

The Effectiveness of Synthetic and Natural Fertilizers on the Height of Basil

Bassel Alaiyoubi
basselalaiyoubi14@gmail.com

ABSTRACT

Following the Green Revolution, the use of synthetic fertilizers became widespread, but their environmental impacts are immense. Consequently, compost became an increasingly popular substitute. Many scientists sought to analyze the effects of synthetic fertilizers versus natural fertilizers. However, no such study adequately addressed the effect these fertilizers had on overall plant height; thus, my research aims to answer the following question: Does compost improve overall plant height compared to chemical fertilizers? This was investigated by observing the effect of both compost and chemical fertilizers on the height of basil seeds to determine which, if any, have a positive effect on plant height.

To gather this data, 90 basil seeds were randomly divided into 3 groups of equal size: seeds grown via soil and compost, seeds grown via soil and synthetic fertilizer, and seeds grown solely via soil. The plants grew over the course of a couple weeks, and at the end of their growing time they were extracted and their heights as well as the average plant height in each cup were recorded (in cm) to run two distinct analyses.

Both analyses concluded that there was no significant difference in plant height between the group aided by compost and the control group. However, the analyses both concluded that there was a significance in plant height of the group aided by fertilizer compared to the other two groups, with fertilizer being significantly less effective. Additionally, the study concluded that there was no significance between the compost-aided group and the control group.

INTRODUCTION & LITERATURE REVIEW

In the mid 20th century, Norman Borlaug—American agronomist and father of the Green Revolution—developed a short-stemmed strain of wheat that significantly improved crop yields compared to taller-stemmed wheat varieties that broke under the weight of their heads as a result of the increased production from fertilizers. The short-stemmed wheat mitigated the effect of the increase in biomass caused by the use of fertilizers that eventually led to lodging of the tall-stemmed wheat plants. This innovation was one of many closely related agricultural advancements, now known as the Third Agricultural Revolution (commonly referred to as the Green Revolution). Borlaug's work increased the

agricultural productivity of India and Pakistan by 60%, helped triple the production of previously failing wheat farms in Mexico, and ultimately saved nearly 1 billion people from starvation and death (Britannica Editors, 1998). However, this great ingenuity did not come without a cost: the popularization of chemical fertilizers.

Fertilizers are any material of synthetic or natural origins to supply nutrients for plants, primarily composed of essential plant nutrients like nitrogen, phosphorus, and potassium, and can be both naturally and industrially produced. Fertilizers have been applied on crops to improve yields for centuries, and mineral fertilizers can be thanked for supplying half the food we eat today, yet their environmental impacts are immense (Sedlacek et al, 2020). The nitrogen and phosphorus in the fertilizer causes a significant increase in the nutrient content in the soil. When it rains, runoff takes the nutrients from the soil downstream along with it. In large quantities this can lead to eutrophication of the water, directly resulting in algal blooms that decrease dissolved oxygen levels and increase the turbidity of the water. Consequently, many organisms do not have enough dissolved oxygen to survive, and the increase in turbidity prevents light from entering the water, thus preventing photosynthetic organisms from producing more dissolved oxygen. Ultimately, a dead zone forms where very few organisms are able to survive.

According to MIT Climate, most of the energy that creates the ammonia that goes into chemical fertilizers is generated through the burning of fossil fuels and methane gas, contributing to 2% of all greenhouse gas emissions. Moreover, much of the applied fertilizer gets broken down in the soil or runs off into bodies of water, releasing greenhouse gases such as nitrous oxide into the atmosphere, a compound that, in equal quantities, warms the atmosphere 300 times more than carbon dioxide (Fertilizer and Climate Change, 2025). These environmental issues raised many concerns to farmers and scientists, prompting the reintroduction of an increasingly popular substitute: compost.

Compost is defined as decayed organic material used as plant fertilizer such as manure and vegetable matter, a natural fertilizer. For the purposes of this study, the terms “compost” and “natural fertilizer” will be used interchangeably, as will the terms “chemical fertilizer” and “synthetic fertilizer”. According to Texas Organics, composting has been an agricultural practice for centuries, beginning as early as 3,000 B.C. in Egypt in the form of animal manure. In the 1900’s, it was estimated that 90% of fertilizers in the United States were derived from compost, but the extent of compost usage in agriculture drastically shifted in 1913 with the production of synthetic nitrogen compounds. By the 1950’s, these new chemical fertilizers became so widespread that fertilizers derived from compost only accounted for 1% of all fertilizer use in the United States.

Back in 1942, J.I. Rodale (founder of the Rodale Institute, formerly the Soil Health Foundation) revived the use of composting as he noticed the hazards associated with synthetic fertilizers versus the environmental benefits of compost. Because the nutrients are contained inside the compost, soil microbes must decompose it over months. As a result, the nutrients are released at slower rates than traditional chemical fertilizers, reducing the potential for eutrophication of the water that leads to dead zones. Moreover, the slow release of nutrients means compost lasts significantly longer than synthetic fertilizers

(Xing et al., 2025). This shows that although store-bought compost is more costly, it also does not need to be purchased as frequently as chemical fertilizers do. Although short-lived, Rodale's ideas were further revived in the 1960s alongside a growing global sense of environmentalism. It wasn't until the 1980s that the composting industry grew once more. From 1983 to 1996, the amount of operational biosolids composting plants increased over 400%, with many industries even beginning their own recycling and composting programs (Goldstein, 1998). According to the United States' Environmental Protection Agency, the spike in popularity of composting can also be attributed to its ease of implementation. Contrary to chemical fertilizers, anybody can create their own compost simply by recycling food scraps, grass and leaves from their backyards, and recyclables like shredded cardboard and newspapers (Composting at Home | US EPA, 2013). This easy-access and cheaper alternative to synthetic fertilizer greatly contributed to its rapid growth, as not only did it reduce waste entering trash and recycling facilities, it made green activities like composting and gardening much more accessible to everyday people.

Today, with the rise in both natural and synthetic fertilizers, many researchers have analyzed the impacts these fertilizers have on plants. Researchers have analyzed the effects on plant traits such as soil structure, water retention, nutrient supply and uptake, disease resistance, resiliency, and more, as well as on economic implications like cost and resource usage. One such study, conducted by Eunhee A. Koh and Daniel Dudek, researchers at Korea Kent Foreign School and Headwaters Science Institute respectively, found that compost-treated plants had a higher average leaf width and root width compared to chemical fertilizer-treated plants. Moreover, unlike synthetic fertilizers, compost actually restores soil quality and is overall better for the environment.

While these findings may make it seem like compost is all around far superior to fertilizer, other works have found different results. The University of Georgia's College of Agricultural and Environmental Studies claims that chemical fertilizers are far cheaper than compost. To get the same nutrients from 40 pounds of 10-10-10 fertilizer, you would need roughly 280 pounds of compost, or 800 pounds of cow manure. In terms of price, the 40 pound 10-10-10 fertilizer bag is about \$20, while the same nutritional value in compost and in cow manure is \$35 and \$96 respectively. For large scale gardens or farms, the difference is significant, and is often the reason why many farmers choose synthetic fertilizers over nutritional ones. Furthermore, they found that in terms of nitrogen release, synthetic fertilizers are easier to apply than compost after a crop is established (Pugliese, 2022).

The difference in areas of benefit have led many researchers to search for a clear answer to which kind of fertilizer, natural or synthetic, is overall the most favorable. As mentioned before, they have analyzed implications within categories like cost, nutritional value, soil degradation, leaf and root width, plant growth time, and more. Yet upon further research, there have only been a couple papers that address a direct comparison of the effects on plant height between compost and chemical fertilizers, but their conclusions are still undecided amongst scientists. Eunhee A. Koh and Daniel Dudek had also found that the compost-treated plants were overall taller than the fertilizer-treated plants, but reported there to be no statistical significance between the treatments. The lack of knowledge on implications to plant height

raises the following question: Does compost improve overall plant height compared with chemical fertilizers? My research aims to determine whether compost or chemical fertilizers are better for overall plant height, hypothesizing that compost will be statistically more effective than synthetic fertilizers.

The significance of the height of plants has to do with its health. Dong He et al, professors at Xinjiang University, East China Normal University, and VU University, report in their 2025 paper that if a plant is able to grow taller, that typically indicates it has more access to nutrients and therefore is able to continue to photosynthesize and grow over time. The result of this study will help farmers and other constituents of the agricultural industry determine which fertilizers, if any at all, are worth the investment as it indicates how different fertilizers impact a plant's ability to grow. While my study is specifically focused on the plant height of basil seeds, the methodology and findings of this study will guide future researchers on how to investigate the effects of different forms of fertilizers on other plants, not just basil seeds, to further populate this particular body of knowledge.

METHODOLOGY

For the purposes of this research, it was necessary to gather data about heights of basil seeds. Although an outdoor organically run experiment would be preferable, unforeseen conditions such as precipitation, cloudiness, and temperature influenced the decision to conduct the experiment in a controlled environment indoors. The experimental design choice was influenced by a study conducted by David R. Hershey, assistant professor at the University of Maryland, who laid out his entire procedure in just six steps. Adopting the simplicity of his experiment inevitably helped the study run smoothly, as there were no overly complicated procedures that could have caused any major errors.

For this experiment, an indoor experimental design with controlled factors like temperature, light, and water was utilized. The decision to grow basil seeds as opposed to some other plant came from their quick growth time, as they are known for taking only about 4-6 weeks to reach full maturity. Initially, the seeds were planted in recycled soda cans of either 7.5 oz or 12 oz, with the larger of the two hosting 3 seeds, and the smaller hosting 2 seeds. To support the cans, a table was set up and the cans were split by soil type (soil, compost & soil, and fertilizer & soil) on the table. The soil, compost, and synthetic fertilizer (see Appendix A) were all purchased from Home Depot. While the synthetic fertilizer product did provide an NPK (Nitrogen, Phosphorus, Potassium) ratio of 2-2-2, the natural fertilizer did not. Since it would be too costly to determine the NPK ratio for the compost, the recommended application ratios were utilized as those ratios were given by their respective products; thus, soil and compost were mixed together at a 60-40 ratio, and the soil and synthetic fertilizer were mixed at a 90-10 ratio in each can in their respective groups. An article released by Utah State University found that basil “loves warm weather, lots of sun and plenty of moisture.” Because of such, a grow light was placed above the table to control the duration of which the seeds are exposed to light, and the temperature remained between 70 and 78 degrees Fahrenheit. This temperature range ensures that the plants are never cold, as basil is incredibly sensitive to cold temperatures. The grow light was turned on for roughly 15 hours per day from 8am to 11pm and

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placed nearly 3 feet away from the plants, and the plants were watered once every couple days (Utah State University, 2020). The step-by-step process is laid out below:

1. Gather the necessary amount of compost, chemical fertilizer, and soil.
2. Gather recycled soda cans of 7.5oz and 12oz, and cut open the tops to allow light to shine through.
3. Split the cans into 3 groups: compost and soil, synthetic fertilizer and soil, and the control group of only soil.
4. Fill the cans with soil in each group, and add compost and synthetic fertilizer to the cans in their respective groups.
5. Mix the cans well to ensure the distribution of the compost and synthetic fertilizer within the soil in the cans.
6. Set up the table and place the cans adjacent to one another, splitting them between their respective groups.
7. Set up the grow light roughly 3 feet away from the table.
8. Water each can with about 2 tablespoons of water to dampen the soil.
9. Plant the basil seeds in each can, planting 2 for the smaller cans and 3 for the larger ones.
10. Water the cans once more, this time with only 1 tablespoon of water. Do not water the plants for another couple of days.
11. Once the two days have passed, water the plants once every two days.

The method seemed to be efficient, but growing multiple seeds in one single can eventually became a problem because as the plants grew, competition for resources (water, nutrients, etc) increased, which stunted the growth of the plants long-term. Moreover, the ideal range the light should be placed from the plants is 6-12 inches, not 3 feet. This is because the closer the light source is to the plants, the more energy the plants absorb and the more photosynthesis the plants can perform, therefore directly supporting the growth of the basil seeds. The inverse square law states that the intensity from a source at any given distance r is the source strength divided by the distance from the source, noted by the equation: $I = 1/r^2$, where r^2 is the distance squared, and I is the calculated intensity. Therefore, as the area the light shines increases, its intensity decreases, and less energy is able to be absorbed by the plants. So if the light is brought closer to the plants, the area decreases, and the intensity of the light increases, supporting the photosynthetic activity of the basil (Newman, 2009). Lastly, the soda cans did not contain any drainage holes, which could have eventually led to waterlogging if too much water was in the can at one time (Herzon, I. & Helenius, J., 2008). When plants are waterlogged it means they are not receiving enough oxygen and are essentially drowning. This directly causes root hypoxia, a condition where plant roots do not receive enough oxygen, suppressing growth and causing wilting.

To fix these issues, the method was shifted to expand the number of cups to 90 to allow each seed its own room to grow, overall having 30 cups for each group. Moreover, rather than using recycled cans, 9oz plastic cups were used as they were easier to create drainage holes in. Additionally, 3D modeled mounts (See Appendix A) for the grow light were printed so it could be moved closer to the plants at a little over

11 inches, and each cup was modified to include 5 drainage holes each a diameter large enough for water to escape, but small enough to contain the soil. The adjusted step-by-step process is laid out below:

1. Gather the necessary amount of compost, chemical fertilizer, and soil.
2. Gather 90 9oz plastic cups, and poke 5 holes on the bottom rim of each cup to serve as drainage holes.
3. Split the cups evenly into 3 groups: compost and soil, synthetic fertilizer and soil, and the control group of only soil.
4. Fill the cups with soil in each group, and add compost and synthetic fertilizer to the cans in their respective groups.
5. Mix the cups well to ensure the distribution of the compost and synthetic fertilizer within the soil in the cups.
6. Set up the table and place the cups adjacent to one another, splitting them between their respective groups (30 in each group).
7. Set up the grow light roughly 11 inches away from the table.
8. Water each cup with about 2 tablespoons of water to dampen the soil.
9. Plant the basil seeds in each cup, planting only one seed in each cup.
10. Water the cups once more, this time with only 1 tablespoon of water. Do not water the plants for another three days.
11. Once the three days have passed, water the plants once every three days.

New seeds were planted, and the effectiveness of these changes were quickly realized. The seeds began to grow healthier, stronger stems, and on average germinated much quicker than before. As the plants continued to grow, fungi began growing near them (see Appendix D), which could've had significant implications regarding plant growth. The Centers for Disease Control and Prevention agency reports that fungi can grow in a number of environments, but that they are especially potent in damp, warm environments. The presence of fungi could cause resource competition between the basil and fungi, possibly stunting the growth of the basil seeds and skewing the results of the experiment. Since the basil was grown in a warm and damp environment, it was the perfect breeding ground for the growth of fungi. They grew rapidly across all three of the experimental groups (see Appendix D). To prevent any nutrient depletion or competition between the basil and fungi, the fungi were carefully removed via tweezers. Additionally, to make sure this did not keep occurring the basil seeds were watered way less frequently at only once every 3 days, making sure the soil was never too damp to promote the growth of any fungus. This significantly reduced the amount of fungi growing while still enabling the basil to grow.

Similar to the analysis Ahmed et al—researchers at the University of Lahore in Pakistan—used in their paper on the effect of selenium and compost on the “physiological, biochemical, and productivity of chili under chromium stress”, a standard ANOVA test between the three groups (fertilizer, compost, soil control group) was conducted to determine the significance of the treatments of each of the three groups on plant heights (Ahmad et al, 2025). As the plants were growing, they began to offshoot from the same

root. Although this is a natural occurrence for the development of basil seeds, it wasn't accounted for in terms of data collection.

To mitigate the potential impact on the findings, two different methods of data collection were utilized. First, the height of each distinct plant from each group (in cm) was recorded (see Appendix B); and secondly, the heights of each plant in each cup were averaged (see Appendix C). An ANOVA test was then run on a computer software, Statistics Kingdom, to determine if there was any statistical significance between the three groups (ANOVA Calculator - One Way ANOVA and Tukey HSD Test, 2026). This proposed form of analysis is suitable for the study's overall goal, to determine the correlation of various forms of fertilizers on the height of basil with respect to each other as well as addressing the knowledge gap defined in the "Introduction and Literature Review", as it gathers two forms of plant heights that can be used to confidently determine a significance or not. The next section will discuss the findings of this analysis.

RESULTS & FINDINGS

For the purposes of the statistical analysis, the "null hypothesis" is not the same as the study's overall hypothesis; rather, it is that there will be no statistical significance between compost and synthetic fertilizers regarding plant height. Out of the 30 cups in each group, 29/30 seeds germinated in the compost group, 25/30 seeds germinated in the synthetic fertilizer group, and 30/30 seeds germinated in the soil (control) group, resulting in germination rates of 96.7%, 83.3%, and 100% respectively. Only the cups that contained seeds that successfully germinated were used in the data collection process.

	Compost & Soil	Synthetic Fertilizer & Soil	Control Group
Sample Size	43	43	54
Mean Height (cm)	2.7165	2.08717	2.67273
SD (cm)	0.63608	0.57038	0.69956
Effect Size (f)		0.44	
ANOVA P-value		0.000005474	
		0.00003614	
Pairwise P-Value		0.00005064	

	0.9407	
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For method one, the result of the ANOVA test concluded that there were statistically significant averages between compost and fertilizer and the control group and fertilizer; however, there was no statistical significance between the compost and control groups. The p-value was less than the alpha of 0.05, at 0.000005474, causing the initial hypothesis—that there is no statistical significance between the groups—to be rejected, and indicating the likelihood for a type I error (that we reject a correct H_0) is ~0.00055%. Additionally, the “observed effect size f [was] large (0.44),” indicating the magnitude of the difference between the averages is large. When Cohen’s f statistic is less than 0.10, it indicates that the data is not statistically significant. In this case the f statistic was 0.44. In other words, the averages were so different from each other that it is extremely likely the data is statistically significant (FAQ How Is Effect Size Used in Power Analysis?, 2026). Regarding the different pairings, the p-value between compost and fertilizer was 0.00003614, the p-value between the control group and fertilizer was 0.00005064, and the p-value between compost and the control group was 0.9407. Because the latter p-value was greater than the alpha of 0.05, we fail to reject H_0 —that there is no significant difference in average plant height between compost and the control group.

	Compost & Soil	Synthetic Fertilizer & Soil	Control Group
Sample Size	29	25	30
Mean Height (cm)	2.658	2.09269	2.71644
SD (cm)	0.44658	0.49054	0.49259
Effect Size (f)		0.58	
ANOVA P-value		0.000006436	
Pairwise P-Value		0.0001167	
	0.8835		0.00001605

For method two, the result of the ANOVA test also concluded that there were statistically significant averages between compost and fertilizer and the control group and fertilizer, and also failed to determine

any statistical significance between the compost and control groups. The p-value was less than the alpha of 0.05, at 0.000006436, yet again causing the initial hypothesis to be rejected, and indicating the likelihood for a type I error is $\sim 0.00064\%$. Moreover, the observed effect size f was even larger, at 0.58, indicating even more of a magnitude of difference between the averages. As for the different pairings, the p-value between compost and fertilizer was 0.0001167, the p-value between the control group and fertilizer was 0.00001605, and the p-value between compost and the control group was 0.8835. Because the latter p-value was greater than the alpha of 0.05, we again fail to reject H_0 .

The results of both of these methods suggest that plants in the chemical fertilizer group did not grow as tall as plants in either the compost or control group. This may be attributed to synthetic fertilizers' rapid release of nutrients, which could have caused an overnutrition in the basil seeds grown with the fertilizer, stunting their growth and overall height. However, there are several other factors that could explain why the chemical fertilizer group did not grow as tall. One such factor could be a pH shift towards more acidic levels. While no pH measurements were taken, the microbes in the soil breaking down the ammonium into nitrate release hydrogen ions that directly lower pH levels, reducing the breakdown of organic matter (Extension, 2025). In addition, since the exact NPK ratios were unknown for the compost group, there is a chance that the plants in the compost group received more nutrients than the plants in the fertilizer, causing the significant difference in overall plant height between the groups.

Nonetheless, this supports the study's initial hypothesis that there was a greater positive impact of plant height by use of compost than by chemical fertilizer. However, the study also concluded that there was no statistical significance between compost and the control group, implying that the use of compost had no significant impact on plant height than without any natural fertilizer. This could likely be due to the short duration of the experiment, as the microbes may not have had enough time to fully break the compost down and release the nutrients into the soil. The Discussion will address the implications and limitations of these findings, in addition to how these limitations can be addressed in future research.

DISCUSSION

This section aims to address both the implications and limitations of the overall study, as well as what future research can and should be done.

Implications

One such implication has to do with a shifted economical perspective when deciding which kind of fertilizer to use. Since compost performed similarly to the control group, while synthetic fertilizers reduced basil height under the conditions of the experiment, some may argue it would be economically advantageous to grow plants with natural fertilizers than with synthetic ones, even though it may cost more to purchase natural fertilizers if people do not have the time to create their own compost. On that note, as reported by the Sustainable Packaging Coalition, many cities across the United States have begun

implementing composting as a part of city recycling efforts, providing citizens with compost bins in addition to their regular trash and recycling bins to reuse food waste and other compostable materials that would have otherwise entered landfills or recycling facilities in an effort to eliminate the amount of waste entering these facilities (Composting Maps: Urban Access - Sustainable Packaging Coalition, 2023). According to the EPA, not only does this practice support the local environment, it also supports the local economy. The food scraps are composted and collected from the citizens by the city, and that compost is then sold to local farmers by the city and used to grow produce. That produce is then purchased by local citizens and the cycle continues, keeping the flow of commerce inside of the city while simultaneously boosting city revenue (Community Composting | US EPA, 2023).

With that being said, one could argue it would be equally as advantageous to not use any synthetic or natural fertilizers at all, since there was no significance between compost and the control group; however, there are other factors to consider besides plant height: nutrient benefits, disease resistance, and water retention to name a few. Compost is known to improve soil structure and to drastically increase water retention, so eliminating the use of compost entirely solely to save money could hurt the overall growth of the plants, likely reducing crop yields and possibly disrupting the global food supply chain if done on a large enough scale.

Limitations

Nonetheless, the study still has a number of limitations that are crucial to understanding the extent to which these findings can be applicable. The kind of soil, compost, and fertilizer used (see Methodology) could have had an impact on the effectiveness of the different treatments, potentially influencing the findings of the study. What's more, because the study was conducted purely using genovese basil seeds, the findings cannot be generalized for all species of basil; rather, it can only be generalizable to genovese basil seeds (see Appendix A). Following the National Library of Medicine of the National Institutes of Health, for the findings of the study to truly be reliable it should be conducted multiple times to determine how frequent these findings occur. This ensures the result of the experiment was not by chance, a fluke, or an experimental error (Science, 2019).

Lastly, the artificial indoor environment may not have adequately replicated natural growing conditions, which could have affected plant development. Although the grow light was used consistently and mirrored the amount of light exposure of natural light from the sun, its intensity differs from that of natural light, which could have made an impact on the photosynthetic productivity of the basil seeds, as a result influencing the plant height. Also, the stable temperature the basil were exposed to eliminated the natural fluctuations of the outdoors, which could have had an effect on the growth rate of some of the plants. Simultaneously, the limited air circulation indoors may have caused an increase in moisture retention that stimulated the growth of the fungi. Such growth suggests that conditions like humidity and soil moisture may not have been fully controlled, possibly introducing unintended variability across the different treatment groups.

On that note, the presence of fungi could have skewed the results, especially since the majority of the fungi grew in the soil & fertilizer group. This could have increased nutrient competition amongst the fungi and basil, impeding on the growth of the plant. Additionally, fungi have a significant impact on water retention. Generally speaking, there are two possible results on moisture levels when fungi grow into such an environment: stability or blocking. A study published to the NIH finds that fungi species like arbuscular mycorrhizal may alleviate water stress, while other species like pythium and fusarium are known to be both aggressive and destructive (Fresno et al., 2023). Since the exact species of fungi were not identified, we cannot determine with complete certainty that the fungi had a positive or negative impact on moisture levels. However, since most fungi grew in the soil & fertilizer group, which significantly underperformed the other two groups, we can assume an inverse association between fungi presence and overall plant height.

Future Research

Future researchers should seek to address these limitations in a number of ways. First, this study should be quantified to ensure its findings reliability. In addition, they should replicate this experiment on other plants, not just genovese basil seeds. This allows the findings to be generalizable to plants as a whole, determining whether this outcome is different amongst different plant varieties, and possibly why. Moreover, researchers should test different concentrations of both fertilizers, and their respective NPK ratios, and observe any impacts the change has on the findings. Furthermore, researchers should prolong the length of the study to allow time for the nutrients in the compost to be fully broken down by microbes and absorbed into the plants in order to survey any differences in growth. Also, future researchers should replicate the experiment with different kinds of soil, and determine if the kind of soil used has any impact on the effectiveness of the different fertilizers.

Additionally, to prevent the growth of fungi in future experiments, researchers should consider using a fungicide. According to the National Pesticide Information Center, fungicides are a form of pesticide that are used to “kill or prevent the growth of fungi and their spores”. They work primarily by damaging fungal cell membranes or by interfering with energy production within fungal cells (Fungicides, 2026). Consequently, the growth of the fungus is stopped entirely, thus mitigating its potential impact on the outcome of the experiment. The proposed areas of future research help add to the body of knowledge, addressing the knowledge gap on a direct comparison of the implications on plant height of synthetic and natural fertilizers.

CONCLUSION

The debate on whether the continued use of synthetic fertilizers or the application of compost is where society is and should head towards continues to intensify. This study focused on showing the impacts these two forms of fertilizers had on the height of genovese basil seeds, concluding that growing such seeds in soil containing natural fertilizers and soil without any fertilizer proved to have no statistical

difference on overall plant height, while soil containing synthetic fertilizers appeared to have reduced overall plant height. Additionally, the study discussed the implications such findings could have—like city composting efforts, as well as the extent to which these implications should be considered. Moreover, the study proposed areas which were not explored that should be introduced to the current body of knowledge to better understand the range and significance of the findings, including replication, expanding the experiment to other plants, varying concentrations of the fertilizers, prolonging the length of the experiment, etc. As discussion about our environment becomes more prevalent, so should the resources targeted to finding solutions and expanding our current understanding of the world around us.

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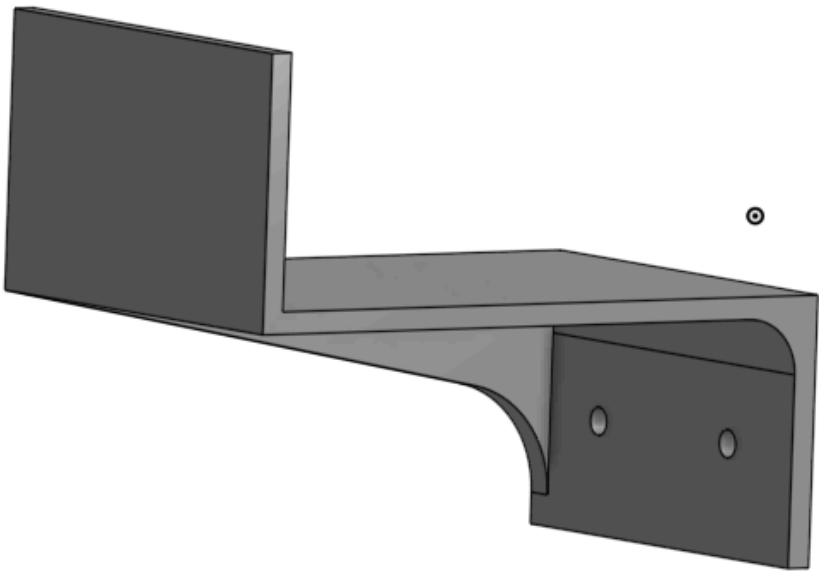
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APPENDICES

Appendix A: Experimental Setup

	Products Purchased
Compost	Texas Native Organic Compost
Synthetic Fertilizer	Dr. Earth Organic & Natural All Purpose Fertilizer
Soil	Vigoro All Purpose Garden Soil
Seeds	Back To The Roots Genovese Basil Seeds



Appendix B: Plant Height Per Seed Data

		Height (cm)		
		Soil & Compost	Soil & Fertilizer	Control Group
	Plant 1	2.9845	1.5875	3.81
	Plant 2	3.0353	2.54	3.429
	Plant 3	2.2225	3.2258	2.921
	Plant 4	2.9591	2.1209	2.9464
	Plant 5	4.4704	3.175	3.2512
	Plant 6	2.54	2.4892	2.159
	Plant 7	2.2479	2.5908	2.7225
	Plant 8	2.53492	1.9304	1.27
	Plant 9	2.286	1.6002	1.524
	Plant 10	2.9845	1.6256	1.3208
	Plant 11	2.8956	3.4036	2.1336
	Plant 12	3.048	1.9304	2.3622
	Plant 13	2.2225	2.16916	2.2352
	Plant 14	3.175	2.2225	3.4798
	Plant 15	2.54	1.143	2.5908
	Plant 16	1.905	2.3622	2.1082
	Plant 17	2.667	1.5494	2.9718
	Plant 18	2.7178	1.4732	2.2352
	Plant 19	2.54	2.1082	2.9972
	Plant 20	2.9591	1.6002	1.905
	Plant 21	2.413	1.9304	2.9718
	Plant 22	3.556	1.7018	2.0066
	Plant 23	2.6416	2.9845	1.4986
	Plant 24	2.2352	3.0226	2.9464

Plant 25	2.54	1.5875	3.2258
Plant 26	2.2479	2.3114	1.9304
Plant 27	2.9845	1.6129	4.064
Plant 28	4.318	1.6002	3.048
Plant 29	1.905	3.1242	3.302
Plant 30	2.2098	2.5146	2.1336
Plant 31	3.429	2.1082	2.5654
Plant 32	2.667	1.6002	2.2098
Plant 33	3.4798	2.2479	3.175
Plant 34	3.937	2.3368	2.0066
Plant 35	1.905	1.27	3.1496
Plant 36	2.2225	2.0066	4.445
Plant 37	1.778	2.5146	3.2004
Plant 38	3.175	1.6129	3.5306
Plant 39	3.048	1.6002	2.5146
Plant 40	3.175	1.8542	2.4638
Plant 41	1.5875	1.3208	2.0574
Plant 42	2.1971	1.9304	3.0226
Plant 43	2.2225	2.1082	4.2164
Plant 44			1.9812
Plant 45			2.9591
Plant 46			2.54
Plant 47			2.5654
Plant 48			2.9845
Plant 49			2.8702
Plant 50			3.2004
Plant 51			2.5146
Plant 52			2.159
Plant 53			2.54
Plant 54			1.9558
Average Plant Height (cm)	2.716500465	2.087171163	2.672731481

Note: The black borders around the data entries of plant height indicate the plants grew inside of the same cup/originated from the same seed.

Appendix C: Average Plant Height Per Cup Data

	Height Per Cup (cm)		
	Soil & Compost	Soil & Fertilizer	Control Group
Cup 1	2.9845	2.06375	3.81
Cup 2	2.6289	2.67335	3.175
Cup 3	2.9591	3.175	2.9464
Cup 4	3.5052	2.54	2.7109
Cup 5	2.2479	1.71873	1.3716
Cup 6	2.53492	2.667	2.1336
Cup 7	2.286	2.16916	2.3622
Cup 8	2.94005	1.90923	2.8575
Cup 9	3.048	1.5494	2.5908
Cup 10	2.2225	1.4732	2.54
Cup 11	2.8575	1.8796	2.37913
Cup 12	1.905	1.7018	2.4892
Cup 13	2.667	3.00355	2.55693
Cup 14	2.7178	1.94945	2.9972
Cup 15	2.54	1.6129	3.048
Cup 16	2.9591	2.3622	2.7178
Cup 17	2.413	2.5146	2.3876
Cup 18	3.0988	1.8542	3.175
Cup 19	2.2352	2.29235	2.0066
Cup 20	2.54	1.27	3.7973
Cup 21	2.6162	2.0066	3.2004
Cup 22	2.8109	2.5146	3.0226
Cup 23	3.048	1.60655	2.4638
Cup 24	3.7084	1.7018	2.54
Cup 25	1.905	2.1082	3.0988
Cup 26	2.0003	N/A (none grew)	2.9591
Cup 27	3.1115	N/A (none grew)	2.5527
Cup 28	2.3813	N/A (none grew)	3.01837

Cup 29	2.2098	N/A (none grew)	2.3368
Cup 30	N/A (none grew)	N/A (none grew)	2.2479
Average Plant Height	2.657995517	2.0926888	2.716441

Appendix D: Images of the Fungi

