

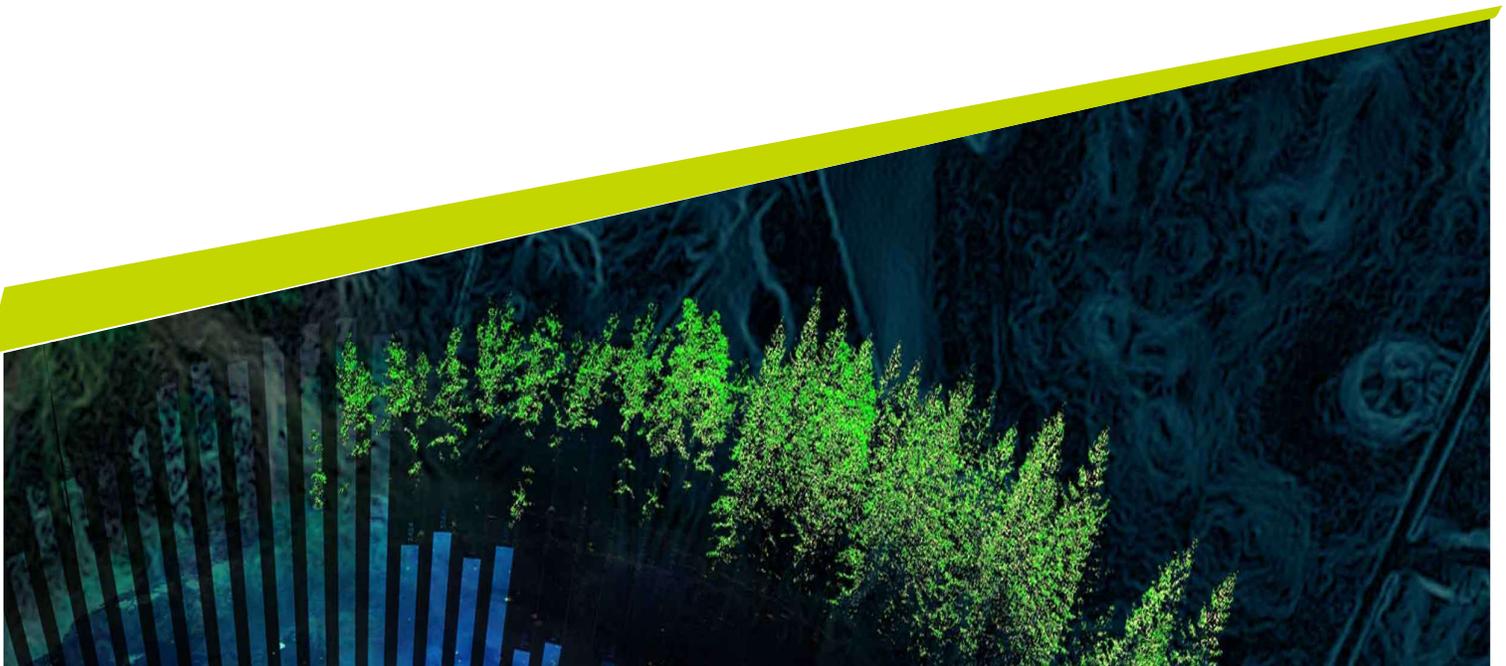


Effects of Organic Fertilizers on Strawberry Plants

Testing Plant Growth, Pollen Viability, and Chlorophyll Content

Tristie Le

Independent project • 30 credits
Swedish University of Agricultural Sciences, SLU
Department of Biosystems and Technology
Agroecology Master's Programme
Alnarp 2026



Effects of Organic Fertilizers on Strawberry Plants

Testing plant growth, pollen viability, and chlorophyll content

Tristie Le

Supervisor: Samar Khalil, Swedish University of Agricultural Sciences, Department of Biosystems and Technology

Assistant supervisor: Carolina Diller, Swedish University of Agricultural Sciences, Department of Plant Protection Biology

Examiner: Johan Stenberg, Swedish University of Agricultural Sciences, Department of Plant Protection Biology

Credits: 30 credits

Level: Second Cycle, A2E

Course title: Independent Project in Agricultural Science

Course code: EX0848

Programme/education: Agroecology – Master's Programme

Course coordinating dept: Department of Biosystems and Technology

Place of publication: Alnarp, Sweden

Year of publication: 2026

Copyright: All featured images are used with permission from the copyright owner.

Keywords: Food waste, aquaculture, wastewater, vegetative growth, chlorophyll, nitrogen, strawberry, pollen viability

Swedish University of Agricultural Sciences

Faculty of Landscape Architecture, Horticulture, and Crop Production Sciences

Department of Biosystems and Technology

Alnarp

Abstract

The demand for strawberries is affected by climate change and environmental impacts. Farmers are resulting to unsustainable methods to keep up with the demands regarding high yield and good product quality. Synthetic fertilizers is one of the main culprits intensively used in strawberry cultivation and with high environmental impacts. Synthetic fertilizers release N_2O , a long-lasting, harmful greenhouse gas and contribute to eutrophication of ground water. To mitigate this, it is encouraged to switch over to organic fertilizers, which has limited availability at commercial level. The reuse of side streams could be an alternative to reuse organic nutrients and apply them in food production system. Different streams are of interest including food waste, aquaculture and wastewater, However, the impact of such streams on plant growth and quality I still with unknown effect. In this experiment, three different types of organic fertilizers: water fraction from food compost, fish water, and wastewater, are tested in comparison to the commercial synthetic fertilizers to see their effects on two strawberry cultivars (Honeoye and Sonsation). We measured a series of vegetative and reproductive traits throughout a period of eight weeks and used R-studio to see if different organic fertilizers affected the vegetative growth, chlorophyll content, and reproduction aspects of the strawberry cultivars. The two cultivars responded differently to the treatments likely due to the different nitrogen content. Honeoye is better for vegetative reproduction with organic fertilizers that have higher nitrogen content while Sonsation is better for fruit yield with fertilizers that have specifically, higher nitrate content. The differences in nitrate and ammonium content within the fertilizers also played a role on nitrogen uptake between the two different cultivars. Significant differences on pollen viability and chlorophyll content could be indicated due to the cultivars but not to the treatments. Overall, this data could be used to explore more possibilities in adjusting organic fertilizers for strawberry farmers.

Keywords: Food waste, aquaculture, wastewater, vegetative growth, chlorophyll, strawberries, pollen viability

Table of contents

Abstract	3
1. Foreword	8
2. Introduction	9
3. Background	10
3.1 Organic Fertilizers	10
3.2 Importance of Strawberries	10
3.3 Plant Growth	11
3.4 Reproduction.....	11
4. Materials	12
4.1 Plant Material	12
4.2 Fertilizers and Substrates	12
5. Methods	12
5.1 Plant Growth Measurements	12
5.2 Pollen Viability Testing	12
5.3 Chlorophyll Content.....	13
5.4 Statistical Analysis	13
5.5 Nutrient Analysis	14
6. Results	14
6.1 Plant Growth	14
6.1.1 Vegetative traits	14
6.1.2 Reproductive Traits.....	16
6.2 Pollen Viability.....	18
6.3 Chlorophyll Content.....	20
6.4 Nitrogen Contents	22
7. Discussion	23

7.1 Limitations	25
8. Conclusion.....	25
References	26
Acknowledgements	33

List of Tables

Table 1: <i>Nitrogen content tested in different treatments</i>	14
Table 2: <i>Number of flowers sampled for the pollen viability test</i>	15

List of Figures

Figure 1: Average Leaf Count by Cultivars (a) and Treatments (b).	16
Figure 2: Average leaf growth per week by cultivars (a) and treatments (b).....	17
Figure 3: Raw data of average flower (a), fruit (b), and runners (c) throughout the 8-week experiment.....	19
Figure 4: Mean Pollen Viability between different Cultivars (a), Treatments (b), and their interactions (c).....	21
Figure 5: Mean chlorophyll content between cultivars (a), treatments (b), and their interaction (c).....	23
Figure 6: Content of nitrate and ammonium in the substrate after eight weeks of cultivation from two strawberry cultivars, Sensation and Honeoye, using four different organic fertilizers.....	24

1. Foreword

When I was younger, I remember all I wanted to do was to help people, animals, everything. In high school, learning about how humans were destroying the planet and contributing to climate change, all I wanted to do was to reverse it. My goal in life is to protect animals as they are unable to protect themselves. I thought I had figured everything out when I started college, but the more I learned, the less I knew. During my third year as a bachelor's student, I remember taking the chance to take an insect ecology class with David Holway. I remember being fascinated by how little I knew about over 80% of animals. I was glad that I got a chance to work in his lab with his PhD student, Jess Mullins, who still helps me out to this day. This lab was specifically impactful to me because I had no idea what I wanted to study but created a path of resources for me today.

I would like to believe that time is not linear, but instead a spiral: it progresses with patterns of repetition, but not the same as before. I wanted people to care about insects and animals the way I do, but how? The most impactful way would be to connect them to something they care about. For me, I love food, and I know many Americans do as well. By connecting food to climate change, to biodiversity, I believe that I can start creating the reverse in climate change by making people care. I looked up the top schools to study agriculture and instead found SLU's master's program in Agroecology. Knowing nothing about it, I was interested as it had the two key words: agriculture and ecology, two fields that I wanted to study. Coming to SLU was a culture shock, not only because it is a different country, but also because of the passion the school has for sustainability. I enjoyed taking the classes and learning from not only the professors, but also the international students. I knew that I wanted to do my master's thesis on something that will be interesting to talk to non-academic people about. I was lucky to be able to do it on one of the most popular fruits in the world.

During my time at SLU, I felt a lot of growth. I remember calling my dad and he would ask me what I was studying. Back then, there was not much to talk about since it was basics such as math and English, but now, he is genuinely interested in what I study. My dad is an immigrant from Viet Nam, and although his education is not high, his curiosity is—and I would like to believe that he's living vicariously through me with my research.

This thesis was an amazing opportunity for me to learn multiple skills to make me a better scientist. Although I did not work with insects like I liked, learning about plants is also important as plants are the basis of life. Through this current thesis, I have learned how to use R and to think outside of my usual scope. I came to know that I like eating strawberries, but now I understand the work and effort it takes to grow them. I am grateful to Samar, my supervisor, for giving me the opportunity to work on such an amazing project. I am also very thankful to Carolina, my co-supervisor, for teaching me and guiding me through the technical parts. I would like to especially thank Raj and Teun for creating such an amazing Agroecology program and the opportunities for students like me to learn. I would also like to thank my dad and my partner, Ryan, for always supporting me and pushing me to challenge myself every day. I promise that I will teach the world my findings one day and that we can make a change.

2. Introduction

It has become unsustainable to provide food for a growing population. As the global population and the impact of climate change increase, we resort to environmentally harmful methods to keep up with demand. This is mainly due to the release of N₂O and other greenhouse gases, and environmental impacts related to eutrophication and the use of synthetic fertilizers (Baumert et al. 2005; Davidson 2009). Organic fertilizers have been found to help mitigate these challenges and the release of N₂O (Geng et al. 2021). While many studies show that organic fertilizers are better for plants, their overall impact still needs to be investigated.

Different crops have different ideal fertilizers. In watermelon, livestock manure has a higher yield than pigeon and synthetic fertilizer (Massri & Labban 2014). For okra, the plants have the highest yield and growth from poultry fertilizer (Khandaker et al. 2017). Tomatoes did not have a preference between different types of organic fertilizers (Duuml Rdane et al. 2011). Differences in plants play a role in preference towards a specific fertilizer.

Strawberries (*Fragaria x ananassa*) are among the top 50 produce that are grown on six continents, which benefit greatly from organic fertilizers (Simpson 2018). Organic fertilizers have been evident in helping plant health, increasing yield, and preventing pests and diseases (Hartmann et al. 2015; Zhou & Yao 2020; Li et al. 2022; Sayğı 2022). Over 40% of the greenhouse gases emitted from strawberries are from the production period, where synthetic fertilizers are used (Denstedt et al. 2010). Compost, fish water, and wastewater are all evident to help increase plant growth and strawberry production, but have never been directly compared with each other (Wang & Lin 2002; Al-Karabliegh et al. 2024; Korbee et al. 2025a).

In this thesis, the aim is to identify the effects of organic fertilizers on strawberry plants, specifically focusing on their vegetative growth, reproductive health, and photosynthetic activity. Using synthetic fertilizer as our control, we tested the effects of three different types of organic fertilizers (water fraction from food compost, fish water, and wastewater) on two different cultivars of strawberries (Honeoye and Sonsation). To measure vegetative growth, leaf growth was counted every week. For reproductive health, the number of flowers, fruits, and runners were also counted weekly. The pollen viability was also used as a reproductive indicator using a staining method, and chlorophyll content was measured as a vegetative indicator for photosynthetic activity. From the nitrogen tests for fertilizers, we also predict that wastewater would be the best for plant growth, as it has the highest nitrogen content. By comparing the different research on the treatments, food compost fertilizer appears to have the highest growth compared to the control (Wang & Lin 2002; Djillali et al. 2020; Korbee et al. 2025b). Food compost fertilizer was thus predicted as the best for strawberry yields. Since similar types of cultivars are used, a significant difference in the treatment effects between the two cultivars has no strong prediction.

By testing the effects of different organic fertilizers, an increase in strawberry production is expected to keep up with the demands. It helps also to gain insight into improving soil quality for food production. Discovering the best organic fertilizer for the crops can help to develop

strategies that can reduce the traditional use of synthetic fertilizers, leading to more sustainable methods. Hopefully, food production will be alleviated from its role in harming the environment.

3. Background

3.1 Organic Fertilizers

Organic fertilizers are defined by their origin: naturally occurring sources. The choices can be overwhelming since there is a large variety of organic fertilizers. The most common organic fertilizers are manure from farm animals such as cows and chickens (Karagöz 2021). Fertilizers from fish are increasing in popularity due to the rise in vertical farming (Yep & Zheng 2019). Countries with a large amount of aquacultural waste could benefit from recycling the nutrients. Food waste is an abundant source for farmers to use if they choose not to raise animals (Cerdeira et al. 2018). Finally, the usage of human waste would help sanitize wastewater without using intense chemicals (Larsen et al. 2007). This would not only help developing countries with water sanitation but also guide them to using organic fertilizers as well (Sangare et al. 2015). While there are all these different types of organic fertilizers, it is difficult to control the proper nutrients for plants (Bergstrand 2022).

Nitrogen is the main focus when growing plants, as it provides most of the protein for plant cells (Novoa & Loomis 1981). High nitrogen is correlated mostly with vegetation development, as high nitrogen content means higher chlorophyll content (Patane & Vibhute 2014). While high nitrogen fertilizers are helpful to maintain healthy plants, our most popular crops require more than just vegetative growth. FAO listed maize, wheat, soybeans, potatoes, sugarcane, oil palm fruit, cassava, and sugar beet to make up 60% of global crop production: eight of which require more than vegetative growth. Crops that need to produce fruit or seeds need nutrients to focus on reproductive growth, while tubers like potatoes and cassava need root growth.

3.2 Importance of Strawberries

Strawberries are popular for their flavor and health benefits, thus producing a lot for the economy. From 2019-2023, strawberry production increased by over 1 million tons globally (FAOSTAT 2025). While there is an increase in production, climate change threatens it. Climate change changes strawberry production by affecting their growth, fruiting, and increasing pests (Husaini & Xu 2016). The increase in temperatures affects pollination by desynchronizing flowering rates with the pollinator visitations (Neri et al. 2012). Growing strawberries in greenhouses became advantageous for farmers as they can maintain the ideal temperature for production year-round (Tang et al. 2020). A controlled environment helps increase yield, but the carbon footprint also increases due to building costs, electricity usage, and synthetic fertilizers (Khoshnevisan et al. 2014). To decrease greenhouse gas emissions, providing an organic feed will not only be more sustainable, but it can also increase fruiting, pollination, and reproduction in strawberries (Bergstrand 2022).

June-bearing strawberries are popular for commercial production and home gardeners as they have large fruit and bear fruit early (Hancock 1999). Sonata (replaced with Sonsation in this study) is a June-bearing Dutch cultivar, while Honeoye is a June-bearing American cultivar (Sønsteby et al. 2017). Honeoye is a more popular cultivar of choice as it has been around longer and bears large fruits, but it is highly susceptible to root rot. Sonsation is emerging in popularity as it was bred to be more resistant to diseases and climates.

3.3 Plant Growth

Plants are special in that they have meristems that allow them to continuously grow (Bäurle & Laux 2003). Since plants grow using unspecialized cells, they choose to focus growth on vegetation, roots, or reproduction. The more leaves a plant has, the more activity occurs (Harper 1989; Kikuzawa & Ackerly 1999). By focusing on this aspect, plants would direct nutrients and energy towards vegetative growth instead of root development or reproduction. Having more leaves would benefit plants as this increases photosynthetic activity, allowing the plant to have more nutrient uptake.

Chlorophyll content measures the health of a plant as an indicator of photosynthetic activity (Pérez-Patricio et al. 2018). Organic soils improve chlorophyll content (Amujoyegbe et al. 2007; Zhou & Yao 2020). Through the chlorophyll content, it can be used to estimate the health of the plant and predict biomass and productivity (Liu et al. 2019). Higher chlorophyll content also correlates with higher fruit yields (Schaffer et al. 1986; Santin et al. 2017). This factor can change during different stages of a plant's life, as it focuses primarily on vegetation growth (Schaffer et al. 1986). Using a higher nitrogen fertilizer could induce higher chlorophyll content in plants (Patane & Vibhute 2014). A plant's survival is essential for its ability to reproduce.

3.4 Reproduction

To develop strawberries, there needs to be a focus on reproductive growth as well (Ledesma & Sugiyama 2005; Lata et al. 2018). Strawberries can reproduce asexually and sexually (Jurik 1985). They have stolons, or runners, that create a sister plant (Savini et al. 2008). They also flower, containing both male and female parts. Plant health is important for strawberry production as it affects pollen viability. Pollen is the male reproductive part of flowers, which is measured through pollen viability. Pollen viability counts the healthy pollen grains that have the potential to germinate (Dafni & Firmage 2000). This results in the creation of the strawberry fruit itself. Physical flower attributes affect pollen growth, such as the number of anthers, their size and weight, and shape (Zebrowska 1997). External factors such as temperature and diseases also affect pollen viability (Howlett 1936; Delph et al. 1997; Lata et al. 2018). These factors, in return, could potentially influence pollinator visits amongst strawberry plants (Ahrenfeldt et al. 2019). Nitrogen is a factor that can increase pollen viability by increasing the number of pollen grains in plants (Razzaq et al. 2019). In apples, it has been shown that nitrogen has a positive correlation with pollen viability (Howlett 1936; Atasay et al. 2013). Although there are many studies on strawberry reproduction, there is a knowledge gap between different organic fertilizers and strawberry pollen viability—and organic fertilizers on pollen viability overall.

4. Materials

4.1 Plant Material

The June-bearing strawberry plants (*Fragaria x ananassa* cv Honeoye and Sonsation) were bought from SW Horto AB and used in the study. The plants were potted in 1.5L pots filled with coir as growing media. One plant per pot was used. 96 plants were used and labeled under four different organic fertilizing treatments originating from purified wastewater, water fraction of food waste, and aquaculture, using 12 replicates per treatment. The plants were kept in the greenhouse at a day temperature of 20°C and a night temperature of 18°C. Fertilization based on a nitrogen content of 15 mg/L started three weeks after potting. Twice a week, each plant receives 100 mL of fertilizers corresponding to its treatment. The plants were manually irrigated once a day on non-fertilizing days.

4.2 Fertilizers and Substrates

Four types of fertilizers were used. For treatment one, the control fertilizer is based on synthetic fertilizers using 1% of YaraTera's Kristalon Red and 1% of Calcinit. Treatment two was used based on a water fraction from food waste collected by RecoLab (Helsingborg – Sweden). For treatment three, fish water was taken from an aquaponics system raising tilapia. Finally, for the fourth treatment, purified wastewater that was also taken from RecoLab was used.

Table 1: Nitrogen content tested in different treatments. The table includes nitrate, ammonium, and total nitrogen in the four treatments used in the experiment. This information helps analyze the nitrogen content in the substrate later to see how much nitrogen uptake occurred.

	Nitrate	Ammonium	Total Nitrogen
Control	10.1 mg/L	1.9 mg/L	12 mg/L
Food Compost	1.56 mg/L	9.65 mg/L	11.21 mg/L
Fish Water	13 mg/L	1 mg/l	14 mg/L
Wastewater	10.2 mg/L	7.98 mg/L	18.18 mg/L

5. Methods

5.1 Plant Growth Measurements

Plant growth parameters based on the number of leaves, flowers, fruit, and runners were counted once a week. Leaves were counted if they had a stem showing, but did not have to be open. Flowers are counted when the pistil is visible. Buds are not counted. Fruit is counted after the loss of petals, enlarged pistils, and loss of stamens.

5.2 Pollen Viability Testing

Pollen viability tests healthy pollen grains that are potentially able to germinate and reproduce. The tests were run at 13:15 every time on days when the plants were not watered. This allowed

the flowers to be dry and properly selected for the tests. Flowers were selected if they were fully bloomed with open petals. Flowers that were losing petals or loss of stamen were not selected. Up to five flowers were taken at a time, as the staining solution only lasted one hour.

To make the staining solution, a sugar solution with 2.4 grams of sucrose in 10 ml of distilled water was created (Pinillos & Cuevas 2008). Using 99 microliters of the sugar solution, it was mixed with one microliter of fluorescein diacetate (FDA), which was diluted 1:3, in an Eppendorf tube (Heslop-Harrison et al. 1984). The solution was mixed, and 20 microliters were pipetted out in separate Eppendorf tubes. The stain marks the healthy (live) pollen grains for the machine to recognize. To collect pollen, ten stamens were plucked from the flowers and mixed with the staining solution before resting for at least five minutes. 10 microliters of the pollen & staining solution are then pipette into DeNovix CellDrop FL Automated Cell Counter. We used the AO App within the automated cell counter machine to count the number of fluorescing (live) pollen cells, and the TryphonBlue TissueCulture App to count the total number of pollen cells (live and dead). 24 flowers were sampled in total (see Table 2).

Table 2: Number of flowers sampled for the pollen viability test. The table shows how many flowers were used for each treatment and cultivar.

	Honeoye	Sonsation	Total
Control	2	4	6
Food Compost	4	1	5
Fish Water	4	5	9
Wastewater	1	3	4
Total	11	13	24

5.3 Chlorophyll Content

Chlorophyll content was measured using Apogee Instruments Inc.’s MC-100 chlorophyll meter. The machine emits two wavelengths: red and infrared. This allows the machine to measure the chlorophyll content through the ratio of radiation. The machine uses the average of five areas of the leaf (5 mm diameter circle) before returning the Soil Plant Analysis Development (SPAD) values. Five leaves were sampled from every plant.

5.4 Statistical Analysis

We used Rstudio for all our statistical analyses (Kronthaler & Zöllner 2021). For the mixed model analysis, packages “car” and “lme4” were used. For leaf count, we ran a mixed model. The model included treatment and cultivar as fixed factors and plant individual as a random factor. Due to a lack of time, only the leaf data statistically tested, but raw data for the flowers, fruit, and runners are reported. Through measuring the amount of leaves every week, we were able to analyze the differences between the cultivars, treatments, and their interaction together. For chlorophyll content and pollen viability, we ran a two-way ANOVA. Plots were plotted through “ggplot2” packages.

5.5 Nutrient Analysis

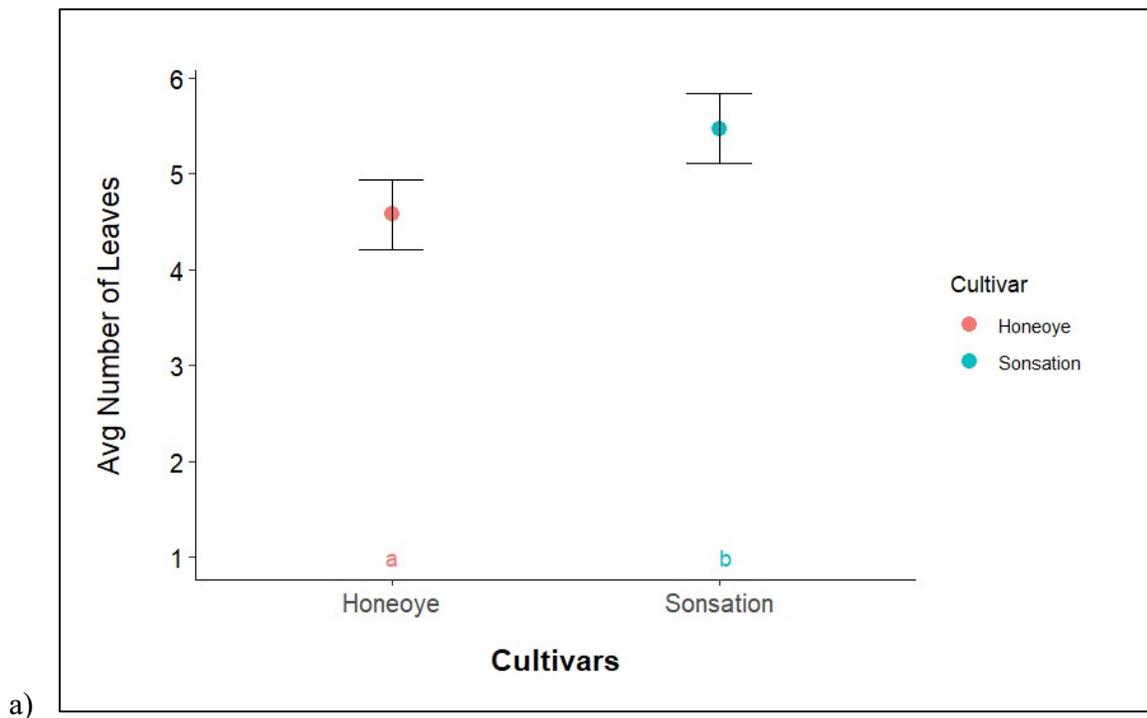
Before the treatment of plants, the treatments were tested to see how much nitrogen, broken down to nitrate and ammonium content, were contained (see Table 1). One random sample of soil from each cultivar-treatment was collected at the end of the experiment and sent to a lab for testing to test nutrient uptake.

6. Results

6.1 Plant Growth

6.1.1 Vegetative traits

The mixed model helps see how the cultivars and treatments affect leaf growth over time. Sonsation overall has more leaves than Honeoye (Figure 1a). The difference between them is significant ($p < 0.005$). When compared to the averages of the treatment, the treatments were not significant (Figure 8b). Figure 2 shows a barplot of the average cultivars and treatments' growth within 8 weeks. Sonsation is significantly different than Honeoye at the beginning (weeks 1 and 2) and at the end (weeks 7 and 8) (Figure 2a). Treatments by weeks are also significant ($p < 0.05$), showing that they changed significantly with time as well (Figure 2b). The plants experienced a major increase in growth after week 6 (Figure 2). The control ended up being significantly different than the other treatments during weeks 7 and 8. The number of weeks and cultivars were significant to influencing leaf growth ($p < 0.05$). The effects of the weeks on treatments and cultivars were also significant ($p < 0.05$).



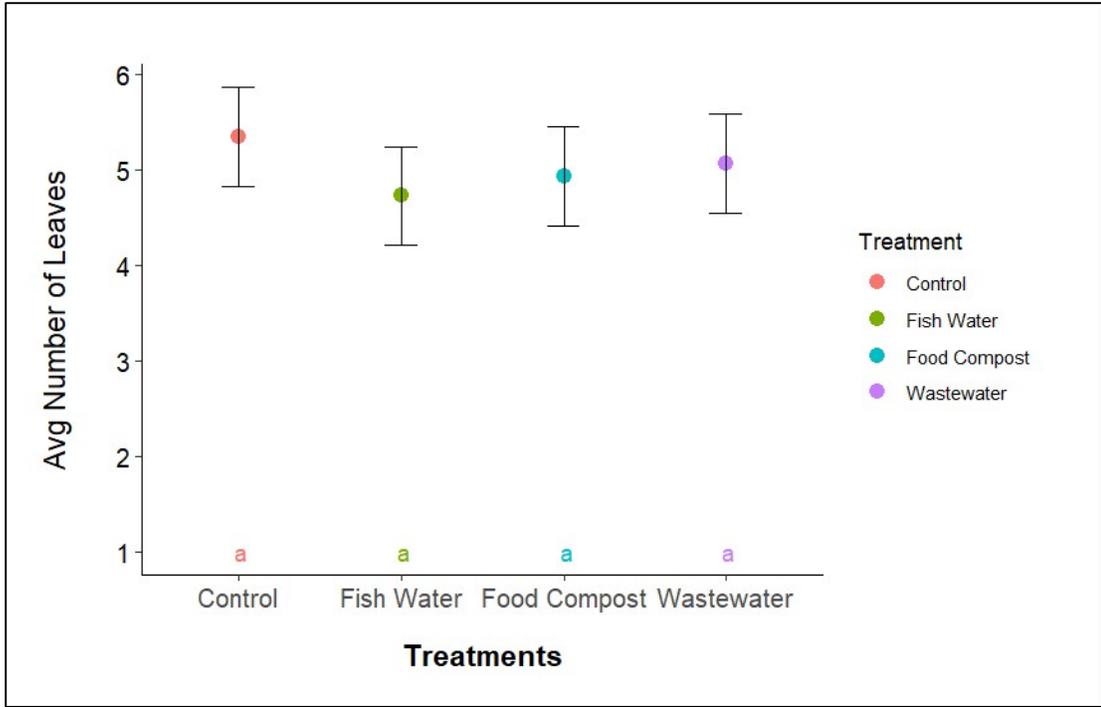
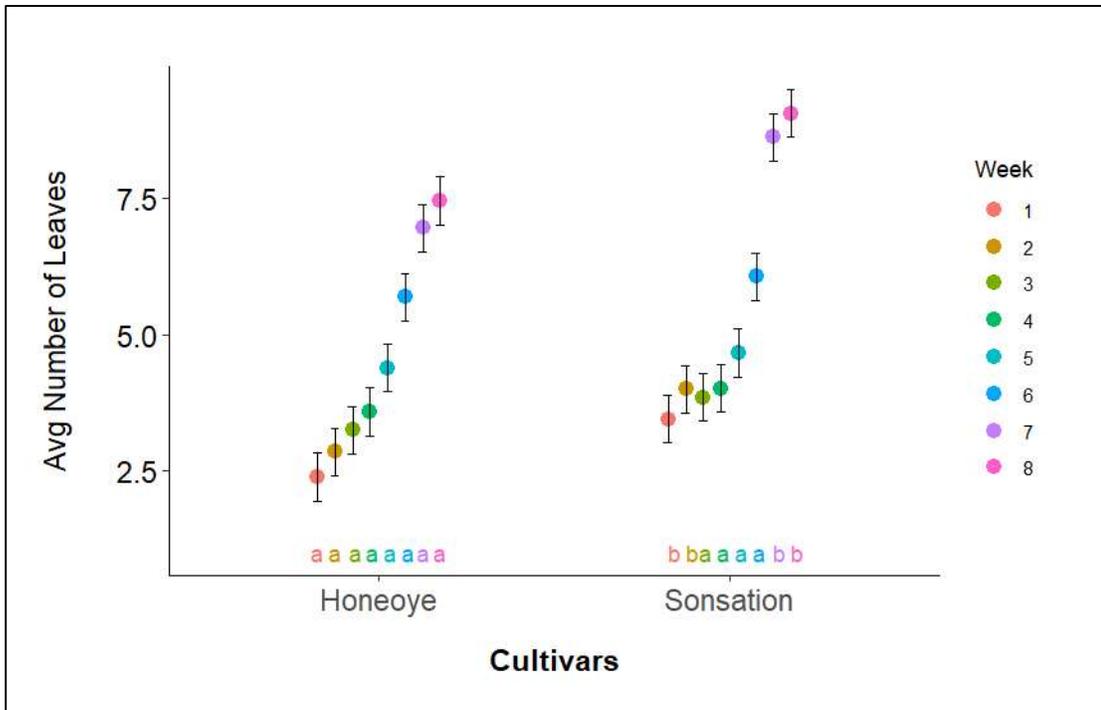
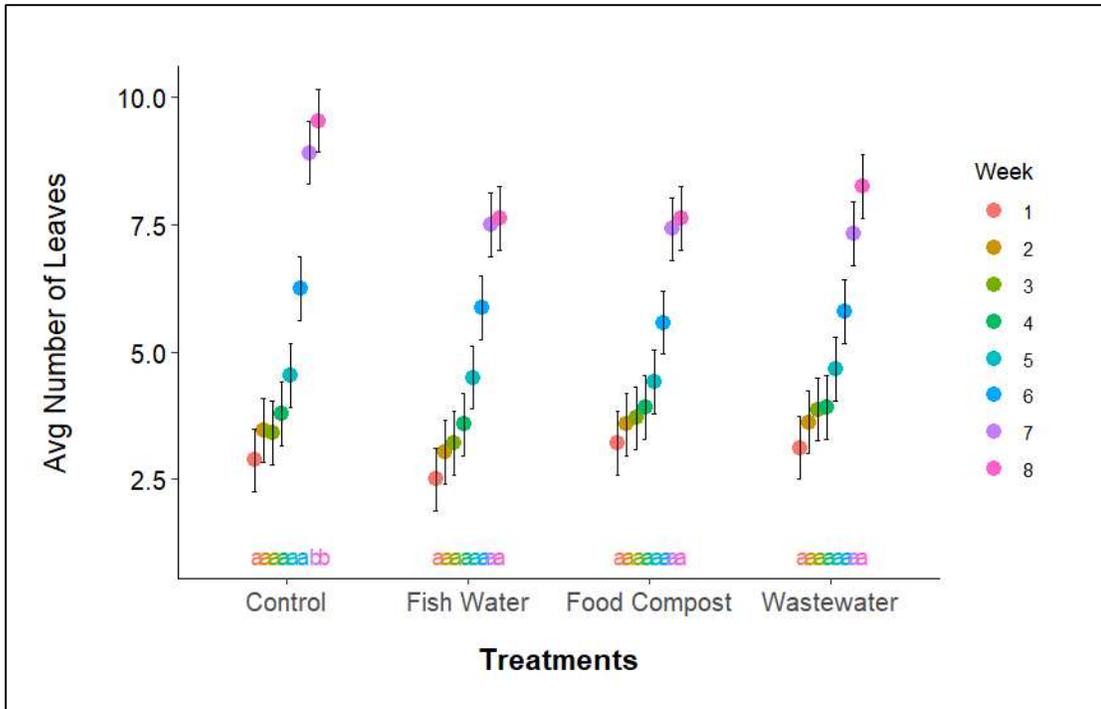


Figure 1: Average Leaf Count by Cultivars (a) and Treatments (b). This figure shows the average leaf count throughout the experiment. In the first part (a), the average is compared by different cultivars while the second part (b) is comparing between the different treatments.



a)

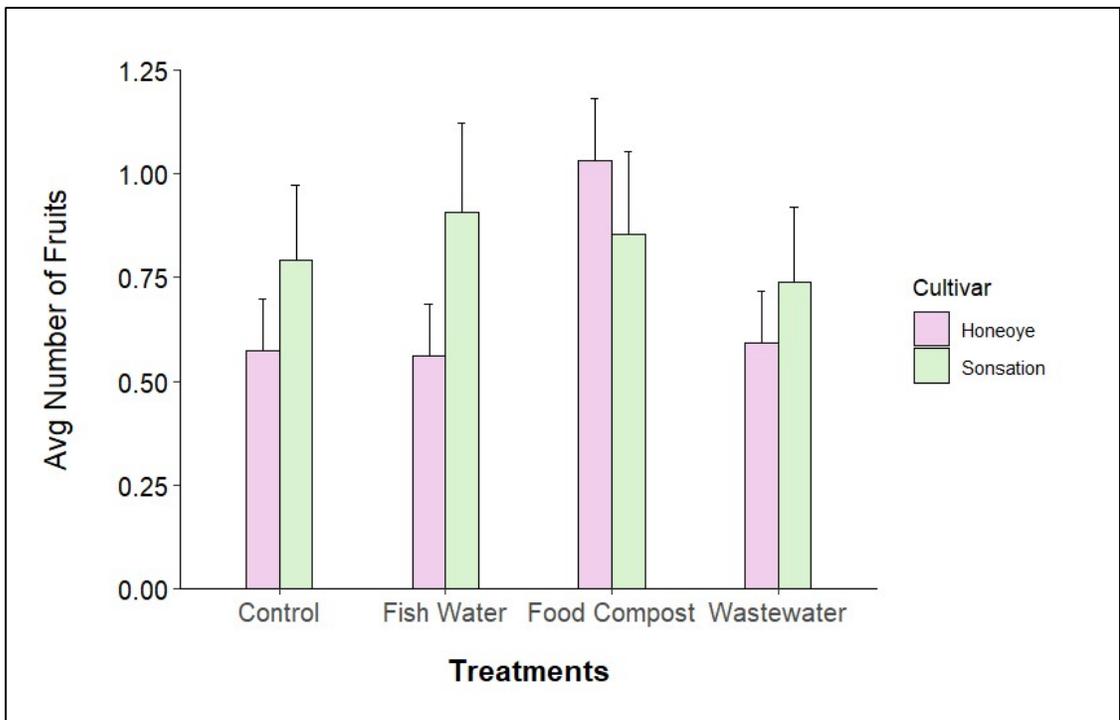
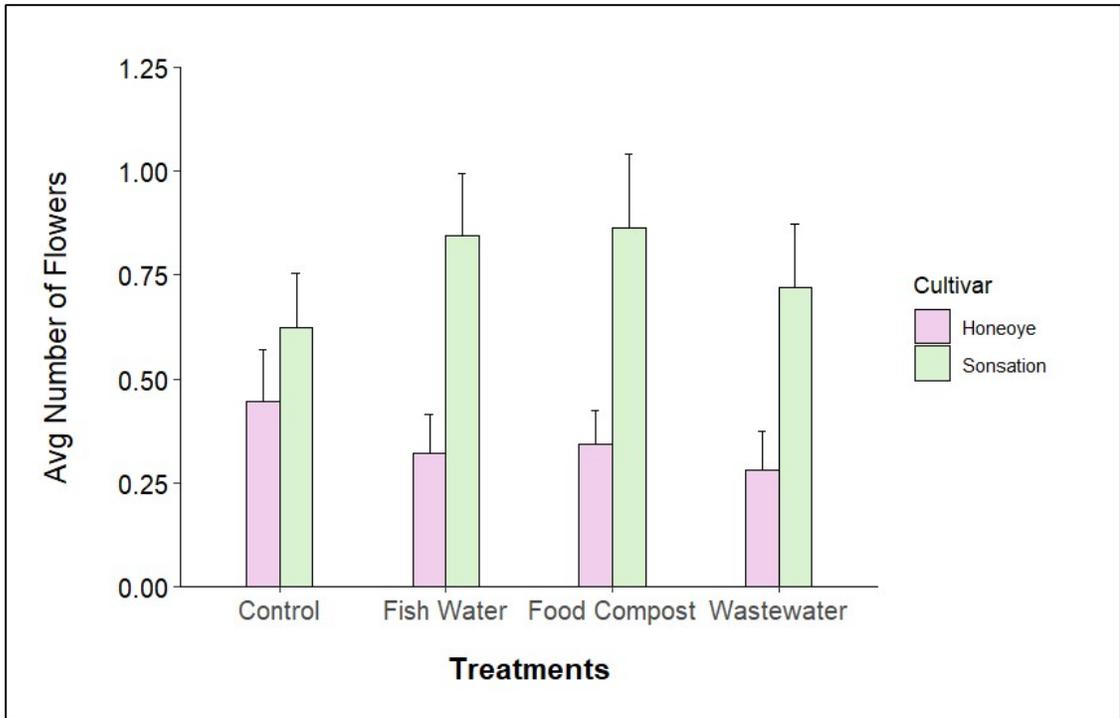


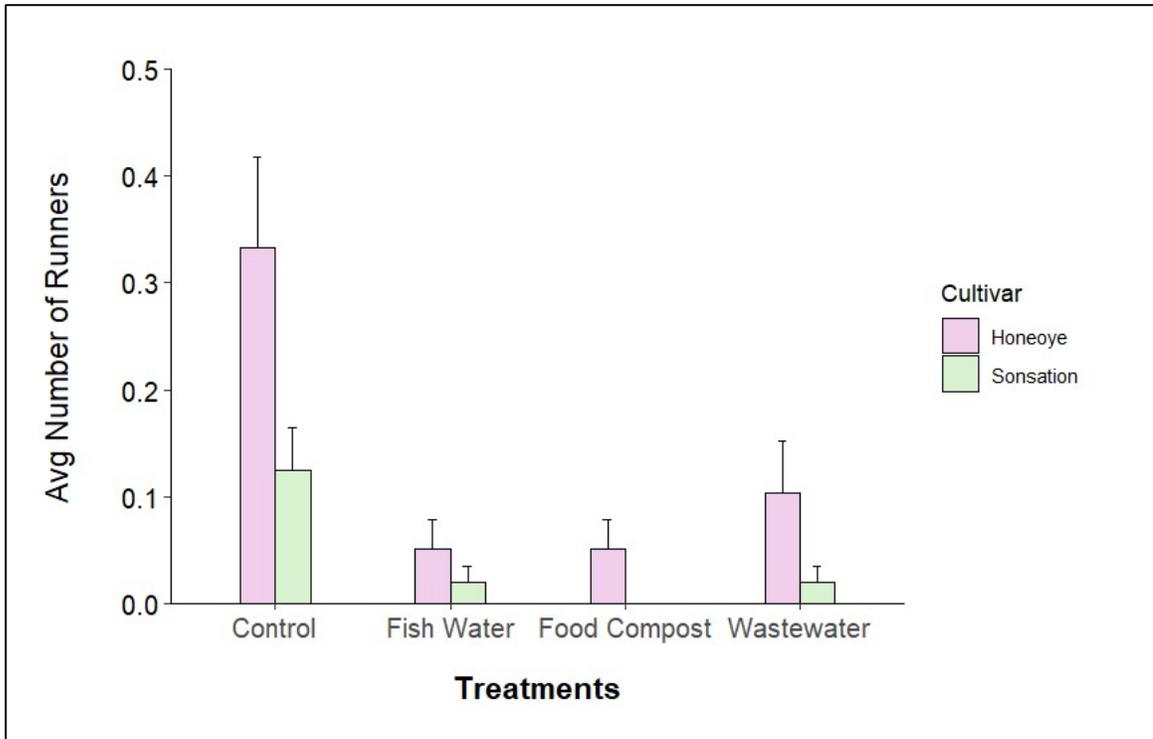
b)

Figure 2: Average leaf growth per week by cultivars (a) and treatments (b). This figure shows the average leaf count each week of the experiment. In the first part (a), the averages are arranged by different cultivars while in the second part (b), the averages are arranged by different treatments.

6.1.2 Reproductive Traits

Although not statistically tested, there is a pattern between asexual and sexual reproduction between the cultivars and treatments. Sonsation produced more flowers (Figure 2a) and fruits (Figure 2b), but fewer runners than Honeoye (Figure 2c). Furthermore, Sonsation responds with increased flower and reduced runner count in all treatments compared to the control. The treatment effect is less clear for Honeoye, although runner production is also visibly reduced in the treatments compared to the control.

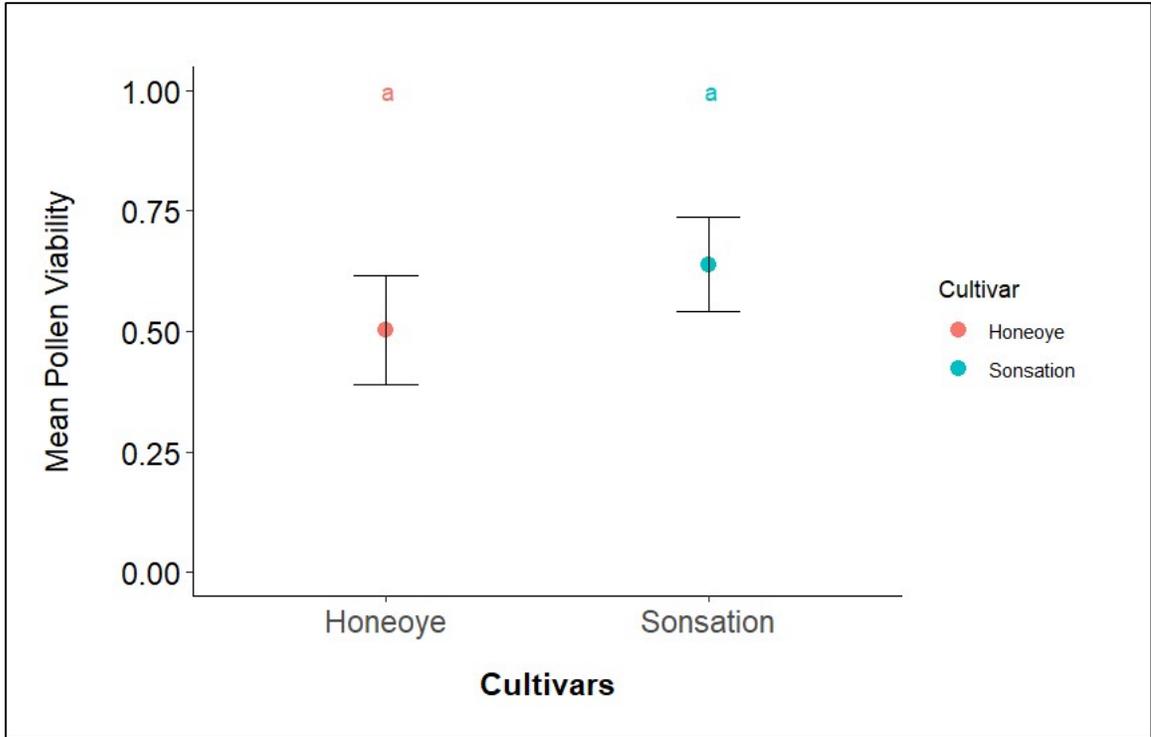




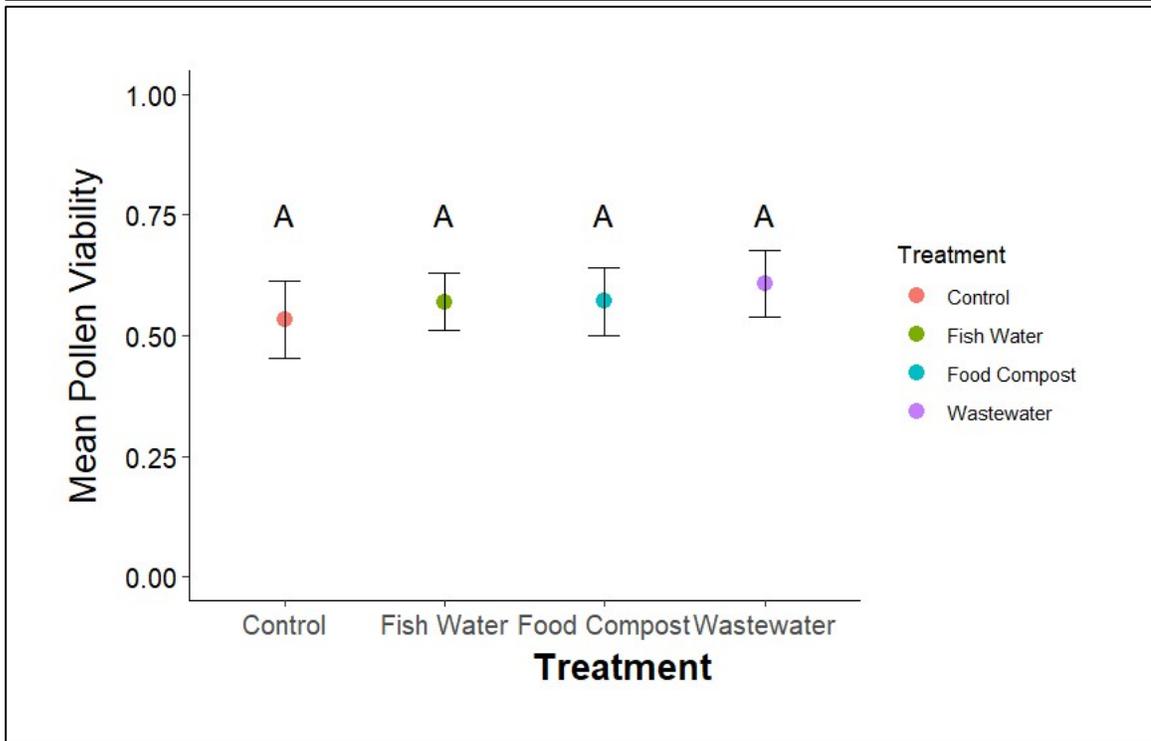
c) **Figure 3:** Raw data of average flower (a), fruit (b), and runners (c) throughout the 8-week experiment. This figure shows the averages between flowers, fruit, and runners organized by treatment and cultivars. Honeoye is shown in pink while Sonsation is shown in green.

6.2 Pollen Viability

Pollen viability was significantly different between the two cultivars, with Sonsation having a higher pollen viability than Honeoye (Figure 4a). There is no significance between the different treatments and their average pollen viability, only varying slightly (Figure 4b). Even though there is no statistically significant interaction between the treatments and cultivars, it is important to note that for the wastewater treatment, Honeoye has a higher mean pollen viability than Sonsation (Figure 4c).



a)



b)

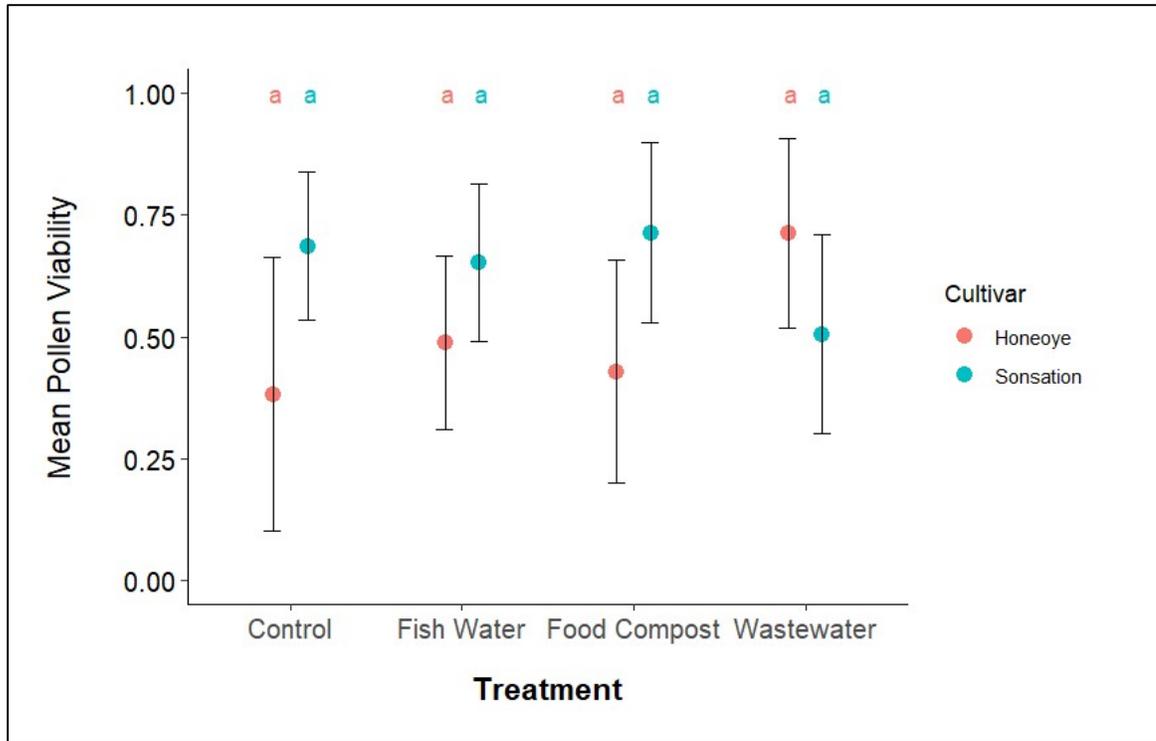
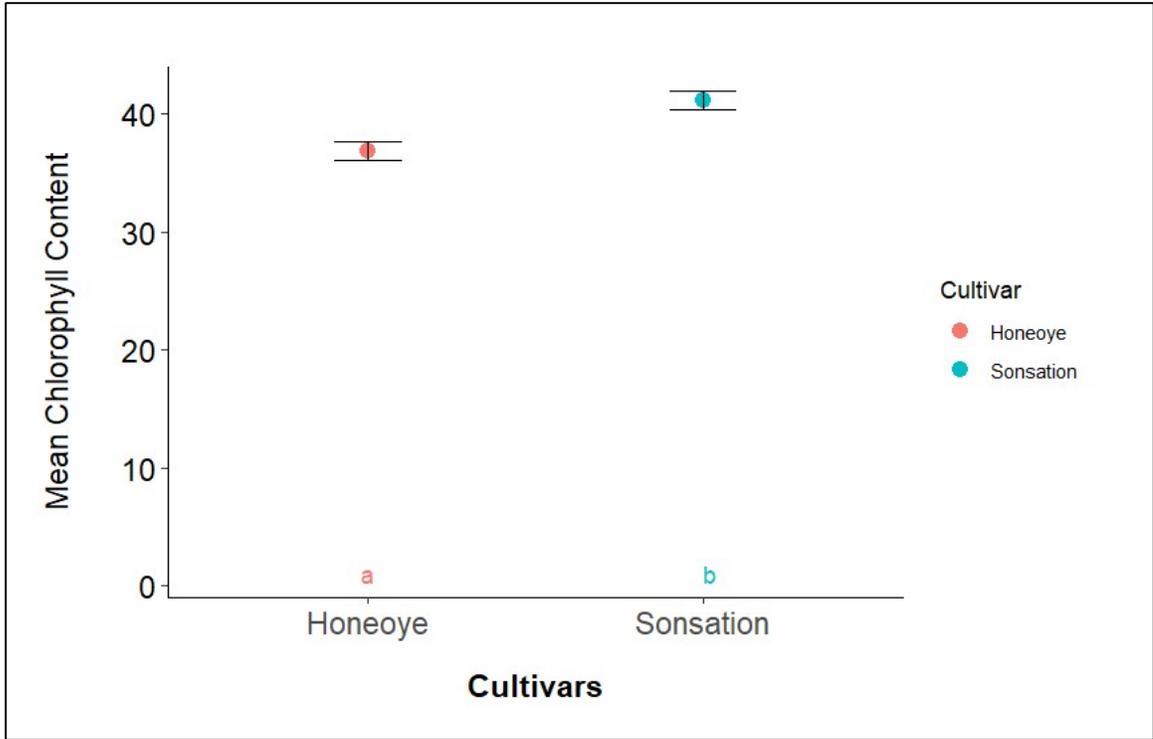


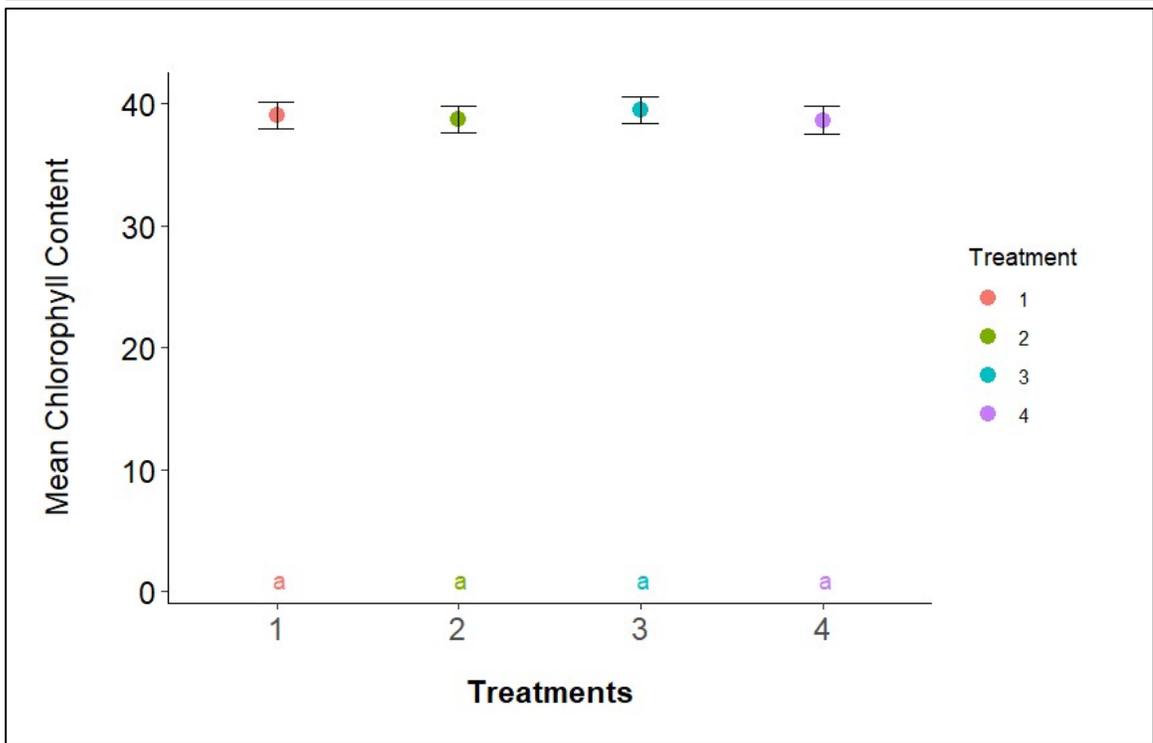
Figure 4: Mean Pollen Viability between different Cultivars (a), Treatments (b), and their interactions (c). This shows various barplots to help visualize the average pollen viability.

6.3 Chlorophyll Content

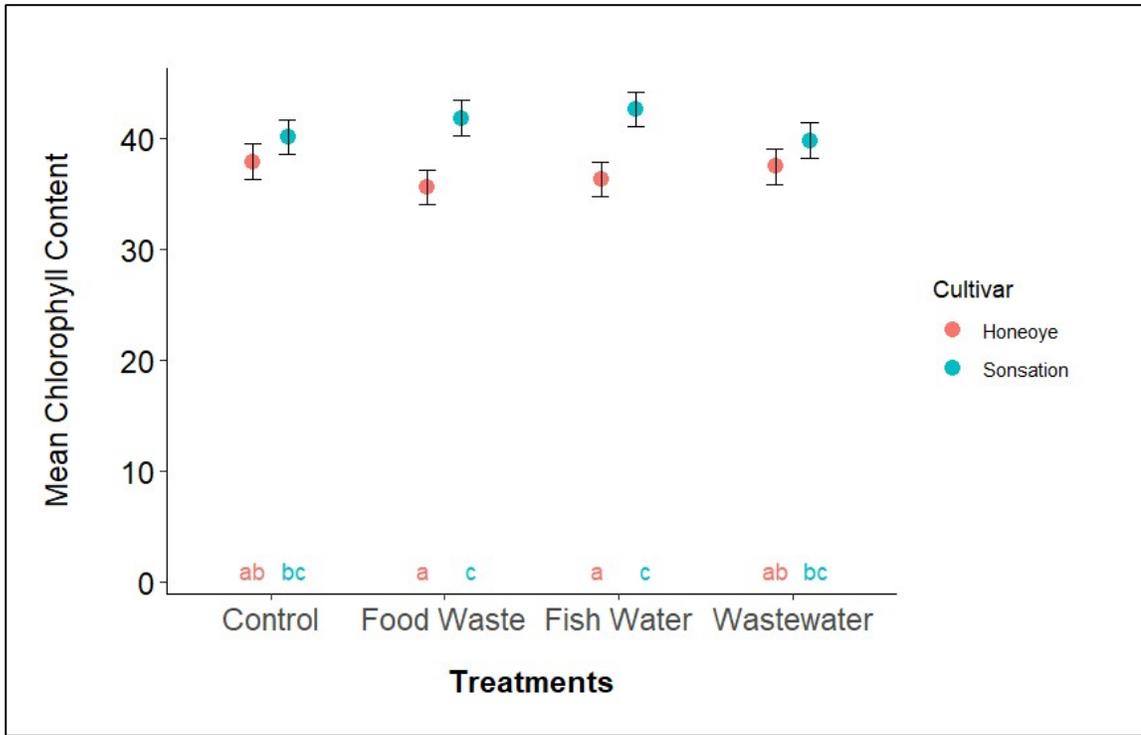
The measurement of chlorophyll content also helps show the differences between the cultivar, treatments, and their relationship. Cultivars showed to be a major influence in affecting the chlorophyll content, and there is a significant interaction between treatments and cultivars (Figure 5a). Figure 5a shows that Sonsation has higher average chlorophyll content than Honeoye that is significant ($p > 0.05$). Treatments do not have a significant effect on chlorophyll (Figure 5b). In Figure 5c, we can see the interaction between treatments and cultivars. Honeoye under the control treatment is significantly different from Sonsation with food waste and fish water. Likewise, Sonsation under the control treatment is significantly different from Honeoye with food waste and fish water. The control treatment and wastewater have similar effects on both cultivars.



a)



b)



c) **Figure 5:** Mean chlorophyll content between cultivars (a), treatments (b), and their interaction (c). This shows barplots of the significance of the mean chlorophyll content between cultivars, treatments, and their interactions.

6.4 Nitrogen Contents

At the end of the experiment, the remaining nitrogen content in the substrate shows how much nitrogen uptake occurred. For the control and wastewater, Honeoye and Sonsation have similar amounts in both nitrate and ammonium. For food compost and fish water, the remaining nitrogen content is very high in nitrates. In fish water, there is hardly any remaining ammonium.

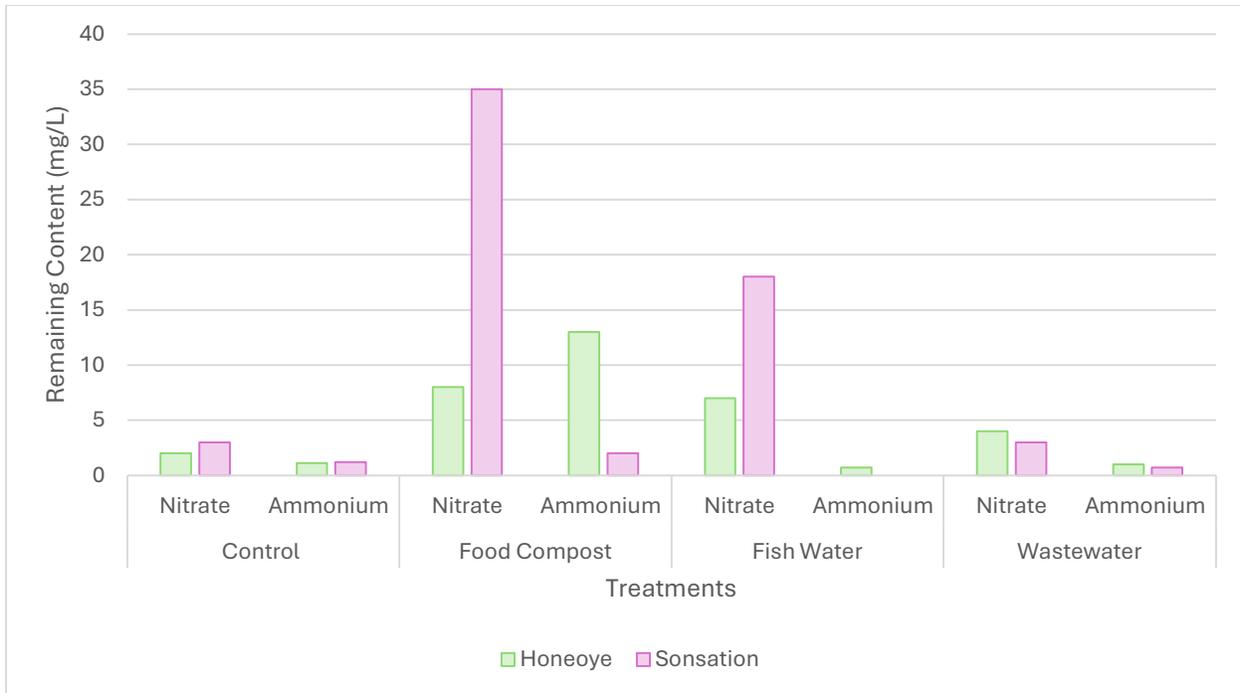


Figure 6: Content of nitrate and ammonium in the substrate after eight weeks of cultivation from two strawberry cultivars, Sonsation and Honeoye, using four different organic fertilizers. This figure shows the remaining nitrogen content, divided into nitrate and ammonium, at the end of the experiment.

7. Discussion

Although the treatments have no significant effects overall, there is evidence that treatments have specific effects on the different cultivars. When looking at the nitrogen content at the end of the experiment (Figure 6), Honeoye has lower amounts of nitrogen compared to Sonsation. The difference could potentially be explained by the strawberry plant's preference between nitrate and ammonium. In Jia et al. (2024)'s study, strawberry plants prefer different forms of nitrogen at different levels of nitrogen concentrations. At medium levels (around 15N), the plants prefer nitrate. Our food compost overall had 11.21 mg/L of nitrogen, meaning that the strawberry plants would prefer nitrates. Unfortunately, the food compost had very low amounts of nitrates (1.56 mg/L) compared to ammonium (9.65 mg/L). Furthermore, control and wastewater have the lowest amounts of nitrogen remaining in the substrate. This agrees with Jia et al. (2024)'s study as the control and wastewater have higher levels of nitrates (10.1 and 10.2 mg/L respectively) than ammonium (1.9 mg/L and 7.98 mg/L respectively).

While the difference in nitrogen uptake did not affect the leaf growth data, it may explain the differences observed for our chlorophyll data. The amount of nitrogen is a predicting factor in chlorophyll content (Patane & Vibhute 2014). They share a positive correlation, and that helps the plant focus more on vegetative growth. When comparing the treatments individually, there are no significant effects overall; however, chlorophyll content was affected by two factors:

cultivars and the treatment on cultivars. Even with a higher nitrogen uptake, Honeoye still has a lower chlorophyll average than Sonsation. When looking at the timeline of the growth of plants, Sonsation flowered and started producing fruit later than Honeoye. While the difference in chlorophyll is significant, it can be due to the different stages of the plants instead. Honeoye was already blossomed and fruited when chlorophyll content was collected. In Schaffer et al. (1986)'s results, they reported that older strawberry plants that have fruited report lower amounts of chlorophyll in their leaves.

Furthermore, there is a significant difference among the two cultivars for which type of reproduction they focus on. For instance, among flowers and fruits (Figure 3a-b), Sonsation appeared to have more than Honeoye (minus food compost). Food compost happens to have the highest ammonium content compared to the other treatments (Table 1). It is possible that the two cultivars' rejection of nitrogen content from the food compost fertilizer resulted in having reversed fruit yield. To thoroughly understand the relationship between the cultivars and the treatments in this case, we must test the nutritional needs of the two cultivars. Sonsation is better for fruit production than Honeoye, but when comparing runners, Honeoye has more. Honeoye focuses more on asexual reproduction than sexual. This may be cultivar specific as it has been reported that Sonsation (similar to Sonata) produces more fruit than Honeoye (Kampuss et al. 2021). It is also shown that plants grow more runners when the nitrogen content is high (Savini et al. 2008; Yafuso & Boldt 2025). This can mean that organic fertilizers with high nitrogen content are unsuitable for Honeoye, as they would produce more runners than fruit. This is evident in how Honeoye has the most runners in the control treatment (Figure 3c), where nitrogen content was one of the lowest (Table 1). As stated earlier, the plants prefer higher nitrate content, resulting in a higher nitrogen uptake from the control treatment over the wastewater (Table 3). The differences in nitrogen uptake also affected the cultivar's choice in reproduction.

Finally, we observed Sonsation has a higher pollen viability than Honeoye. This was seen in Symington and Glover's paper (2024). Sonsation's pollen viability is significantly higher than Honeoye, meaning that Sonsation focuses more on sexual reproductive growth. This is evident in how they have more flowers and fruit than Honeoye. Nitrogen is absorbed by anthers to protect themselves from stress (Santiago & Sharkey 2019). Our results indicate a possible interaction between treatment and cultivar (Figure 5c), as pollen viability was inverted between cultivars in the wastewater treatment in comparison to the other treatments. However, this interaction was not statistically significant. This experiment should be repeated with a larger sample size (see Table 2) to determine if there is a true interaction effect or not. We know that there is a positive correlation between nitrogen content and fruit yield, as plant health is important for plant reproduction (Razzaq et al. 2019). Although Howlett (1936)'s paper claims that nitrogen deficiency plays a little role in pollen viability, carbohydrate deficiency results from nitrogen intensity (Wang & Ruan 2015). High nitrogen contents result in carbohydrate deficiency that can affect pollen viability (Wang & Ruan 2015). Since these are studies done mostly with apples and tomatoes, with more experiments with strawberries, we can have clearer results on fertilizer treatments on pollen viability.

7.1 Limitations

Unfortunately, there is still a lot of data within this experiment to analyze. For instance, doing statistical analysis on the flowers, fruit, and stolon data could provide further insight of the treatment and cultivar effects for these specific areas. There is also the biomass aspect that can contribute to the vegetation vs reproduction arguments.

Due to lack of time, there was also a lot of data not collected. As mentioned previously, more pollen viability samples could have shown more statistical data. Seeing how pollinators prefer organic fertilizers, an extension to this data set could be testing pollinator preferences (Cardoza et al. 2012; Ahrenfeldt et al. 2019).

8. Conclusion

Overall, it's been proven many times that organic fertilizers are the best way to feed your plants without deteriorating the environment. However, within organic fertilizers, there are various ways to obtain them. For farmers to have successful crops, they need successful feed for the crops. Although there is no clear conclusion over which treatment works the best, we learned that different cultivars focus on different forms of reproduction. Honeoye is better for vegetative reproduction while Sonsation is better for fruit yield. We also note that difference amounts of ammonium and nitrates matter when it comes to treating strawberries as well. In the ideal strawberry nitrogen range, it is best to have more nitrates for plant absorption. In the end, even if the study did not prove my hypothesis, it still provided valuable insights into strawberry growth and reproduction.

References

- Ahrenfeldt, E.J., Sigsgaard, L., Hansted, L., Jensen, A.C. & Toldam-Andersen, T.B. (2019). Forage quality and quantity affect red mason bees and honeybees differently in flowers of strawberry varieties. *Entomologia Experimentalis et Applicata*, 167 (8), 763–773. <https://doi.org/10.1111/eea.12820>
- Al-Karabliegh, N., Al-Shomali, I., Al-Elaumi, L., Tabieh, M., Al-Karablieh, E., Al-Jaghibir, M. & Del Bubba, M. (2024). The impact of treated wastewater irrigation on strawberry development, fruit quality parameters, and microbial and chemical contaminant transfer: A health risk assessment. *Scientia Horticulturae*, 329, 113014. <https://doi.org/10.1016/j.scienta.2024.113014>
- Amujoyegbe, B.J., Opabode, J.T. & Olayinka, A. (2007). Effect of organic and inorganic fertilizer on yield and chlorophyll content of maize (*Zea mays* L.) and sorghum *Sorghum bicolor* (L.) Moench). *African Journal of Biotechnology*, 6 (16). <https://doi.org/10.5897/AJB2007.000-2278>
- Atasay, A., Akgül, Hüseyin, Uçgun, Kadir & Şan, B. (2013). Nitrogen fertilization affected the pollen production and quality in apple cultivars “Jerseymac” and “Golden Delicious.” *Acta Agriculturae Scandinavica, Section B — Soil & Plant Science*, 63 (5), 460–465. <https://doi.org/10.1080/09064710.2013.798683>
- Baumert, K.A., Herzog, T. & Pershing, J. (2005). *Navigating the numbers: greenhouse gas data and international climate policy*. World Resources Institute.
- Bäurle, I. & Laux, T. (2003). Apical meristems: the plant’s fountain of youth. *BioEssays: News and Reviews in Molecular, Cellular and Developmental Biology*, 25 (10), 961–970. <https://doi.org/10.1002/bies.10341>
- Bergstrand, K.-J. (2022). Organic fertilizers in greenhouse production systems – a review. *Scientia Horticulturae*, 295, 110855. <https://doi.org/10.1016/j.scienta.2021.110855>
- Cardoza, Y.J., Harris, G.K. & Grozinger, C.M. (2012). Effects of Soil Quality Enhancement on Pollinator-Plant Interactions. *Psyche: A Journal of Entomology*, 2012 (1), 581458. <https://doi.org/10.1155/2012/581458>
- Cerda, A., Artola, A., Font, X., Barrena, R., Gea, T. & Sánchez, A. (2018). Composting of food wastes: Status and challenges. *Bioresource Technology*, 248, 57–67. <https://doi.org/10.1016/j.biortech.2017.06.133>
- Dafni, A. & Firmage, D. (2000). Pollen viability and longevity: practical, ecological and evolutionary implications. In: Dafni, A., Hesse, M., & Pacini, E. (eds) *Pollen and Pollination*. Springer. 113–132. https://doi.org/10.1007/978-3-7091-6306-1_6
- Davidson, E.A. (2009). The contribution of manure and fertilizer nitrogen to atmospheric nitrous oxide since 1860. *Nature Geoscience*, 2 (9), 659–662. <https://doi.org/10.1038/ngeo608>
- Delph, L.F., Johannsson, M.H. & Stephenson, A.G. (1997). How Environmental Factors Affect Pollen Performance: Ecological and Evolutionary Perspectives. *Ecology*, 78 (6), 1632–1639. [https://doi.org/10.1890/0012-9658\(1997\)078\[1632:HEFAPP\]2.0.CO;2](https://doi.org/10.1890/0012-9658(1997)078[1632:HEFAPP]2.0.CO;2)
- Denstedt, C., WOLTHAUS, L., Breloh, L., Eimer, M. & Blanke, M. (2010). Carbon footprint of early Huelva strawberries imported into Germany—from farm to fork. *Proceedings of Proceedings of the LCA (Foods) Congress, Università Aldo Moro Bari*, 2010. 499–504

- Djillali, Y., Chabaca, M.N., Benziada, S., Bouanani, H., Mandi, L., Bruzzoniti, M.C., Boujelben, N. & Kettab, A. (2020). Effect of treated wastewater on strawberry. *Desalination and Water Treatment*, 181, 338–345. <https://doi.org/10.5004/dwt.2020.25095>
- Duuml Rdane, Y., Naif, G., Yusuf, Y., Mine, A. & Perihan, C.A. (2011). Effect of different organic fertilizers on yield and fruit quality of indeterminate tomato (*Lycopersicon esculentum*). *Scientific Research and Essays*, 6 (17), 3623–3628. <https://doi.org/10.5897/SRE10.1083>
- FAOSTAT (n.d.). <https://www.fao.org/faostat/en/#data/TCL> [2024-03-22]
- Geng, Y., Wang, J., Sun, Z., Ji, C., Huang, M., Zhang, Y., Xu, P., Li, S., Pawlett, M. & Zou, J. (2021). Soil N-oxide emissions decrease from intensive greenhouse vegetable fields by substituting synthetic N fertilizer with organic and bio-organic fertilizers. *Geoderma*, 383, 114730. <https://doi.org/10.1016/j.geoderma.2020.114730>
- Hancock, J. (1999). Strawberries crop production science in horticulture. *CABI, Publishing, Oxon, Uk*, 109–112
- Harper, J.L. (1989). The value of a leaf. *Oecologia*, 80 (1), 53–58. <https://doi.org/10.1007/BF00789931>
- Hartmann, M., Frey, B., Mayer, J., Mäder, P. & Widmer, F. (2015). Distinct soil microbial diversity under long-term organic and conventional farming. *The ISME Journal*, 9 (5), 1177–1194. <https://doi.org/10.1038/ismej.2014.210>
- Heslop-Harrison, J., Heslop-Harrison, Y. & Shivanna, K. (1984). The evaluation of pollen quality, and a further appraisal of the fluorochromatic (FCR) test procedure. *Theoretical and applied genetics*, 67, 367–375
- Howlett, F.S. (1936). The Effect of Carbohydrate and of Nitrogen Deficiency upon Microsporogenesis and the Development of the Male Gametophyte in the Tomato, *Lycopersicon esculentum* Mill. *Annals of Botany*, 50 (200), 767–803
- Husaini, A.M. & Xu, Y.W. (2016). Challenges of climate change to strawberry cultivation: uncertainty and beyond. In: Husaini, A.M. & Neri, D. (eds) *Strawberry: growth, development and diseases*. 1. ed. CABI. 262–287. <https://doi.org/10.1079/9781780646633.0262>
- Jia, Z., Zhang, J., Jiang, W., Wei, M., Zhao, L. & Li, G. (2024). Different nitrogen concentrations affect strawberry seedlings nitrogen form preferences through nitrogen assimilation and metabolic pathways. *Scientia Horticulturae*, 332, 113236. <https://doi.org/10.1016/j.scienta.2024.113236>
- Jurik, T.W. (1985). Differential costs of sexual and vegetative reproduction in wild strawberry populations. *Oecologia*, 66 (3), 394–403. <https://doi.org/10.1007/BF00378305>
- Kampuss, K., Sivicka, I., Sergejeva, D. & Kampuse, S. (2021). Yield quality of vertically grown strawberries in greenhouse and open area. *Acta Horticulturae*, (1309), 525–532. <https://doi.org/10.17660/ActaHortic.2021.1309.75>
- Karagöz, İ. (2021). Fertilization and Fertilizer Types. In: *Applied Soil Chemistry*. John Wiley & Sons, Ltd. 123–148. <https://doi.org/10.1002/9781119711520.ch7>
- Khandaker, M.M., Jusoh, N., Abadiyah, N.H. & Ismail, S.Z. (2017). THE EFFECT OF DIFFERENT TYPES OF ORGANIC FERTILIZERS ON GROWTH AND YIELD OF ABELMOSCHUS ESCULENTUS L. MOENCH (OKRA).
- Khoshnevisan, B., Shariati, H.M., Rafiee, S. & Mousazadeh, H. (2014). Comparison of energy consumption and GHG emissions of open field and greenhouse strawberry production.

- Renewable and Sustainable Energy Reviews*, 29, 316–324.
<https://doi.org/10.1016/j.rser.2013.08.098>
- Kikuzawa, K. & Ackerly, D. (1999). Significance of leaf longevity in plants. *Plant Species Biology*, 14 (1), 39–45. <https://doi.org/10.1046/j.1442-1984.1999.00005.x>
- Korbee, N., Bautista, B., García-Sánchez, M., Cobos, P., Ferres-García, J.L., Figueroa, F.L. & Medrano, E. (2025a). Evaluating hydroponics and aquaponics: Comparative insights into sustainability and strawberry quality. *Agricultural Water Management*, 312, 109412. <https://doi.org/10.1016/j.agwat.2025.109412>
- Korbee, N., Bautista, B., García-Sánchez, M., Cobos, P., Ferres-García, J.L., Figueroa, F.L. & Medrano, E. (2025b). Evaluating hydroponics and aquaponics: Comparative insights into sustainability and strawberry quality. *Agricultural Water Management*, 312, 109412. <https://doi.org/10.1016/j.agwat.2025.109412>
- Kronthaler, F. & Zöllner, S. (2021). R and RStudio. In: Kronthaler, F. & Zöllner, S. (eds) *Data Analysis with RStudio: An Easygoing Introduction*. Springer. 1–12. https://doi.org/10.1007/978-3-662-62518-7_1
- Larsen, T.A., Maurer, M., Udert, K.M. & Lienert, J. (2007). Nutrient cycles and resource management: implications for the choice of wastewater treatment technology. *Water Science and Technology*, 56 (5), 229–237. <https://doi.org/10.2166/wst.2007.576>
- Lata, S., Sharma, G., Garg, S. & Mishra, G. (2018). Pollen viability, germination and stigma receptivity studies in different strawberry cultivars. *Agricultural Research Journal*, 55 (4), 627. <https://doi.org/10.5958/2395-146X.2018.00115.1>
- Ledesma, N. & Sugiyama, N. (2005). Pollen Quality and Performance in Strawberry Plants Exposed to High-temperature Stress. *Journal of the American Society for Horticultural Science*, 130 (3), 341–347. <https://doi.org/10.21273/JASHS.130.3.341>
- Li, Q., Zhang, D., Song, Z., Ren, L., Jin, X., Fang, W., Yan, D., Li, Y., Wang, Q. & Cao, A. (2022). Organic fertilizer activates soil beneficial microorganisms to promote strawberry growth and soil health after fumigation. *Environmental Pollution*, 295, 118653. <https://doi.org/10.1016/j.envpol.2021.118653>
- Liu, C., Liu, Y., Lu, Y., Liao, Y., Nie, J., Yuan, X. & Chen, F. (2019). *Use of a leaf chlorophyll content index to improve the prediction of above-ground biomass and productivity [PeerJ]*. <https://peerj.com/articles/6240/> [2025-06-05]
- Massri, M. & Labban, L. (2014). Comparison of Different Types of Fertilizers on Growth, Yield and Quality Properties of Watermelon (&i>Citrillus lanatus&i>). *Agricultural Sciences*, 05 (06), 475–482. <https://doi.org/10.4236/as.2014.56048>
- Neri, D., Baruzzi, G., Massetani, F. & Faedi, W. (2012). Strawberry production in forced and protected culture in Europe as a response to climate change. *Canadian Journal of Plant Science*, 92 (6), 1021–1036. <https://doi.org/10.4141/cjps2011-276>
- Novoa, R. & Loomis, R.S. (1981). Nitrogen and plant production. *Plant and Soil*, 58 (1), 177–204. <https://doi.org/10.1007/BF02180053>
- Patane, P. & Vibhute, A. (2014). Chlorophyll and Nitrogen Estimation Techniques: A Review. 2 (4)
- Pérez-Patricio, M., Camas-Anzueto, J.L., Sanchez-Alegría, A., Aguilar-González, A., Gutiérrez-Miceli, F., Escobar-Gómez, E., Voisin, Y., Rios-Rojas, C. & Grajales-Coutiño, R. (2018). Optical Method for Estimating the Chlorophyll Contents in Plant Leaves. *Sensors (Basel, Switzerland)*, 18 (2), 650. <https://doi.org/10.3390/s18020650>

- Pinillos, V. & Cuevas, J. (2008). Standardization of the fluorochromatic reaction test to assess pollen viability. *Biotechnic & Histochemistry*, 83 (1), 15–21. <https://doi.org/10.1080/10520290801987204>
- Razzaq, M.K., Rauf, S., Khurshid, M., Iqbal, S., Bhat, J.A., Farzand, A., Riaz, A., Xing, G. & Gai, J. (2019). Pollen Viability an Index of Abiotic Stresses Tolerance and Methods for the Improved Pollen Viability. *Pakistan Journal of Agricultural Research*, 32 (4)
- Sangare, D., Sou/Dakoure ,M., Hijikata ,N., Lahmar ,R., Yacouba ,H., Coulibaly ,L. & Funamizu, N. (2015). Toilet compost and human urine used in agriculture: fertilizer value assessment and effect on cultivated soil properties. *Environmental Technology*, 36 (10), 1291–1298. <https://doi.org/10.1080/09593330.2014.984774>
- Santiago, J.P. & Sharkey, T.D. (2019). Pollen development at high temperature and role of carbon and nitrogen metabolites. *Plant, Cell & Environment*, 42 (10), 2759–2775. <https://doi.org/10.1111/pce.13576>
- Santin, A., Villa, F. & Paulus, D. (2017). *Chlorophyll content in plants and fruit yield of strawberry plants grown on mulching | Revista de Ciências Agroveterinárias*. <https://doi.org/10.5965/223811711632017262> [2025-06-05]
- Savini, G., Giorgi, V., Scarano, E. & Neri, D. (2008). Strawberry plant relationship through the stolon. *Physiologia Plantarum*, 134 (3), 421–429. <https://doi.org/10.1111/j.1399-3054.2008.01145.x>
- Sayğı, H. (2022). Effects of Organic Fertilizer Application on Strawberry (*Fragaria vesca* L.) Cultivation. *Agronomy*, 12 (5), 1233. <https://doi.org/10.3390/agronomy12051233>
- Schaffer, B., Barden, J.A. & Williams, J.M. (1986). Net Photosynthesis, Dark Respiration, Stomatal Conductance, Specific Leaf Weight, and Chlorophyll Content of Strawberry Plants as Influenced by Fruiting. *Journal of the American Society for Horticultural Science*, 111 (1), 82–86. <https://doi.org/10.21273/JASHS.111.1.82>
- Simpson, D. (2018). The Economic Importance of Strawberry Crops. In: Hytönen, T., Graham, J., & Harrison, R. (eds) *The Genomes of Rosaceous Berries and Their Wild Relatives*. Springer International Publishing. 1–7. https://doi.org/10.1007/978-3-319-76020-9_1
- Sønsteby, A., Roos ,U. M. & Heide, O.M. (2017). Phenology, flowering and yield performance of 13 diverse strawberry cultivars grown under Nordic field conditions. *Acta Agriculturae Scandinavica, Section B — Soil & Plant Science*, 67 (3), 278–283. <https://doi.org/10.1080/09064710.2016.1261933>
- Strawberry varieties differ in pollinator-relevant floral traits - Symington - 2024 - Ecology and Evolution - Wiley Online Library* (n.d.). <https://onlinelibrary.wiley.com/doi/full/10.1002/ece3.10914> [2025-06-13]
- Symington, H.A. & Glover, B.J. (2024). Strawberry varieties differ in pollinator-relevant floral traits. *Ecology and Evolution*, 14 (2), e10914. <https://doi.org/10.1002/ece3.10914>
- Tang, Y., Ma, X., Li, M. & Wang, Y. (2020). The effect of temperature and light on strawberry production in a solar greenhouse. *Solar Energy*, 195, 318–328. <https://doi.org/10.1016/j.solener.2019.11.070>
- Wang, L. & Ruan, Y.-L. (2015). Shoot–root carbon allocation, sugar signalling and their coupling with nitrogen uptake and assimilation. *Functional Plant Biology*, 43 (2), 105–113
- Wang, S.Y. & Lin, S.-S. (2002). COMPOSTS AS SOIL SUPPLEMENT ENHANCED PLANT GROWTH AND FRUIT QUALITY OF STRAWBERRY. *Journal of Plant Nutrition*,. <https://doi.org/10.1081/PLN-120014073>

- Yafuso, E.J. & Boldt, J.K. (2025). Adjusting the Percentage of Nitrate in Nutrient Solution to Optimize Strawberry Stolon and Daughter Plant Production. <https://doi.org/10.21273/HORTSCI18245-24>
- Yep, B. & Zheng, Y. (2019). Aquaponic trends and challenges – A review. *Journal of Cleaner Production*, 228, 1586–1599. <https://doi.org/10.1016/j.jclepro.2019.04.290>
- Zebrowska, J. (1997). Factors affecting pollen grain viability in the strawberry (*Fragaria x ananassa* Duch.). *Journal of Horticultural Science*, 72 (2), 213–219. <https://doi.org/10.1080/14620316.1997.11515508>
- Zhou, Z. & Yao, H. (2020). Effects of Composting Different Types of Organic Fertilizer on the Microbial Community Structure and Antibiotic Resistance Genes. *Microorganisms*, 8 (2), 268. <https://doi.org/10.3390/microorganisms8020268>

Popular science summary

Organic fertilizers are helpful for the environment and fruit yield, however, there are many different types to choose from. The goal of the experiment is to see which organic fertilizer is best for growing strawberries. We tested four different organic fertilizers: store-bought, food compost, fish water, and wastewater on two different strawberry cultivars: Honeoye and Sonsation. We tested the effects by counting the amounts of leaves, flowers, fruit, and runners each week. This compares the differences of growth and reproduction between cultivars and to see if the fertilizers had an impact. We also tested the chlorophyll content, a measure that detects plant photosynthesis content. This helps identify the plant content that focuses on growing leaves. Finally, we analyzed male fertility by seeing how many healthy pollen grains there are in each treatment and cultivar. Pollen viability is a measurement to see if pollen can reproduce. Overall, the higher the nitrogen content, the higher vegetative growth is. Sonsation produces more fruit than Honeoye, but Honeoye focuses more on creating more plants instead of fruit. There is no clear evidence of which fertilizer is the best, but there is potential effect of treatments to cultivars that need to be further studied.

Acknowledgements

I would like to acknowledge partnerships with SLU Partnerskap Alnarp for this project.

Publishing and archiving

Approved students' theses at SLU are published electronically. As a student, you have the copyright to your own work and need to approve the electronic publishing. If you check the box for **YES**, the full text (pdf file) and metadata will be visible and searchable online. If you check the box for **NO**, only the metadata and the abstract will be visible and searchable online. Nevertheless, when the document is uploaded it will still be archived as a digital file. If you are more than one author, the checked box will be applied to all authors. You will find a link to SLU's publishing agreement here:

- <https://libanswers.slu.se/en/faq/228318>.

YES, I/we hereby give permission to publish the present thesis in accordance with the SLU agreement regarding the transfer of the right to publish a work.

NO, I/we do not give permission to publish the present work. The work will still be archived and its metadata and abstract will be visible and searchable.