Mung Bean Germination

**Background**

­­During a lifeform’s growth and development, whether it be animal or plant life, is dependant of a lot of different factors. These factors can be almost anything really, from things like sunlight, food, area of development, the development of other lifeforms around it. With animals, there is dependency on things like psychological health as well. There are tons of different things that affect the way something grows. The one thing that all life on planet Earth is dependent on, no matter what, is water. More specifically, life is dependent on hydration. All life is comprised of some percentage of water, with humans having a composition that is about 50-70% water, although there are some lifeforms that are made up of much higher amounts, as seen in some microscopic life.

Salt is a term for crystalized acids. Salt comes in varying levels of acidity and each salt’s composition can be made up several different things. In this context, where in this investigation I use the term ‘salt’, I will be referring to Sodium Chloride (NaCl). One of salts abilities’ is to draw water towards it from around it. Salt is naturally soluble in water, meaning that it will dissolve to create a solution (salt water). Even when it is dissolved, it will still naturally draw water towards itself.

Plant roots have a similar property. To feed it water, the plant will draw up water from around it’s’ roots. The water is then transported throughout the plant, mainly to be used for photosynthesis. The stream can also contain nutrients for the plant. Obviously then, water is extremely crucial for a plant’s growth and survival.

So, how will the plant be affected when the water that is being drawn up contains salt?

**Hypothesis**

My hypothesis is that salt will have an effect on a plant’s growth, specifically that the salt will be detrimental to plant, inhibiting it from growing. I base this hypothesis on the information stated above; where salt pulls in water, as does a plant, meaning the salt will prevent a plant getting the hydration and nutrients it needs.

**Test**

My test will be to follow the growth of mung beans in a controlled environment. Mung beans take only 1-2 days to germinate normally, if exposed to the right amount of water and light. My plan is to grow mung beans alongside each other, using a solution that contains between 0 – 0.3 moles\* of salt. The experiment will take place over 5 days. The concentration of salt in the solution will be measure in 0.05 mole increments. So that’s 7 different salt concentrations.

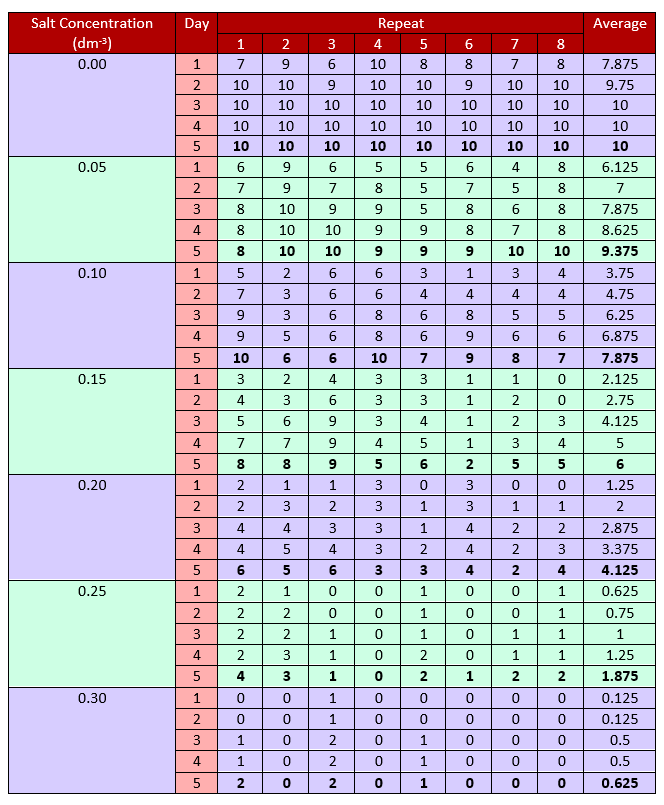
Each concentration level will have a petri-dish containing 10 mung beans, with 7 repeats also in that level. That’s a total of 8 petri-dishes containing 10 mung beans; each contains a solution of different salt concentration. That’s means there will be: (8 x 7 x 10) mung beans, which gives a total of 560 beans.

The solution will be created by measuring out 80ml of distilled water, then adding the salt. Each petri-dish will then be given 10ml of the solution. This makes a ratio of 1:1 ml of solution to bean.

The test will commence at 12:00PM on day 0, where none of the beans will have germinated. Each day afterwards, at 12:00PM I will inspect each petri-dish and record how many beans have germinated in that dish. When a bean germinates, it is removed from the dish. This will carry on for 5 days, where the test will end.

*\*Moles: A unit used when measuring an amount of substances. It is not a measurement of mass (i.e. grams)*

**Data**

As stated above, I will record each petri-dishes’ total seed germination each day. I am keeping the test as absolutely fair as possible, to make sure the results are as valid as possible. All the seeds will be stored in the same condition (in darkness, room temperature). Each petri-dish will have the same amount of solution, differing only in salt concentration, as that is the independent variable. 

Bold – Final Germination Result

As we can observe on the previous side, the concentration of salt has clearly had a negative effect on the germination of the mung bean seeds.

Here is a graph representing changing germination average of each salt concentration over the 5 days:

As we can see, the lower the salt concentration, the higher the germination at any given point.

Here is a small containing just concentration and final germination average:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Salt Concentration (dm-3) | 0.00 | 0.05 | 0.10 | 0.15 | 0.20 | 0.25 | 0.30 |
| Final Germination Average | 10 | 9.375 | 7.875 | 6 | 4.125 | 1.875 | 0.675 |

**Standard Divination + Erroneous Values**

Using this data, we can find out if there are any erroneous results that should be ignored for the sake of validity. To this, we will calculate the standard divination for each concentration.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Salt Concentration (dm-3) | Final Germination Mean | Standard Divination  (3 deci.place) | Mean + 2(S.D) | Mean - 2(S.D) | Erroneous values |
| 0.00 | 10 | 0.000 | 10 | 10 | 0 |
| 0.05 | 9.375 | 0.484 | 10.34375 | 8.40625 | 0 |
| 0.10 | 7.875 | 2.359 | 12.59375 | 3.15625 | 0 |
| 0.15 | 6 | 4.500 | 15 | -3 | 0 |
| 0.20 | 4.125 | 1.859 | 7.84375 | 0.40625 | 0 |
| 0.25 | 1.875 | 1.359 | 4.59375 | -0.84375 | 0 |
| 0.30 | 0.625 | 0.734 | 2.09375 | -0.84375 | 0 |

The above value were calculated by finding out the standard deviation for each concentration’s final germination count, which is used to see if any the values yielded would be considered erroneous. If the value can be inserted into the range:

It means the value is **not** erroneous. And as shown in the table on the opposite page, none of the recorded values are outside this range, meaning no erroneous data.

**Line of Best Fit + Correlation Coefficient**

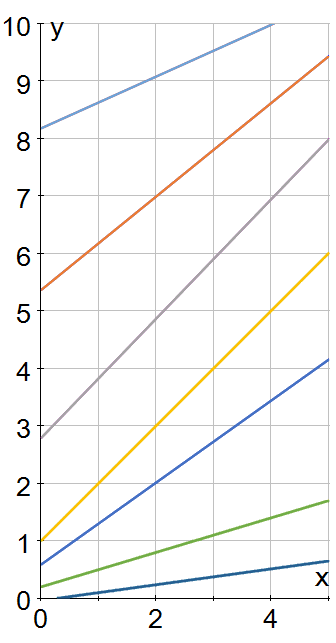
We’ve already shown that salt has a negative effect on the growth of the bean, but this does not show how different concentrations affect the growth trends. To find out this information, we shall calculate the correlation coefficient and the line of best fit for each concentration level.

|  |  |  |
| --- | --- | --- |
| Salt Concentration (dm-3) | Best Fit Equation | Correlation Coefficient (4 s.f) |
| 0.00 |  | 0.7661 |
| 0.05 |  | 0.9991 |
| 0.10 |  | 0.9929 |
| 0.15 |  | 0.9953 |
| 0.20 |  | 0.9971 |
| 0.25 |  | 0.9577 |
| 0.30 |  | 0.9297 |

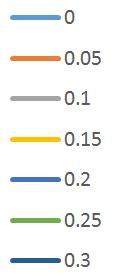
What the correlation coefficient shows is how closely two different variables are *linearly related*. If the number is 1, then there is a perfect positive linear relationship, and if the number is -1, then there is a perfect negative linear relationship. If a number is, then it has a positive relationship, and thus if will make a negative relationship. If equal to, then there is no measurable linear relationship between the two variables.

Here, each correlation coefficient is pretty close to 1, meaning that they all have a fairly strong linear relationship. This means that we can say that as time passes, the amount of beans that germinate will increase.

The reverse of this page contains a graph that shows all the lines of best fit. This is also useful to demonstrate the correlation trend described above.



**Salt Concentration Key:**



**Conclusions**

From just looking at the raw data, we can conclude that the presence of salt in water will prevent a plant from growing properly. The more salt, the worse it is for the plant.

Looking at the standard deviation for each concentration, there is a larger variance in result towards the middle of the measured concentrations. From this we can conclude that predicting specifically how a plant’s growth will be affect is more difficult when only low amounts of salt is used.

Finally, looking at the correlation coefficients, since the values are all quite similar, we can say that the amount of salt is linear in how it affects the plant.

**Real-Word Application**

As stated above, salt is bad for a plant’s growth and survival. Plants such a crops that are farmed in the mainland, would react badly to salt exposure. Since salt is only really prevalent in seawater, this shouldn’t really affect mainland crops. But with rising sea levels, more potential farmland is made unusable due to earth getting saturated with seawater. Combine that with drinkable water being on a decline, this can lead to reduced crop production in the future, which is very bad for the population of Earth.

From this test, we can make the logical steps to do more about how salt will affect plants. We could research more into genetically modifying crops so that salt would not affect their growth, or could potentially help them grow! We could also seek to prevent the earth’s sea levels from rising with better climate control, and also invest more into protecting what farmland there is left from being made unusable by seawater saturation.