouse material that is habitually unused, however, possesses qualities that are remarkably superior to those of other materials. Acrylic has outstanding outdoor weather ability, resistance to Ultra-Violet radiation as well as moderate light diffusion. Such qualities ensure the efficient growth of plants via aided photosynthesis, as well as ensure that any organic life within the greenhouse is not affected by unnecessary Ultra-Violet radiation which may potentially damage, cause unwanted alterations and dry out or weaken the plants. Furthermore, acrylic is naturally optically clear, almost to that of glass, whilst also possesses great acoustic properties, which ensures that any organic life within a greenhouse is not affected, in terms of growth, by any mechanical waves found in gases, liquids and solids. {Marine Ply Substitute, 2015}

Investigating the effectiveness of different greenhouse materials on the growth of wheat grass has exceptional significance to the wider community and to society due to the substantial quantity of agriculture practised throughout the world. Such information is vital for any agricultural worker, business owner or for one who merely owns a personal greenhouse, as it elucidates the optimal material for the efficient growth of plants, meaning that plants, fruits and vegetables are capable of being grown and harvested at an enhanced rate resulting in much more efficient agricultural practices. This is extremely important as in today’s world there is an astronomically high demand on plants, fruits and vegetables, particularly in areas, states or countries prone to natural disasters, which destroy areas of agricultural practice, or in nations that are subject to very cold and/or long winters, where the growth of plants is extensive, difficult and tedious.

AIM

To determine the effectiveness of different greenhouse materials on the growth of wheat grass.

HYPOTHESIS

Polycarbonate will best encourage the growth of wheat grass, due to the exceptional qualities it possesses that supplementary materials, such as acrylic, vinyl and fiberglass, simply lack. Such qualities include substantially high heat resistance, as well as light diffusion, exceptionally aiding photosynthesis and preventing the scorching of plants. These qualities, ensure that the greenhouse covering does not contribute unwanted thermal energy into the atmosphere which may disturb the present climatic conditions, whilst also ensuring enhanced growth rates of the wheat grass due to the diffused light which aids photosynthesis.
MATERIALS

- Fifty averaged sized, 200ml transparent plastic cups
- 200 grams of soil per cup
- Fifty wheat seeds, one per cup
- Sixteen, thirty centimetre thin still rods, OR a 30 centimetre diameter food covering net
- One 100cm length, by 100cm width, by 1cm thick vinyl, polycarbonate, fiberglass and acrylic sheet.
- Glue
- Measuring ruler
- Scale/kitchen scale
- Fifteen litters {15L} of water per week for watering the plants, with each plant receiving 100ml of water every time it is watered.

These materials were chosen as they are cheap, easy to acquire, fulfil the requirements of the experiment, and for some of the materials, such as the greenhouse coverings, there are no alternatives. In addition, such materials are commonly already located in households, such as cups, soil, water, ruler, glue and kitchen scale or may be cheaply and easily purchased from hardware shops, supermarkets or discount variety stores {e.g. Big W}, exceeding a budget of no more than fifty to sixty dollars {$50-$60}.

METHOD

1. Seeds were germinated
2. Four thin metal rods were connected onto a flat board to form the structure of a rectangle with dimensions fifty cm by twenty cm. Construct four of these structures.
3. Holes were poked in the greenhouse materials {Vinyl, Acrylic, Fiberglass, and Polycarbonate} 10cm by 5cm apart.
4. Each of the greenhouse materials were placed over one of the structures created and wrap the material around the structure so that all the sides are covered.
5. The ends of the material were secured to the frame and to the board with glue to ensure it doesn’t move out of place, then place structures in a luminous {sunny} area. NOTE: steps 2-5 may be bypassed by merely purchasing a 30cm diameter food covering net, or an object of similar size.
6. Each of the 50 cups were filled with 200 grams of soil.
7. Holes were made in the centre of each cup 2cm deep, by 2cm wide.
8. Ten seeds were placed inside each hole then buried in soil.
9. The mass of each plant was measured, using a scale.
10. Ten cups were placed into each of the miniature greenhouses constructed previously, and an additional ten cups in the same area, however, not covered by a greenhouse, to serve as the control experiment.
11. Each of the cups were watered with 100ml of water every second day.
12. The cultivation of the plants overtime were observed and any findings made by measuring the height of all the plants every day, for seven days, were recorded.

13. The plants were removed from the greenhouse after one week and their heights and masses, as well as the heights and masses of the ten plants serving as the control experiment, were compared with the heights and masses of the plants when first placed within the miniature greenhouses.

## Risk Assessment

| STEEL RODS | SKIN AND EYES: May cause harm or injury to one if misused or not handled with proper care. May have sharp edges that can cause injury, bleeding and tissue damage. | SAFETY PRECAUTION Use appropriately and safely. Wear goggles and safety gloves to protect oneself from sharp corners and/or dull vertices of the steel rods. |
| SEEDS | STOMACH: May cause stomach pain and indigestion if consumed. | SAFETY PRECAUTION Use appropriately and safely. Keep seeds away from mouth and out of reach from children who may consume the seeds. |
| SOIL | SOIL: {POTMIX} This product contains micro-organisms. Direct contact and exposure through repeated inhalation may cause skin irritation or infection, or respiratory irritation. EYES: May cause mild irritants, eye redness, watering or eye infection. Irrigate immediately with water and if irritation persists, seek medical attention. SKIN: Mild irritants and can cause skin sensitization, dermatitis or skin infection. Wash skin with soap and plenty of water and if irritation persists, seek medical attention. INHALATION: Mild irritants and can cause sensitisation, inflammation or infection of nose, throat and lungs. Avoid inhalation of dust. Remove from exposure and if irritation persists, seek medical attention. | SAFETY PRECAUTION Avoid contact with eyes. Wear suitable protective clothing, gloves as well as eye and face protection. Avoid breathing product dust. Avoid breathing product dust by handling soil in a well ventilated area. |
RESULTS

Average mass and height of wheat grass grown in differently covered greenhouses

<table>
<thead>
<tr>
<th>GREENHOUSE MATERIALS</th>
<th>AVERAGE HEIGHT OF PLANTS (DAY 1)</th>
<th>AVERAGE HEIGHT OF PLANTS (DAY 2)</th>
<th>AVERAGE HEIGHT OF PLANTS (DAY 3)</th>
<th>AVERAGE HEIGHT OF PLANTS (DAY 4)</th>
<th>AVERAGE HEIGHT OF PLANTS (DAY 5)</th>
<th>AVERAGE HEIGHT OF PLANTS (DAY 6)</th>
<th>AVERAGE HEIGHT OF PLANTS (DAY 7)</th>
<th>AVERAGE MASS OF PLANTS AFTER GROWTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO MATERIAL</td>
<td>0mm</td>
<td>6mm</td>
<td>12mm</td>
<td>20mm</td>
<td>29mm</td>
<td>36mm</td>
<td>44mm</td>
<td>211 grams</td>
</tr>
<tr>
<td>VINYL</td>
<td>0mm</td>
<td>12mm</td>
<td>20mm</td>
<td>29mm</td>
<td>38mm</td>
<td>47mm</td>
<td>55mm</td>
<td>232 grams</td>
</tr>
<tr>
<td>ACRYLIC</td>
<td>0mm</td>
<td>15mm</td>
<td>24mm</td>
<td>32mm</td>
<td>41mm</td>
<td>51mm</td>
<td>60mm</td>
<td>241 grams</td>
</tr>
<tr>
<td>POLYCARBONATE</td>
<td>0mm</td>
<td>20mm</td>
<td>31mm</td>
<td>41mm</td>
<td>52mm</td>
<td>60mm</td>
<td>68mm</td>
<td>253 grams</td>
</tr>
<tr>
<td>FIBERGLASS</td>
<td>0mm</td>
<td>9mm</td>
<td>16mm</td>
<td>25mm</td>
<td>34mm</td>
<td>42mm</td>
<td>50mm</td>
<td>220 grams</td>
</tr>
</tbody>
</table>

GRAPH A

Average weight of plants under differently covered greenhouses

Greenhouse materials used
GRAPH B

Average height of plants grown in differently covered greenhouses

Number of Days

Average plant height [millimetres]

- Poly carbonate
- Vinyl
- Acrylic
- Fiberglass
- Not covered
DISCUSSION

The Student Research Project conducted aimed to determine the effectiveness of different greenhouse materials on the growth of wheat grass. The obtained results were accurately demonstrated via the graphs. Graph A and B effectively illustrate that wheat grass grown within the polycarbonate covered greenhouse grew the fastest, with an average plant height of sixty-eight millimetres, and an average plant mass of 253 grams. Whereas the wheat grass grown in the acrylic covered greenhouse cultivated the second fastest, with an average plant height of sixty millimetres, and an average plant mass of 241 grams. Additionally, the wheat grass grown in the vinyl covered greenhouse grew the third fastest, with an average plant height of fifty-five millimetres, and an average plant mass of 232 grams in the fiberglass covered greenhouse germinated the fourth fastest, with an average plant height of fifty millimetres, and an average plant mass of 220 grams. The growth of ten wheat grass plants outside a greenhouse served as a control group, and grew the slowest out of all plants used within the experiment, with an average plant height of forty-four millimetres, and an average plant mass of 211 grams. Such results occurred due to the differing qualities the greenhouse materials possessed, which aid and manipulate the process of photosynthesis and the effects of the sun’s Ultra-Violet and infrared radiation on the growth of plants. An evident trend in the results suggests that materials primarily capable of exceptional light diffusion encourage the efficient growth of plants far more than materials that do not. Such qualities enable for efficient plant growth as the sun’s intensity on the plants is debilitated. This enables efficient photosynthesis as the plants are subject to decreased sunlight intensity and are able to photosynthesise deprived of unnecessary strain and pressure by excessive sunlight. Moreover, the diffusion of light filters an exceptional quantity of the sun’s harmful radiation, which otherwise weakens and/or dehydrates organic life. Such aspects support the initial prediction that polycarbonate best encourages the growth of wheat grass, due to the fact that it provides optimal light diffusion. {Science Alert, Betisize, BBC}

Additionally, findings obtained throughout the conduction of the experiment were exceptionally reliable due to the fact that all controlled variables were sustained, and maintained the same throughout the entirety of the experiment. Moreover, all plants were allocated an equal time to grow, including an extensive sample size experiment used to ensure the minimisation of possible inaccurate findings, thus ensuring the accuracy of the experiment.

Furthermore, throughout the conduction of the experiment virtually no hitches were encountered, however, it was difficult to measure, cut and construct the greenhouse structures, as dangerous machinery was required, such as a saw, and as such adult supervision was entailed as to ensure safety. Additionally, it was difficult and tedious to determine which plant species to use for experimentation, as it was initially feared that differing plant species may produce dissimilar results.

Moreover, the results acquired efficiently demonstrate the effectiveness of different greenhouse materials on the growth of wheat grass. The findings acquired clearly depict that wheat grass within the polycarbonate covered greenhouse grew the fastest, with wheat grass within the acrylic covered greenhouse growing the second fastest. Additionally, wheat grass
within the vinyl covered greenhouse grew the third fastest and wheat grass within the fiberglass covered greenhouse growing the fourth fastest. The growth of ten wheat grass plants outside a greenhouse served as a control experiment, and grew the slowest out of all plants used within the experiment.

Additionally, the findings obtained may have been vastly enhanced, had the plants been allotted a period of time to cultivate, as a means of eliminating any defective seeds used for experimentation. Increased research may have additionally aided findings obtained, as an augmented understanding of wheat grass, greenhouses and photosynthesis may have allowed for a more ideal greenhouse thickness, as well as more accurate wheat grass watering needs and appropriate sunlight exposure.

Furthermore, investigating the effectiveness of different greenhouse materials on the growth of wheat grass has exceptional significance to the wider community and to society due to the substantial quantity of agriculture practised throughout the world. Such information is vital for any agricultural worker, business owner or for one who merely owns a personal greenhouse, as it elucidates the optimal material for the efficient growth of plants, meaning that plants, fruits and vegetables are capable of being grown and harvested at an enhanced rate resulting in much more efficient agricultural practices. This is extremely important as in today’s world there is an astronomically high demand on plants, fruits and vegetables, particularly in areas, states or countries prone to natural disasters, which destroy areas of agricultural practice, or in nations that are subject to very cold and/or long winters, where the growth of plants is extensive, difficult and tedious.

Furthermore, the experiment conducted could be significantly extended upon via the use of increased sample sizes, as to ensure the upmost accuracy of the experiment, as well as via the use of additional greenhouse materials and plant species. Such methods will exceptionally improve results acquired and increase the reliability and accuracy of the experiment, as greater varieties of greenhouse materials and plants are to be tested, providing an augmented probability of determining the optimal greenhouse covering for the efficient growth of plants. However, despite such suggested extensions to the experiment, the initial hypothesis made would not be changed, due to the accuracy of the claim in regards to the efficient growth of plants, via the manipulation and enhancement of a plants photosynthesis.

Moreover, similar research previously conducted by supplementary individuals depict that polycarbonate covered greenhouses best encourage the growth of plants, over additional greenhouse coverings such as glass and plastic {Global Green Hut, Telegraph Media Group, 2016}. Whilst previously conducted research are extensive, they fail to use a wide variety of plants, and rather are limited to fast growing plants such as wheat grass, as well as are limited to polycarbonate, glass and plastic greenhouse coverings. Thus, such experiments are merely partially beneficial, as whilst they support the findings made of polycarbonate best encouraging plant growth, they fail to include supplementary materials such as fiberglass, acrylic and vinyl, thus limiting their usefulness. {Winter Gardens} Additionally, experimentation and research on the efficient growth of plants, via the alteration and efficient process of photosynthesis ought to be investigated to ensure in effective and efficient agricultural practices. Such directions in scientific research have been engaged as it is evident that efficient growth of plants comes about via the manipulation and enhancement of plant photosynthesis.
The conducted experiment investigating the effectiveness of different greenhouse materials, including polycarbonate, acrylic, vinyl and fiberglass, on the growth of wheat grass was successful and supported the initial hypothesis, of polycarbonate being most effective on the growth of wheat grass. Despite a few dissimilarities within the plants subject to experimentation, wheat grass submerged in the polycarbonate covered greenhouse cultivated the fastest, thus supporting the hypothesis.


Nicole Wrinn, published on the 10th of June, 2014, “GROWING FROM THE GREENHOUSE”, edition 1, volume number 1, John Wiley Sons Ltd, Chichester, United Kingdom {Educational Book}