# Lab report: Internship farming project

## Research question:

To what extent does the amount of egg shell in gram (g) affect growth of green onion (Allium fistulosum) measured in length in cm over 4 weeks?

## Introduction:

During the internship, there were two major focuses: the amount of food waste in Korea public schools and factors that maximize plant growth. I expanded my knowledge from internship into realistic implications. The most practical experiment that can utilize both topics was converting wastes from my School cafeteria into fertilizer for plants. It was the egg shell that was most visible in the cafeteria, and it was the same for other public schools(인생은여행). Recycling egg shells was my primary inspiration that led to this experiment.

## Background information


(Moulton)

Eggshells, which consist mainly of calcium carbonate (approximately 95% $CaCO_3$), contain plenty of calcium and small amounts of various minerals such as phosphorus, magnesium, and potassium(Fisher). When used in gardening, calcium from eggshells is reported to harden plant cell and root cell walls, promoting faster and harder growth. Crushed up eggshells in the ground have the same effect as lime, neutralizing acid and enhancing ground quality, which may increase nutrient uptake for numerous crops. As more valuable for its nutrient content, recycling eggshell waste into fertilizer benefits both plant growth and the environment. South Korea, for instance, now uses up approximately 95% of its rubbish food waste (Broom), and cafeterias in schools turn up in great supplies of eggshells that would otherwise end up in rubbish and may now instead end up back in gardens in beneficial form. Recycling eggshells for fertilizer, in addition to their value for plant nutrition, gives not only a plant calcium increase but also lowers school rubbish, supporting both plant growth objectives and waste minimization targets. While it is worth noting that home-prepared eggshell amendments make their plant nutrient contributions in small amounts and only slow up, plant growth effects may therefore appear small at first. Generally, the calcium contribution from eggshells should support plant growth and structure and turn rubbish from cafeterias back into a valuable gardening commodity.

**Hypothesis:**

Increasing the amount of crushed eggshell added to the soil will improve the growth of green onions (Allium fistulosum). This is based on the idea that more eggshell provides more calcium to the soil, strengthening the plants' roots and cell walls and thereby promoting taller growth over the 4-week period. Hypothesis: If the quantity of eggshell fertilizer (in grams) is increased, then the average height of green onion plants will increase, because the additional calcium and minerals from eggshells will enhance soil fertility and support plant growth.

**Control variables**

Table 1: Controlled variables

| control variable | Reason for control | Method to control |
|---|---|---|
| Sun light intensity | Sunlight drives photosynthesis, so unequal light exposure could create differences in growth unrelated to fertilizer. | All pots were placed in the same location to receive equal sunlight (e.g. on the same windowsill or outdoor area). They were rotated periodically so each plant got the same light intensity and duration daily. |
| Amount of water | Water availability affects plant growth; over- or under-watering could mask or mimic the effect of the eggshell fertilizer. | Each pot received the same amount of water on the same schedule (e.g. a fixed volume per pot every day or every other day). This ensured all plants had equal moisture levels throughout the 4 weeks. |
| Temperature | Temperature influences metabolic rates and growth. Variations in temperature could independently affect plant height. | All plants were grown in the same environment and temperature conditions. Pots were kept together in one room/area at approximately the same temperature (ambient ~20–25°C), avoiding any drafts or heat sources that could create temperature differences. |

**Apparatus**:

- Eggshells (cleaned and dried) – Sourced from cafeteria waste; crushed into powder for use as fertilizer.
- Digital scale – To accurately measure eggshell quantities (in grams) for each treatment.
- Mortar and pestle (or grinder) – Used to crush eggshells into fine powder.

- Planting pots – Equal-sized pots (with drainage holes) to grow individual green onion plants. Potting soil – Uniform batch of soil used to fill all pots (provides baseline nutrients and support).
- Green onion seedlings (Allium fistulosum) – Young green onion plants of similar size, one per pot (alternatively, seeds could be started, though seedlings ensure uniformity).
- Ruler or measuring tape – For measuring the length of the green onion plants in centimeters.
- Watering can or measuring cup – To water plants with a controlled volume of water.

1. **Collection and Preparation of Eggshells:**
- Eggshell waste was collected from a school cafeteria. Shells were rinsed thoroughly to remove membranes and residue, then air-dried. Dried shells were crushed into a fine powder using a mortar and pestle to increase surface area and nutrient availability.
2. **Preparation of Planting Pot:**
- Identical pots were filled with the same type and amount of potting soil to ensure consistency. Each pot was labeled according to the amount of eggshell fertilizer it would receive (0 g, 1 g, 3 g, 5 g, 7 g, 9 g, 11 g, 13 g, 15 g, 17 g, 19 g, 21 g). One green onion (*Allium fistulosum*) seedling of similar size was planted per pot.
3. **Application of Eggshell Treatments:**
- Measured quantities of crushed eggshell (using a digital scale) were mixed into the top layer of soil in each pot. The 0 g treatment served as the control group.
4. **Growing Conditions:**
- All pots were placed in the same location to receive equal sunlight exposure. Plants were watered with the same volume of water on a regular schedule (e.g., daily or every other day). Temperature was maintained around 20–25 °C, and all pots were kept in the same environment to minimize variation. No additional fertilizers or soil amendments were used.
5. **Measurement of Plant Growth:**
- The length of each green onion plant was measured weekly for four weeks. Measurements were taken from the base at soil level to the tip of the tallest leaf using a ruler. All measurements were recorded in centimeters and performed at the same time of day to reduce variability.
6. **Data Collection and Analysis:**
- Final growth measurements after 4 weeks were compiled into a data table. The average plant height and standard deviation for each eggshell treatment were calculated from three replicates. A graph of average plant height versus eggshell quantity was plotted to visualize the relationship.

**Table 3: Safety, Environmental and Ethical Concerns**:

| Types of concerns | Description | Mitigation method |
|---|---|---|
| Environment | Some egg wastes occur due to accurate grams of egg shells. Waste of egg shells does not solve the initial | Make an egg shell container so that it can be used in daily gardening, not limited to experiment. |

| | | |
|---|---|---|
| | problem of this experiment. | |

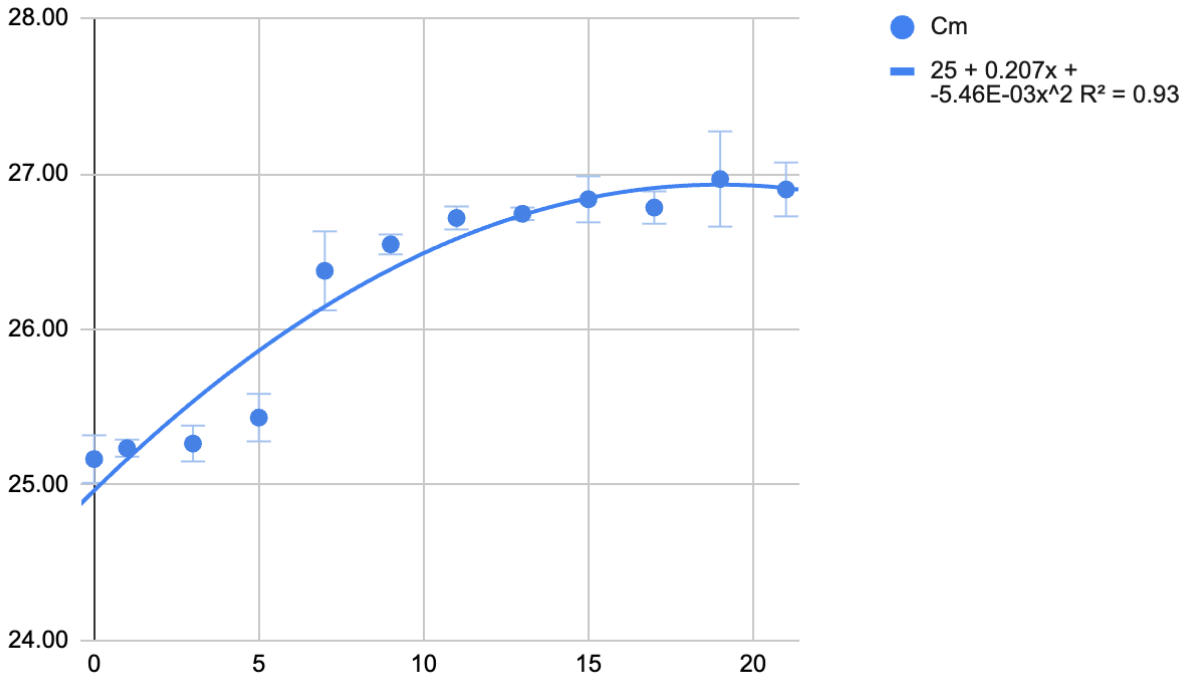
**<u>Quantitative data</u>**:
**Table 4: Raw data**

| Trial 1 | | Trial 2 | | Trial 3 | |
|---|---|---|---|---|---|
| Egg shell (g) | Cm | Egg shell (g) | Cm | Egg shell (g) | Cm |
| 0 | 25 | 0 | 25.3 | 0 | 25.2 |
| 1 | 25.3 | 1 | 25.2 | 1 | 25.21 |
| 3 | 25.2 | 3 | 25.4 | 3 | 25.2 |
| 5 | 25.6 | 5 | 25.3 | 5 | 25.4 |
| 7 | 26.1 | 7 | 26.6 | 7 | 26.43 |
| 9 | 26.5 | 9 | 26.62 | 9 | 26.52 |
| 11 | 26.7 | 11 | 26.65 | 11 | 26.8 |
| 13 | 26.75 | 13 | 26.7 | 13 | 26.78 |
| 15 | 26.8 | 15 | 26.71 | 15 | 27 |
| 17 | 26.9 | 17 | 26.75 | 17 | 26.7 |
| 19 | 26.7 | 19 | 26.9 | 19 | 27.3 |
| 21 | 26.8 | 21 | 26.8 | 21 | 27.1 |

**Table 5: Process data**

| Trial 1 | | Trial 2 | | Trial 3 | | Average | | |
|---|---|---|---|---|---|---|---|---|
| Egg shell (g) | Cm | Egg shell (g) | Cm | Egg shell (g) | Cm | Egg shell (g) | Cm | standard deviation |
| 0 | 25 | 0 | 25.3 | 0 | 25.2 | 0 | 25.17 | 0.153 |
| 1 | 25.3 | 1 | 25.2 | 1 | 25.21 | 1 | 25.24 | 0.055 |
| 3 | 25.2 | 3 | 25.4 | 3 | 25.2 | 3 | 25.27 | 0.115 |
| 5 | 25.6 | 5 | 25.3 | 5 | 25.4 | 5 | 25.43 | 0.153 |
| 7 | 26.1 | 7 | 26.6 | 7 | 26.43 | 7 | 26.38 | 0.254 |
| 9 | 26.5 | 9 | 26.62 | 9 | 26.52 | 9 | 26.55 | 0.064 |
| 11 | 26.7 | 11 | 26.65 | 11 | 26.8 | 11 | 26.72 | 0.076 |
| 13 | 26.75 | 13 | 26.7 | 13 | 26.78 | 13 | 26.74 | 0.040 |
| 15 | 26.8 | 15 | 26.71 | 15 | 27 | 15 | 26.84 | 0.148 |
| 17 | 26.9 | 17 | 26.75 | 17 | 26.7 | 17 | 26.78 | 0.104 |
| 19 | 26.7 | 19 | 26.9 | 19 | 27.3 | 19 | 26.97 | 0.306 |
| 21 | 26.8 | 21 | 26.8 | 21 | 27.1 | 21 | 26.90 | 0.173 |

**Data analysis**
**Graphical representation**:




**Graph analysis:**
The graph shows a clear positive correlation between eggshell quantity and green onion growth. Plants grown without eggshells averaged around 25.2 cm, while those treated with moderate to high amounts (7 g and above) consistently grew taller, reaching 26.8–27.0 cm on average. The steepest growth increase occurred between 5 g and 11 g, where plants grew roughly 1.3–1.5 cm taller than the control. Beyond about 15 g, the growth trend began to plateau, suggesting that once sufficient calcium was available, other nutrients or environmental factors became limiting.

Small fluctuations in the data, such as a slight dip at 17 g, were within the range of natural variation and did not affect the overall upward trend. The low standard deviations (generally below 0.3 cm) indicate consistent results across the three trials. Overall, the data strongly suggest that eggshell fertilizer enhances plant growth up to an optimal level, beyond which additional eggshell has little added effect. This pattern is typical of nutrient response curves, where initial increases in nutrient availability boost growth, but diminishing returns occur once plant requirements are met.

**Conclusion:**

This experiment aimed to establish if the amount of eggshell fertilizer was changed, it would make green onions (Allium fistulosum) grow more in four weeks. The hypothesis stated that adding more crushed eggshells would increase plant height because calcium strengthens plant cell walls and promotes growth. There was support for this hypothesis: green onions fertilized with eggshells tended to grow taller than non-fertilized ones, demonstrating that green onion growth could be promoted through the use of eggshells.

There was greatest improvement when eggshell levels changed from 0 g to approximately 15 g, when plants tended to increase in height approximately 1.5 -- 1.8 cm from the control group.

Data show a characteristic pattern for diminishing returns. While low doses of eggshell (1–5 g) had little effect in comparison to the control, higher additions (7–15 g) exhibited significant increments in growth. past approximately 15–20 g, however, growth trend flattened, with minimal distinction among plants that had been provided highest doses of eggshell. This flattening implies that when adequate calcium level is provided in the ground, more calcium does not have a valuable effect in increasing growth. Rather, other determinants—like nitrogen availability, root space, or genetic growth limits are more likely to become limiting factors. This characteristic is in concert with nutrient response curves experienced in plant physios, in which growth is fast with increase in added nutrients till it levels off after reaching its assimilable range.

These findings also show the viability of utilizing food waste for recycling, an environmentally friendly fertilizer. Eggshells, our key cafeteria waste, had been effectively used to increase plant growth, illustrating an effective use of waste materials in practical and sustainable ways. While the increase in growth was small for this short-study, the encouraging trend points to the merits of implementing food waste recycling in school gardening programs and community gardens. These activities, in addition to minimizing their effects on the environment, serve for building environmental awareness and sustainable agricultural methods in school posterities.

The experiment thus vindicates that green onion growth could be promoted using eggshell fertilizer and thus vindicates our original hypothesis. Although the impact was not spectacular, the regular rise in plant growth in response to higher levels of eggshells indicates that calcium does make a significant contribution to growth. However, observed saturation serves to underline the value of balanced availability of plant nutrients and indicates that eggshells function more optimally in the context of an overall fertilisation programme. With an increased experimental duration and synergistic nourishment, the impacts could even prove larger. Generally, our experiment illustrates both the biological advantage and ecological value of exploiting eggshells for their potential role in sustainable fertiliser applications.