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IB Class

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Effects of Acidity on Seed Germination

**Design Aspect 1:**

**Aim:**

The purpose of this research is to determine how the acidity level of water will affect the germination of a seed. When a seed germinates, it forms a primary root or a radicle. The radicle is essential to a new plant because it functions as an anchor as well as absorbs water. By measuring the length of the radicle, it is possible to determine how acidity will affect seed germination.

**Research Question:**

How will the germination of the common sweet pea, *Lathyrus* *odoratus* (*L. odoratus*), be affected by levels of acidity?

Independent Variable: Level of pH (1, 2, 3, 4, 5, 6, 7)

Dependent Variable: length of radicle, measured in millimeters

**Design Aspect 2:**

|  |  |
| --- | --- |
| **Controlled Variables** | **How I Will Control It** |
| Time | Measurements will be taken after the specified amount of time has passed. In this case, I will start the trial at 8:00 am. After five complete days have passed I will take my measurements again at 8:00 am. |
| Air | The packages will be wrapped up in plastic wrap and then placed inside a double sealed plastic bag. This will ensure that there is no access to outside air flow. |
| Temperature | The wrapped bags will be placed in an area of the room that has no drafts. I will ensure that the temperature experiences no major fluctuations throughout the day. |
| Exposure to solution | Each seedling will receive the same amount of solution – 15.0 ml |
| Concentration of acid | Each solution will be made to a specific pH. Beginning with distilled water, a calculated volume of nitric acid will be added and carefully mixed. Each solution will be clearly labeled and marked then tested with an electronic pH meter to verify acidity. |
| Exposure to light | The seedling bags will be placed in a dark room without exposure to light or any additional source of heat. |

**Design Aspect 3:**

***Procedures:***

***Should be very detailed and specifically address each controlled variable.***

1. A series of five trials will take place for each pH: 1, 2, 3, 4, 5, 6, 7 (neutral)
   1. Five *L. odoratus* seeds will be placed on 10 inches of paper towel
   2. 10 ml of solution will be added
   3. The paper towel will be wrapped up loosely and placed within a double sealed bag
   4. Each bag will then be marked with the appropriate pH label and placed in an environment without access to light or major temperature changes.
   5. This process will then be repeated for a total of five trials
2. Each seedling will be measured precisely the same way. The radicle length will be measured in millimeters.

**Data Aspect 1:**

Raw Data:

*Ruler: Uncertainty of +/- 0.5 mm*

Table 1:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Radicle length (mm) by level of pH** | | | | | | | |
|  | **1 pH** | **2pH** | **3pH** | **4pH** | **5pH** | **6pH** | **7pH** |
| **Trial 1** |  |  |  |  |  |  |  |
|  | 1.5 | 4.0 | 7.5 | 8.0 | 13.0 | 8.0 | 7.0 |
|  | 2.0 | 4.5 | 6.0 | 7.5 | 9.5 | 8.5 | 6.5 |
|  | 1.5 | 3.5 | 7.0 | 9.5 | 12.5 | 7.0 | 6.5 |
|  | 1.0 | 2.0 | 5.0 | 6.0 | 14.0 | 8.5 | 7.0 |
|  | 2.0 | 4.5 | 7.0 | 7.5 | 16.0 | 8.0 | 5.0 |
| **Trial 2** |  |  |  |  |  |  |  |
|  | 3.5 | 4.0 | 8.0 | 9.5 | 15.5 | 6.0 | 7.5 |
|  | 2.5 | 5.5 | 7.5 | 9.0 | 14.5 | 7.5 | 5.0 |
|  | 0.0 | 4.0 | 6.5 | 8.5 | 13.5 | 7.5 | 6.5 |
|  | 0.5 | 5.5 | 7.0 | 9.5 | 11.5 | 8.5 | 6.5 |
|  | 1.5 | 4.0 | 7.0 | 6.5 | 14.0 | 8.0 | 5.0 |
| **Trial 3** |  |  |  |  |  |  |  |
|  | 1.5 | 5.5 | 7.0 | 9.0 | 14.0 | 8.0 | 5.0 |
|  | 2.0 | 4.5 | 7.5 | 8.0 | 12.0 | 9.5 | 7.5 |
|  | 0.0 | 4.5 | 8.0 | 9.0 | 10.0 | 7.5 | 6.0 |
|  | 1.5 | 4.0 | 6.0 | 8.0 | 13.5 | 7.5 | 5.5 |
|  | 0.0 | 5.0 | 7.0 | 9.5 | 16.0 | 7.0 | 5.0 |
| **Trial 4** |  |  |  |  |  |  |  |
|  | 1.5 | 4.5 | 7.0 | 8.5 | 13.5 | 8.5 | 7.5 |
|  | 2.5 | 4.0 | 7.5 | 7.0 | 16.1 | 8.0 | 5.0 |
|  | 1.0 | 3.5 | 7.0 | 9.0 | 12.5 | 7.5 | 6.5 |
| **Radicle length (mm) by level of pH (continued)** | | | | | | | |
|  | **1 pH** | **2pH** | **3pH** | **4pH** | **5pH** | **6pH** | **7pH** |
| **Trial 4** |  |  |  |  |  |  |  |
|  | 0.5 | 5.0 | 7.0 | 9.0 | 15.0 | 7.0 | 5.0 |
|  | 1.0 | 4.5 | 7.0 | 6.5 | 14.5 | 8.0 | 5.0 |
| **Trial 5** |  |  |  |  |  |  |  |
|  | 1.5 | 5.5 | 7.5 | 9.0 | 14.0 | 8.5 | 5.0 |
|  | 2.5 | 4.5 | 7.5 | 8.0 | 12.5 | 9.0 | 7.0 |
|  | 0.5 | 4.5 | 8.5 | 9.0 | 10.0 | 7.5 | 6.5 |
|  | 1.0 | 4.5 | 6.5 | 8.5 | 13.5 | 7.5 | 5.5 |
|  | 0.0 | 5.0 | 7.0 | 9.5 | 16.5 | 7.0 | 5.0 |

**Data Aspect 2: Processed Data**

Calculations Performed:

Average (Mean) : Sum of all numbers / # of values

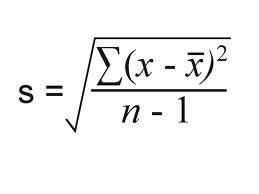
[](http://www.google.com/url?sa=i&rct=j&q=formula+for+standard+deviation&source=images&cd=&cad=rja&docid=dQ6fJ45mCHltNM&tbnid=5QdGE8SBNzNRpM:&ved=0CAUQjRw&url=http://www.studyblue.com/notes/note/n/test-two-/deck/3921674&ei=aO4LUpbaIo7M9gTgtoCgBw&bvm=bv.50723672,d.b2I&psig=AFQjCNHNnReFsk_DJK9foybl08AIhWAr0A&ust=1376600024664318)Standard Deviation:

Table 2:

*Uncertainty of measurement: +/- 0.5 mm*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Average and standard deviation of radicle length by pH (mm)** | | | | | | | |
|  | **1 pH** | **2pH** | **3pH** | **4pH** | **5pH** | **6pH** | **7pH** |
| Average  Length | 1.3 mm | 4.4 mm | 7.1 mm | 8.4 mm | 13.5 mm | 7.8 mm | 6.0 mm |
| Standard Deviation | 0.9 mm | 0.8 mm | 0.7 mm | 1.0 mm | 1.9 mm | 0.7 mm | 1.0 mm |

Sample Calculations: Can be done by hand

**Data Aspect 3: Presenting Processed Data**

Graph 1:

***Once printed out, display standard deviation as error bars on finished graph***

***Other potential data processing that could be done: t-test between 2 specific pH’s***

**Conclusion Aspect 1:**

**What are the features of an effective conclusion?**

Effective conclusions will have many of the following characteristics.

 There will be references to the quantitative data in the body of the conclusion.

 Where applicable there will be references to other experiments or literature values.

Begin by addressing whether your data supports or refutes your prediction. (Be sure to restate your prediction.) This should be discussed not just stated. You need to *justify* your interpretation of the data (as supporting or not supporting your prediction) by referring to the information in your graphs. Avoid the use of the words "proof" or "proves” within your conclusion because your data will not actually *prove* anything.

**Conclusion Aspect 2:**

*Weaknesses and limitations*

**Distinguish between limitations in the design of procedures and limitations in the performance of procedures.**

Limitations of the design of procedures discuss how well your experimental design helped answer your experimental question. Here you discuss what worked well, and **why,** plus what did not work well, and **why**. Outlier points, results of statistical tests, what the error bars on graphs show, etc. can be discussed.

Limitations in the performance of procedures discuss the realistic and useful improvements could be made to the design of procedures that could possibly lead to better results if the investigation were to be conducted again.

**Conclusion Aspect 3:**

*Realistic improvements:*

For every weakness that you listed, have at least one realistic and relevant way to improve it.

**Works Cited**

**At the very least, you may use your textbook as a reference. Other potential references would be websites that you used as a guide, published data to compare against or similar research.**

**APA formatting must be used.**

[**http://citationmachine.net/index2.php**](http://citationmachine.net/index2.php) **= your best friend for citations ☺**