LACATAN BANANA (*Musa acuminata colla*) PEELINGS AND SOYBEAN (*Glycine Max*) MEAL AS FERTILIZER FOR SWEET POTATOES (*Ipomea batatas*)

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CHAPTER 1

THE PROBLEM: RATIONALE AND BACKGROUND

The Philippines is primarily an agricultural country with a large portion of Filipinos residing in rural areas and supporting themselves through agricultural activities. The Philippines' biggest agricultural sub-sectors have historically been farming and fishing due to the country's topography and tropical environment. The nation's biggest crop production was of sugarcane, palay or rice, coconut, and bananas, which were also among the most popular exports (Statista Research Development, 2022)

One of the mentioned crops is the sweet potato. Sweet potatoes, locally known as “Camote,” is one of the most common foods consumed in the country. According to the survey conducted by the Statista Research Department (2022), in 2021, the Philippines' production of sweet potatoes was worth around 11.84 billion Philippine Pesos. Over the past ten years, the value of sweet potato output in the nation has been steadily rising. One of the top producers of sweet potatoes in the Asia-Pacific area is the Philippines.

Also one of the mentioned crops, people usually consume bananas. Banana peelings are usually tossed out by households after consumption. Some households dispose them in compost pits. Though, most households usually just toss them out after eating. The peelings accounts for 30% to 40% of the weight of a banana and contributes to most of the garbage created by its consumption, accounts for around 3.5 million tons of waste annually. The idea that banana peels are useless and inedible is one of the factors contributing to the trash that bananas generate (Engwing-Chow, 2022). These disposed banana peelings can be used as fertilizer for plants. Banana peelings and soybean meal can be used together as fertilizer. They have the nutrients needed for plants to grow.

The by-product of the extraction of soybean oil is soybean meal. After the oil is taken from whole soybeans, what is left is what is known as soybean meal. The primary protein supplement fed to cattle is soybean meal. The meal is often fed to pigs, beef cattle, dairy cattle, fish, and a little part even ends up as pet food. (Best Oil Mill Plant, n. d.)

The fact that soybean meal has a very high nitrogen content for an organic fertilizer—often reaching 7%—is one of its advantages. Soybean meal is a naturally slow-releasing fertilizer with a usual analysis of 7-1.5-1 (N, P, and K). Since soybean meal is not water soluble, unlike synthetic fertilizers, it does not leak and contaminate rivers (Ferguson, n. d.). Thus, with the abundance of banana peel waste, and the nutrients found in the soybean meal, the researcher chose the banana peelings and soybean meal as fertilizer for sweet potatoes.

Statement of the Problem

The main objective of this study was to determine the effectiveness of Banana Peelings and Soybean meal as fertilizer for sweet potatoes.

Specifically, this study aims to answer the following questions:

1. What was the number of sweet potato yields that were applied with:
    a. Banana Peelings and Soybean Meal?
    b. Commercial Fertilizer? and
    c. Water Only?
2. What was the mass of the yields that were applied with:
    a. Banana Peelings and Soybean Meal?
    b. Commercial Fertilizer? and
    c. Water Only?
3. Was there a significant difference on the number of sweet potato yields that were applied with:
    a. Banana Peelings and Soybean Meal;
    b. Commercial Fertilizer; and
    c. Water Only?
4. Was there a significant difference on the mass of the sweet potato yields that were applied with:
    a. Banana Peelings and Soybean Meal;
    b. Commercial Fertilizer; and
    c. Water Only?

Theoretical/Conceptual Framework

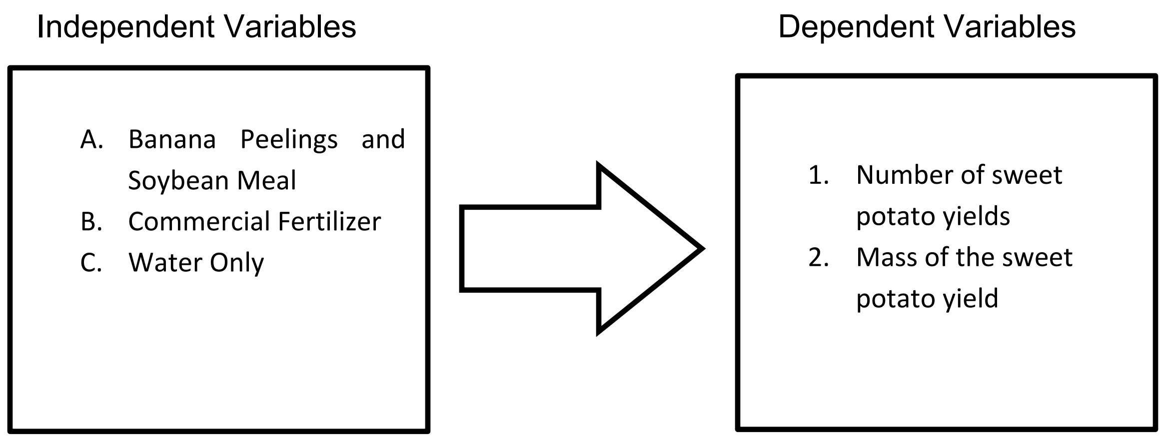

Figure 1: Paradigm of the Independent Variables and Dependent Variables on the effectivity of Banana Peelings and Soybean Meal as Fertilizer for Sweet Potatoes.

Assumptions

The following assumptions served as the basis for the study:

1. The soil where the sweet potatoes were planted was organic and not mixed with fertilizer and were of the same source.
2. The subjects used were of the same quantity and were planted at the same time span.
3. The same amount of water was watered to each plant with the same water source.
4. The amount of banana peelings and soybean meal is enough to have an effect on the plant.
5. The sweet potato plants were exposed to the same environmental conditions.

Hypotheses

The researcher has formulated the following null hypotheses:

1. There was no significant difference in the number of yields among the sweet potatoes yields that were applied with banana peelings and soybean meal, commercial fertilizer, and water only.
2. There was no significant difference in the mass among the sweet potatoes yields that were applied with banana peelings and soybean meal, commercial fertilizer, and water only.

Significance of the Study

Sweet Potatoes are a staple food to locals. Locally known as Camote, they are usually eaten as snacks or meals. While Soybean Meal is a popular feed for livestock, it has a potential to be an effective alternative to commercial fertilizer. Tossed banana peelings can also be used as an alternative to commercial fertilizer. Thus, this study can benefit the following:

Farmers. Some farmers use soybean meal to feed animal livestock. Since soybean meal is already used for livestock feed, farmers can utilize the surplus and unused soybean meal for fertilizer. Since banana peelings and soybean meal are organic, they would not have to worry about soil damage unlike the chemically made commercial fertilizer.

Soybean Farmers. Aside from just animal feeds, they can supply farmers with soybean meal for an organic fertilizer. They can also reuse the by-product of the extraction process to use as fertilizer for their soybeans.

Gardeners. For gardeners who prefer using organic fertilizers, using soybean meal can be an inexpensive alternative to commercial fertilizers. Disposed banana peelings can also be used.

Future Researchers. They will be encouraged to find alternatives to commercial fertilizers. They will also be encouraged to test soybean meal on other plants.

Scope and Limitations of the Study

This study was conducted at Tagbilaran City Science High School and the experimentation was done at Purok 2, Totolan, Dauis, Bohol.

This study was made to determine the effectiveness of banana peelings, specifically lakatan bananas and soybean meal as a fertilizer for sweet potatoes, specifically the Yam or locally known as Camote variant.

Nine sweet potatoes were planted into nine separate pots. Each set-up had three pots, set-up A treated with banana peelings and soybean meal, set-up B treated with commercial fertilizer, and set-up C treated with only water.

Each set-up was watered every day once at the same time. The sweet potatoes were planted with 20 centimeters of soil depth. The sweet potatoes were not treated during the first month to ensure their growth. After four weeks, the sweet potatoes were treated with the corresponding treatments. The treatments were reapplied every two weeks. After 16 weeks, the sweet potatoes were harvested and weighed in a weighing scale, the number of sweet potato yields were also counted. The duration of the experiment was sixteen weeks.

The data collected was the mass of the sweet potato yields in grams, and the number of yields per pot. The data was applied with statistical treatments, specifically One-Way Analysis of Variance (ANOVA) and Tukey Honestly Significant Difference (HSD) Test.

Definition of Key Terms

To provide an understanding of the study, the following terms will be defined as they were used in the study:

Banana peelings. The experimental treatment used in the study. The peeled-off skin of a banana. Usually yellow, it is the protective layer of the flesh of the banana.

Commercial Fertilizer. Chemically produced and inorganic fertilizers that improves plant growth.

Fertilizer. A treatment used to increase the growth of the sweet potato plants.

Mass. The weight of the sweet potato yields in grams.

Soybean meal. The experimental treatment used in the study. The by-product of the extraction of soybean oil. Light brown color with an irregular shape and a granular to flaky texture.

Sweet potato yields. The crops that the sweet potato grew.

Chapter 2

Review of Related Literature

Plate 2.1: Banana

The banana (*Musa acuminata*) is an elongated, edible fruit – botanically a berry–produced by several kinds of large herbaceous flowering plants in the genus Musa. The banana, which is cultivated in the tropics, is widely consumed there as well as in the temperate region, where it is prized for its flavor, nutritional content, and consistent availability. The Cavendish dessert banana is the kind that non-tropical nations most frequently import even though hundreds of variants are grown as a staple food source in tropical areas. The ripe fruit is low in protein and fat and abundant in potassium, vitamins C and A, and carbs (mostly sugar). Bananas may be cooked, though they are typically eaten raw. (Encyclopaedia Britannica, 2023)

Table 2.1: Banana nutrients per 225g

Nutrition Facts	
Portion Size	**225 g**
Amount Per Portion **Calories**	**200**
	% Daily Value *
Total Fat 0.7g	**1 %**
Saturated Fat 0.3g	**2 %**
Sodium 2.3mg	**0 %**
Total Carbohydrate 51g	**19 %**
Dietary Fiber 5.9g	**21 %**
Sugar 28g	
Protein 2.5g	**5 %**
Vitamin D 0mcg	0 %
Calcium 11mg	1 %
Iron 0.6mg	3 %
Potassium 806mg	17 %

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contribute to a daily diet. 2000 calories a day is used for general nutrition advice.

Source: (NutritionValue, n.d.)

A banana peel or banana skin is the outer cover of the banana. Banana peels has one of the highest organic sources of potassium(K). It contains 42% potassium (K), one of the three major components of fertilizer, along with nitrogen (N) and phosphorus (P) (Barbano, 2020).

An organic fertilizer that can supply nutrients to your indoor or outdoor plants is banana peel fertilizer. Numerous nutrients included in banana peels help plants grow strong. By aiding in the breakdown of soil nutrients and their distribution throughout the plant's system, the element calcium aids plant development. Magnesium, a key element in plant photosynthesis, magnesium helps plants use the sun's energy by assisting in the process of photosynthesis. Phosphorus, this mineral helps plants grow stronger stems and roots and promotes the development of floral buds and pollen. A crucial mineral for plants, potassium aids in the regulation of enzymes and the distribution of nutrients throughout plant systems. Additionally, it promotes stronger stems and new development (MasterClass, 2021).

Tubers are a group of plants having underground stems or side roots that have tubers that are used for food, fodder, or as raw materials for manufacturing. Most root crops come from different families and are often native to the tropics.

Root crops needs well-drained, loose soil to expand their roots. Removing sticks, stones, lumps of clay and soil can help provide space for the roots to grow. Root crops forms taproots that tunnel into the soil. Limit the treatment of nitrogen fertilizers as it can cause hairy roots or lush green tops but small roots. Water the soil bed deeply regularly rather than shallow watering. This encourages bigger and longer roots (Nardozzi, 2021).

Tubers are usually short and thickened, developing below the earth. They represent different plants' resting stages and allow many species to overwinter. They are mostly made up of starch-storing parenchyma tissue. Most tubers have modified stems that sprout tiny scale leaves, each of which has a bud that may grow into a new plant. The Jerusalem artichoke and the potato are examples of common tubers (Encyclopaedia Britannica, 2019).

Sweet potatoes are widely cultivated in tropical and warm climates. Sweet potatoes usually have a long and trailing stem and have lobed or unlobed leaves. Roots' colors ranges from white to orange and from light buff to

Plate 2.2: Sweet Potatoes

brown and purplish red outside. The edible part is the tuberous root that varies in shape, from fusiform to oblong or pointed oval (Encyclopaedia Britannica, 2022).

Sweet potatoes are nutritious. It packs a good amount of vitamin A, vitamin C and manganese into a serving. They also have anti-cancer properties and promotes immune functions, gut health, brain function, and eye health (Julson, 2022).

This tropical crop is heat and drought-tolerant and has few pests or illnesses, although it does require at least four months of warm weather and warm soil. There are now several short-season types of sweet potatoes, even though they are typically more of a Southern crop. When cultivated in sandy soil or raised beds with a black plastic mulch to keep the soil warm, they can be grown in the North (Boeckmann, 2023).

Although sweet potatoes may be grown in any outdoor space, it should be noted that they thrive best in sunny vegetable gardens and can take 85 to 120 days to completely develop. Sweet potatoes will thrive in poor soil, but in thick clay or long, stringy sand, malformed roots may emerge. Utilize a lot of compost and stay away from nitrogen-rich fertilizers that result in luxuriant vines and twisted tubes. To maintain the soil's warmth and encourage robust development in the North, cover the elevated rows with black plastic. Provide 1 inch of water once per week in dry conditions up until two weeks before harvesting; after that, allow the soil to gradually dry out. Avoid overwatering plants since they can endure dry spells better than wet ones and might decay (Thomas, 2023).

The soybean meal is a byproduct of the extraction of oil from the soybeans. It contains a large amount of protein. It is commonly used to feed livestock animals due to its high protein count. Early in the 20th century, scientists began investigating soy's potential as a source of protein and oil outside of pasture. New technology and processing techniques enhanced the quality of soy byproducts, making the meal safer for animals to ingest as domestic soybean output increased (Anderson International Crop, 2023).

Plate 2.3: Soybean Meal

Tofu, candles, and other goods may all be made from soybean meal, a byproduct of the soybean plant. The extraction of soybean oil results in the production of soybean meal. When soybean meal decomposes, its organic materials produce a great deal of nitrogen. Nitrogen (N) is essential for vitality. Soybean meal helps infuse the soil with the necessary nitrogen for crop growth (Smyth, 2022). To extract the oil from the soybeans, they are crushed, cooked, and dried; the resulting solid residue is called soybean meal. It often has a golden or brown tint. The fact that soybean meal has a very high nitrogen content for an organic fertilizer—often reaching 7%—is one of its advantages. Soybean meal is a naturally slow-releasing fertilizer with a typical analysis of 7-1.5-1 (N, P, K). One to two pounds per 100 square feet of garden are usually used. Since it releases nutrients gradually, a lot of gardeners favor it. It just has to be applied once a year. Since soybean meal is not water soluble, unlike synthetic fertilizers, it does not leak and contaminate rivers (Ferguson, n. d.).

Commercial fertilizers are fertilizers that are chemically manufactured. The three essential plant nutrients nitrogen, phosphorus, and potassium are included in many fertilizers that are often used in agriculture. Certain "micronutrients," like zinc and other metals, that are essential for plant growth are also present in some fertilizers. Commonly referred to as "soil amendments," these substances are used on the land primarily to improve the characteristics of the soil (rather than as plant food) (EPA, 2022).

The most typical issue with commercial fertilizers is the overapplication of nitrogen, which is sometimes referred to as "toxic nitrogen overload." Commercial fertilizers may burn plants when used excessively, which actually lowers the soil's production. Additionally, they may run off into water sources and harm the environment, and prolonged exposure to them may be unhealthy for people. Commercial fertilizers lower farmer profitability since they are also pricey (BioWash, n. d.).

Nitrogen (N) is a crucial component of amino acids, which serve as the building blocks for enzymes and proteins in plants. All living things are made of proteins, and enzymes help with the enormous variety of biochemical processes that take place within a plant. Additionally, nitrogen is a part of the chlorophyll molecule, which helps plants use photosynthesis to absorb solar energy, promoting plant growth and crop output. To guarantee that energy is accessible when and where the plant needs it to maximize output, nitrogen plays a crucial role within the plant. Even the roots contain this essential vitamin because proteins and enzymes control water and nutrient intake (KOCH, n. d.).

Phosphorus (P) plays a crucial role in plants' ability to absorb, store, and transform solar energy into biomolecules like adenosine triphosphate (ATP), which power biological activities like photosynthesis from seed to mature grain. Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), which provide instructions on how plants should carry out normal tasks including synthesizing proteins, lipids, and nucleic acids, as well as metabolizing carbohydrates, include phosphorus. Phosphorus enhances tillering, encourages early root development, winter hardiness, and seed production, and improves water usage efficiency (Chakraborty & Prasad, 2021).

Potassium (K) is involved in the flow of water, minerals, and carbohydrates. It has a role in the plant's enzyme activation, which has an impact on the synthesis of protein, starch, and adenosine triphosphate (ATP). The rate of photosynthesis can be controlled by ATP synthesis. Additionally, potassium aids in controlling the stomata's opening and shutting, which controls the exchange of water vapor, oxygen, and carbon dioxide. Lack of or inadequate potassium supply will impede plant development and lower output (Kaiser, D. & Rosen, C., 2018).

Table 2.3: Guaranteed Analysis of Commercial Fertilizer

Total Nitrogen (N)*		14.00%
	Ammoniacal Nitrogen	5.52%
	Urea Nitrogen	6.48%
Available Phosphate (P205)**		14.00%
Potassium (K)**		14.00%
Sulfur (S) Total		3.26%
	Combined Sulfur	3.26%
Iron (Fe)		0.45%
	Water Soluble Iron (Fe)	0.04%
Manganese (Mn)		0.45%
	Water Soluble Manganese (Mn)	0.04%

Source: LESCO PROFESSIONAL LANDSCAPE AND ORNAMENTAL ALL-PURPOSE FERTILIZER

RELATED STUDIES

The results of the study "Effect of Vine Cutting Length and Potassium Fertilizer Rates on Sweet Potato Growth and Yield Components" conducted by Dumbaya, G. et al (n. d.) showed that although there was no significant increase in the overall number of roots, the total number of marketable and non-marketable roots, or the non-marketable roots yield, potassium fertilizer rates had a significant impact on the yield of roots and marketable roots. This shown that although the size of sweet potato roots is increased when potassium fertilizer is applied, the number of tuber roots is not increased. The positive effect of K in activating more than 60 enzymes required for vital plant activities such energy use, starch synthesis, N metabolism, and respiration may be the cause of the considerable response indicated by some of these yield components. The outcome demonstrates that potassium fertilizer boosts sweet potato output by encouraging the growth of big tuber roots.

A study conducted by Ekwere and Efretuei (2021) on “Substituting NPK Fertilizer with Soybean Meal Can Increase Okra Yield in a Humid Tropical Environment” where they tested soybean meal as fertilizer in a humid tropical environment, the soil at the test site was acidic (pH 5.32), which is typical of soils in Nigeria's rainforest region. In comparison to the levels necessary for soils in this ecological zone, the organic matter content of the soil (1.42%), nitrogen (0.12%), and potassium (0.136) levels were all below average. These findings point to the necessity of boosting soil nutrients using SBM and NPK 20:10:10. on contrast to soils with highly large nutrient stores, crops react better to fertilizer application on soils with very low nutrient levels. The positive effect of fruit output to greater rates of SBM is confirmed by the rise in fruit yield with increasing SBM rate. According to the findings of the two-year study, SBM applied between 9 and 12 tons/ha at precisely the right time to coincide with plant nutrient absorption can boost production to as much as 4 tons/ha. The enhanced vegetative development during the growing season seen at higher rates of SBM is probably the cause of the linear response of fruit production to SBM rates. SBM has a significant nitrogen concentration, along with cottonseed, rapeseed, and sunflower seed oil. It has been noted that increasing the nitrogen supply to okra increases fruit and vegetative output. In conclusion, higher SBM rates were related to higher fruit production, higher plant height, and fewer days to 50% blooming. SBM is an appropriate substitute for inorganic fertilizers for producers looking to boost yields and produce organic okra. This means that soybean meal has enough nutrients, with a high nitrogen concentration, for plant growth.

Similarly, from a study conducted by Khairnar and Nair (2019) on “Eggshells and Fruits Peels as Fertilizer” showed that the eggshell is less acidic than bananas, according to tests on sample pH levels. Because citric acid is readily available, sweet limes are acidic. We can control the quantity of eggshell and fruit peel powder necessary for a given soil by experimenting with eggshell, sweet lime peel, and banana peel formulation for pH testing. Eggshell is a rich source of calcium, which regulates a variety of biochemical and metabolic processes. According to CHNS research, banana peel has more hydrogen than the other samples whereas sweet lime has a higher availability of nitrogen and carbon. This experiment has shown that fertilizer may be made from eggshell powder, sweet lime peel powder, and banana peel powder. Since these samples of organic waste were taken from household waste, none of the three powders are cost-bearing. It was found that banana peel powder, together with eggshell powder and sweet lime peel powder, had the nutrients needed for plant growth.

CHAPTER 3

METHODOLOGY

This chapter describes the research approach used in this study. The purpose of this study was to determine the effectiveness of banana peelings and soybean meal as fertilizer for sweet potatoes.

A. Research Design

This study used the Random Design. The experiment investigates the effect of Banana Peelings and Soybean Meal on the mass of the sweet potato yield. There were three replications per treatment, Trials 1, 2, and 3.

B. Subject of the Study

The subjects used were from the common variety of sweet potatoes, locally known as Camote. In the experiment, nine sweet potatoes were planted in pots. Three pots were randomly assigned to each treatment and named Trials 1, 2, and 3.

C. Sampling Technique

The sweet potato pots were randomly assigned for each treatment by using a random number generator. Pots labeled ‘A’ were treated with Banana Peelings and Soybean Meal, ‘B’ were treated with commercial fertilizer, and ‘C’ received water only. The pots were then labeled A1, A2, A3, B1, B2, B3, C1, C2, C3.

D. Research Instrument to Be Used

The main instrument used was the Experimental Approach. Tabular format was used to record the collected data. The data collected was inputted in the corresponding tables. The table designed had the first column assigned with the Setups (Setup A, B, C) with the trials in the second column. The third column had the average mass of the sweet potato yields per trial. The fourth column had the average mass per setup. This table was used for the data of the mass of the yields. A similar table was used for the number of sweet potato yields. The mass and the number of sweet potato yields were recorded in the data table. The instrument used to determine the mass of the sweet potato yields was a weighing scale. The sweet potato yields were counted manually.

E. Procedure of Data Gathering

The experiment was carried out by using banana peelings and soybean meal, commercial fertilizers, and water only as treatments. A total of nine pots were used in this study. No treatments were added during the first four weeks of the experiment but were watered daily. After four weeks, the treatments were added to their corresponding setups. The plants were randomly assigned to the three setups. Treatments were reapplied every two weeks. After 16 weeks of the experimentation, the sweet potato plants were dug and harvested. The sweet potatoes were counted and then weighed, and the mass were recorded in grams using a digital weighing scale.

F. Statistical Treatment

One-Way ANOVA was used to determine the significant difference of the mass of the sweet potato yields of the three treatments. The computed f statistic was checked against the Table of Significant Values to verify its significant difference at 0.05 level.

Tukey's Honestly Significant Difference (HSD) Test was used when an Analysis of Variance (ANOVA) gives a significant result, this indicates that at least one setup differs from the other groups. The Tukey Test was used to determine the significant difference between two treatments.

G. Collection of Materials

Soybean meal were gathered from the market. The Banana Peelings were peeled from lacatan bananas bought from the local market. The commercial fertilizer was bought from the local market. The sweet potatoes planted were bought from the local market. The nine pots were purchased from the local supermarket. The containers used were collected from the residence.

H. Preparation of Treatment

The banana peelings were collected from eaten bananas. They were washed using water then left to air dry for a day. The banana peelings and soybean meal were weighed to the corresponding amount to treat the experimental setup.

I. Procedure

Phase I

The sweet potatoes were planted in different pots. No treatments were added during the first 4 weeks of the experiment. The sweet potatoes were planted with 20 centimeters of soil depth. The pots were equally spaced from each other in each setups.

Phase II

After four weeks, the treatments were added to each setup. Every four weeks, the treatments were added again to maintain the nutrients.

The Control setup was only given water for the whole duration of the experiment. The commercial fertilizer setup was given 75g of 14-14-14 NPK commercial fertilizer for every trial. The experimental setup was given 60g of soybean meal and 15g of banana peelings for each trial. The treatments were scattered on each pot, then the trials were watered.

Phase III

No treatments were added three weeks before the end of the experiment. After 16 weeks, the sweet potatoes were harvested and weighed. The mass was recorded in grams using a weighing scale. The number of yields were counted in each trial. The sweet potatoes were then stored in their corresponding containers.

J. Disposal

The materials used in the study were disposed properly. The yields were washed and stored to be consumed. The water was reused for other pots of plants. The pots used were stored to be used for other plants. The commercial fertilizer was stored to be used for other plants. The containers were washed and reused for reuse. The weighing scale was stored for reuse.

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter shows the results of the experiment and the analysis done. The results are presented through tables.

Table 4.1: Number of Sweet Potato Yields After Being Treated with The Varied Setups

Setups	Trials	Number of Yields	Total	Average
Banana peelings and soybean meal	1	2	7	2
	2	2		
	3	3		
Commercial fertilizer	1	2	4	2
	2	2		
	3	2		
C	1	1	3	1
	2	1		
	3	1		

Table 4.1 shows the number of sweet potato yields per trial treated with banana peelings and soybean meal, commercial fertilizer, and water only. The trials 1 to 3 in banana peelings and soybean meal had a number of two (2) yields, two (2) yields, and three (3) yields respectively. The average number of yields for setup A was 2 (two) yields. The number of sweet potato yields in commercial fertilizer had two (2) yields in each trial, having an average of two (2)

yields The trials in water only had one (1) yield in each trial, having an average of one (1) yield.

Banana peelings and soybean meal was observed to have the highest number of yields among the three setups, with the total of seven (7) yields, averaging 2.33 per trial. Followed by commercial fertilizer with a total of six (6) yields and an average of two (2) yields per trial. Lastly, the group with the least observed number of yields was water only, with a total of three (3) yields having an average of one (1) yield per trial. Statistical treatments were then applied to the data.

Table 4.2: One Way Analysis of Variance on the Number of Yields of Sweet Potatoes.

Source	Sum of Squares	Degrees of freedom	Mean Square	F-Statistic	F-Critical	P-value
Treatment	2.8889	2	1.4444	13.0000	5.14	0.0066
Error	0.6667	6	0.1111			
Total	3.5556	8				

Table 4.2 shows the One-Way Analysis of Variance on the Mass of Yields of the sweet potatoes after being treated with banana peelings and soybean meal, commercial fertilizer, and water only. The result showed the computed F-statistic value of 13.0000 which was greater than the F-critical value of 5.14 at 0.05 level of significance, indicating that there was a significant difference among the number of sweet potato yields treated with banana peelings and soybean meal, commercial fertilizer, and water only. Each setup

was compared, the Tukey HSD Test was used to check the setups that were significantly different from each other.

Table 4.2.1: TUKEY HSD Test Summary for Number of Yields of Sweet Potatoes.

Treatments Pair	Tukey HSD Q Statistic	Tukey HSD Q Critical	Tukey HSD interference
Water Only vs Commercial Fertilizer	5.1962	4.3341	significant
Water Only vs Banana Peelings and Soybean Meal	6.9282		significant
Commercial Fertilizer vs Banana Peelings and Soybean Meal	1.7321		insignificant

Table 4.2.1 shows the Tukey HSD Test Summary for Numbers of Yields of the sweet potatoes after being treated with banana peelings and soybean meal, commercial fertilizer, and water only. The results showed that the water only vs Commercial Fertilizer group showed a significant difference with the q-statistic value of 5.1962 greater than the q-critical value of 4.3341 at 0.05 level of significance. The water only group was not treated with any treatments that the plant needed to increase growth. However, the commercial fertilizer group had a significantly higher mass because the nutrients from the commercial fertilizer increased the growth of the sweet potato plants. Specifically, the nutrients Nitrogen (N), Phosphorus (P), and Potassium (K). Meanwhile, the water only group did not have enough nutrients that can increase the plant growth.

Similarly, the results showed the water only vs Banana Peelings and Soybean Meal group showed a significant difference with the q-statistic value of 6.9282 greater than the q-critical value of 4.3341 at 0.05 level of significance. The water only group was not treated with any treatments that the plant needed to increase the yields. The Banana Peelings and Soybean Meal group had the nutrients which the plant needed to increase growth. Banana peelings and soybean meal had enough nutrients to be effective as a fertilizer for sweet potatoes. The banana peelings had a high amount of potassium, and the soybean meal had the nutrients needed such as nitrogen, phosphorus, and potassium. Meanwhile, the water only group did not have enough nutrients that can increase the plant growth.

The results showed the Commercial Fertilizer vs Banana Peelings and Soybean Meal group showed an insignificant difference with a q-statistic value of 1.7321 lower than the q-critical value of 4.3341 at 0.05 level of significance. The commercial fertilizer and the banana peelings and soybean meal had no significant difference on mass of the yields. Since they both have the nutrients needed for plant growth and yield, namely Nitrogen (N), Phosphorus (P), and Potassium (K).

Table 4.3: Mass of Sweet Potato Yield of the Different Setups (in grams)

Setups	Trials	Average mass of Sweet Potato Yield	Total Mass	Average
Banana peelings and soybean meal	**1**	80	252.5	84.17
	2	109		
	3	63.5		
Commercial fertilizer	**1**	84	206	68.67
	2	74		
	3	48		
Water Only	**1**	25	74.5	24.83
	2	23		
	3	26.5		

Table 4.3 shows the mass of the sweet potato yields in each trial per setup. The trials 1 to 3 in banana peelings and soybean meal obtained a mass of 80g and 109g, 63.5g respectively, with an average mass of 84.17g. The trials 1 to 3 in commercial fertilizer obtained a mass of 84g, 74g, 48g respectively, with an average mass of 68.67g. Lastly, the trials 1 to 3 in water only obtained an average mass of 25g, 23g, and 26.5g respectively, with an average mass of 24.83g.

Setup C treated with banana peelings and soybean meal was observed to have the highest average mass out of the three setups with an average of 84.17g. Followed by Setup B with an average of 68.67g, then setup A with an average of 24.83g. Statistical treatments were then applied to these data.

Table 4.4: One Way Analysis on the Mass of Yields

Source	Sum of Squares	Degrees of Freedom	Mean Square	F-statistic	F-critical	P-value
Treatment	5,701.1667	2	2,850.5833	9.6666	5.14	0.0133
Error	1,769.3333	6	294.8889			
Total	7,470.5000	8				

Table 4.4 shows the One-Way Analysis on the Mass of Yields of the sweet potatoes. The result showed the computed F-statistic value of 9.6666 which was greater than the F-critical value of 5.14 at 0.05 level of significance, indicating that there was a significant difference among the mass of the sweet potato yields treated with banana peelings and soybean meal, commercial fertilizer, and water only. Next, each setup was compared, the Tukey HSD Test was used to check the setups that were significantly different from each other.

Table 4.4.1: TUKEY HSD Test Summary for Mass of Yields

Treatments Pair	Tukey HSD Q Statistic	Tukey HSD Q Critical	Tukey HSD interference
Water Only vs Commercial Fertilizer	4.4548	4.3341	significant
Water Only vs Banana Peelings and Soybean Meal	5.9845		significant
Commercial Fertilizer vs Banana Peelings and Soybean Meal	1.5298		insignificant

Table 4.4.1 shows the Tukey HSD Test Summary for Mass of Yields of the sweet potatoes. The results showed that the water only vs Commercial Fertilizer group showed a significant difference with the q-statistic value of 4.4548 greater than the q-critical value of 4.3341 at 0.05 level of significance. The water only group was not treated with any treatments that the plant needed to increase growth. However, the commercial fertilizer group had a significantly higher mass

because the nutrients from the commercial fertilizer increased the growth of the sweet potato plants. Specifically, the nutrients Nitrogen (N), Phosphorus (P), and Potassium (K).

Similarly, the results showed the water only vs Banana Peelings and Soybean Meal group showed a significant difference with the q-statistic value of 5.9845 greater than the q-critical value of 4.3341 at 0.05 level of significance. The control group was not treated with any treatments that the plant needed to increase growth. The Banana Peelings and Soybean Meal group had the nutrients which the plant needed to increase growth. Banana peelings and soybean meal had enough nutrients to be effective as a fertilizer for sweet potatoes. The banana peelings had a high amount of potassium, and the soybean meal had the nutrients needed such as nitrogen, phosphorus, and potassium.

The results showed the Commercial Fertilizer vs Banana Peelings and Soybean Meal group showed an insignificant difference with a q-statistic value of 1.5298 lower than the q-critical value of 4.3341 at 0.05 level of significance. The commercial fertilizer and the banana peelings and soybean meal had no significant difference on mass of the yields. Since they both have the nutrients needed for plant growth, namely Nitrogen (N), Phosphorus (P), and Potassium (K).

Since the results showed that the water only group, and the Banana Peelings and Soybean Meal had a significant difference in terms of the mass and the number of sweet potato yields. It is an effective fertilizer for sweet potatoes. Additionally, the Commercial Fertilizer group, and the Banana Peelings and Soybean Meal group had no significant difference in terms of mass and the number of sweet potato yields. Thus, Banana Peelings and Soybean Meal can serve as an alternative to commercial fertilizer.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was conducted to investigate the effectivity of banana peelings and soybean meal as fertilizer for sweet potatoes.

Table 4.1 shows the number of the sweet potato yields of the different treatments after 16 weeks of experimentation. Banana peelings and soybean meal was observed to have the highest number of yields among the three setups, with a total of seven (7) yields, averaging 2.33 yields per trial. Followed by commercial fertilizer with a total of six (6) yields and an average of two (2) yields per trial. Lastly, the group with the least observed number of yields was water only, with a total of three (3) yields having an average of one (1) yield per trial.

Table 4.2 shows the results of One-Way Analysis on the mass of the sweet potatoes yields. The results showed the computed F-statistic value of 13.0000 which was greater than the F-critical value of 5.14 at 0.05 level of significance, indicating that there was a significant difference among the mass of the sweet potato yields among the three setups.

Table 4.2.1 shows the results of the Tukey HSD Test Summary for the number of the sweet potato yields. It showed that the commercial fertilizer and banana peelings and soybean meal group had a calculated q-statistic of 1.7321 which is lesser than the q-critical value of 4.3341 at 0.05 level of significance. This means that the two set-ups had an insignificant difference on the mass of the okra fruits. It also showed that the water only and the banana peelings and soybean meal group had a calculated q-statistic of 6.9282, and that the water only and the commercial fertilizer group had a calculated q-statistic of 5.1962. The two calculated q - value are greater than the q-critical value of 4.3341 at 0.05 level of significance. Which means that the two pairs had a significant difference on the number of the sweet potato yields.

Table 4.3 shows the mass in grams of the sweet potatoes of the different treatments after 16 weeks of experimentation. The sweet potatoes in treated with banana peelings and soybean meal, trial 1 had a mass of 80g, trial 2 had a mass of 109g, and trial 3 had a mass of 63.5g. The average mass of the sweet potatoes was 84.17g. The sweet potatoes were treated with commercial fertilizer, trial 1 had a mass of 84g, trial 2 had a mass of 74g, and trial 3 had a mass of 48g. The average mass of sweet potatoes was 68.67g. Lastly, the sweet potatoes in water only, trial 1 had a mass of 25g, trial 2 had a mass of 23g, and trial 3 had a mass of 26.5g. The average mass of the sweet potatoes was 24.83g. Based on these results, the sweet potatoes in Setup C had the highest average mass among the three Setups.

Table 4.4 shows the results of One-Way Analysis on the mass of the sweet potatoes yields. The results showed the computed F-statistic value of 9.6666 which was greater than the F-critical value of 5.14 at 0.05 level of significance, indicating that there was a significant difference among the mass of the sweet potato yields among the three setups.

Table 4.4.1 shows the results of the Tukey HSD Test Summary for the mass of the sweet potato yields. It showed that the commercial fertilizer and banana peelings and soybean meal group had a calculated q-statistic of 1.5298 which is lesser than the q-critical value of 4.3341 at 0.05 level of significance. This means that the two set-ups had an insignificant difference on the mass of the okra fruits. It also showed that the water only and the banana peelings and soybean meal group had a calculated q-statistic of 5.9845, and that the water only and the commercial fertilizer group had a calculated q-statistic of 4.4548. The two calculated q - value are greater than the q-critical value of 4.3341 at 0.05 level of significance. Which means that the two pairs had a significant difference on the mass of the sweet potato yields.

Conclusions

The Tukey HSD Test revealed that banana peelings and soybean meal are an effective organic fertilizer for sweet potatoes and an alternative to commercial fertilizer. The banana peelings and soybean meal have a significantly higher average mass and sweet potato yields than the water only group. The water only group had no nutrients that was essential to increase the plant growth.

Banana peelings and soybean meal can be an organic fertilizer because they have the nutrients necessary to increase plant growth.

The commercial fertilizer, and the banana peelings and soybean meal treatment had a minimal difference in the mass of the sweet potato yield. Therefore, banana peelings and soybean meal can be an organic alternative to commercial fertilizers.

Recommendations

The researcher recommends the application of banana peelings and soybean meal on other types of plants, aside from tubers, to further determine their effectivity. Non-tubers are recommended, tomatoes and eggplants, for example.

Using other variants of bananas and soybeans as treatments. Similarly using other types of sweet potatoes or potatoes. The researcher also recommends having more trials to have more data to be collected. Lastly, the researcher recommends planting the sweet potatoes in bigger pots or sacks, or in an open field.

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APPENDICES

APPENDIX A

Preparation of the Materials and Equipment

Plate A.1: Weighing Scale

Plate A.2: Plastic Pot

Plate A.3: Soybean Meal

Plate A.4: Banana peelings

APPENDIX B

Setups

Plate B.1: Setup C

Plate B.3: Setup B

Plate B.2: Setup A

APPENDIX C

Sample Number of Sweet Potato Yields

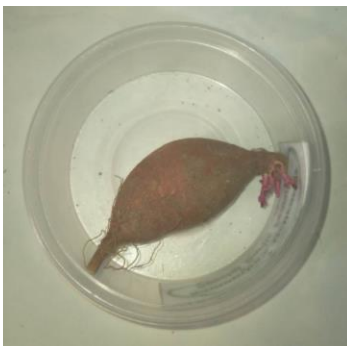

Plate C.1: Sample Yields of Setup C

Plate C.2: Sample Yields of Setup B

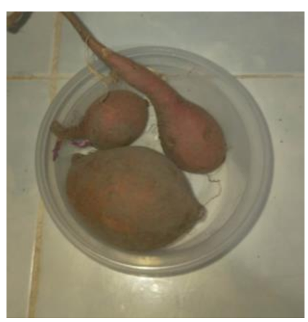

Plate C.3: Sample Yields of Setup A

APPENDIX D

Sample Mass of Sweet Potato Yields

Plate C.1: Sample Mass of Setup C

Plate C.2: Sample Mass of Setup B

Plate C.3: Sample Mass of Setup A