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The Effect of Complete Fertilizer towards the Chemical Composition of Different Types of Soil

Submitted to
Sir Fritz Ferran

In partial fulfillment of the requirements for
Research 3: Scientific Research

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CHAPTER 1: BACKGROUND OF THE STUDY

I. Introduction

On September 25, 2015, countries who are part of the United Nations (UN) all adopted “a set of goals to end poverty, protect the planet, and ensure prosperity for all”, as part of their sustainable development goals. Each goal is targeted to resolve a certain issue in the next 15 years. Among these goals is “Life on Land”, wherein it aims to preserve life on and in the surface of the Earth, whether it is the flora or fauna of the land, promote the sustainable management of forests, and reduce the degradation of and conserve natural habitats and ecosystems. As stated by The Department of Economic and Social Affairs of United Nations (2015), Life on Land is the 15th sustainable goal that is for the promotion of the ecosystems around the world. Implementation of proper management and restoration of damaged land forms fall under this sustainable goal. As stated by, Lubchenco, J, Melillo, J.M. et al. (1997). Around one third and one half of the landforms found on earth has been transformed from human action, considering that the concentration of carbon dioxide increased around roughly 30 percent since the start of the industrial revolution. From the the book*, Assessing Biofuels*, Bringezu, S. et al. (2009) indicated the many efficient and sustainable ways leading to the reduction of environmental pressures. Considering the following, improve the production of biomass and consider different energy supply systems.

As stated by The Department of Economic and Social Affairs of United Nations (2015), the 12th sustainable goal, Responsible Consumption and Production, follows through all countries taking action. Specifically for developed countries to lead and assist developing countries, enhancing the capabilities of these countries. Achieve a sustainable management of natural resources and reduce waste generation through following proper practices, reuse, reduce and recycle. Further components under this sustainable goal includes, to ensure that people are aware of relevant information about sustainable lifestyle and development, to support developing countries in regards to strengthening their scientific and technological capacity and to implement certain tools that will lead to sustainable tourism.

The reasons behind the addition of this goal to the overall agenda can be briefly explained through statistics (United Nations Development Programme, n.d.):

1. From 1998 to 2013, approximately one fifth of the world's land covered in vegetation shows persistent declining trends in terms of productivity.
2. Forests are home to more than 80 percent of all terrestrial animals and plants.
3. 2.6 billion people depend directly on agriculture, but 52 per cent of the land used for agriculture is affected by soil degradation.
4. Arable (farmable) land loss is estimated to be at 30 to 35 times the historical rate.

From these numbers, it can be seen that improving the quality of the world's land is vital in attaining part of the Sustainable Development goals. As previously mentioned, one reason as to why there is a deficiency in agriculture is due to the degrading quality of the land. As demands for natural resources from the land increase, more space is required. To help remedy the lowered quality of soil that comes with high demands, some farmers apply artificial fertilizer on their lands, as this has procures immediate effects (The Effects of Synthetic Fertilizers, n.d.). However, this comes with potential adverse effects on both the soil and organisms living in or on it. The use of inorganic fertilizer is known to deplete carbon, nitrogen, and phosphorus levels, elements essential in proper plant growth (Ayoola, Olukemi, & Titilola, 2006). It also increases the amount of acidic and insoluble matter absorbed by plants (Basri, M. H. A., et al, 2013).

Soil is defined as a complex mixture of minerals, elements (water, air, etc.), and organic matter and organisms (Soil Science Society of America, n.d; Paul, 2015.). It forms the surface of the earth, and serves as the medium of growth for plants. It is essential in many ecological functions, such as:

1. Absorption, purification, and filtration of water.
2. Modification of atmosphere via multiple gas cycles.
3. Recycling of nutrients.

Soil is made up of primary micronutrients and secondary micronutrients. Primarily, it is composed of nitrogen, phosphorus and potassium, with additional components being calcium, magnesium and sulfur, all of which are necessary nutrients for both plants and soil microorganisms. The soil may also contain boron, copper, iron, chlorine, molybdenum, manganese, and zinc, which act as sources of additional sustenance.

In this study, the researchers will explore the chemical components of synthetic fertilizer, and observe how these components affect the composition, quality, and fertility of soil. Additionally, it will differentiate the aforementioned effects of synthetic fertilizer on the three different types of soil, namely clay, loam, and sand.

II. Conceptual Framework

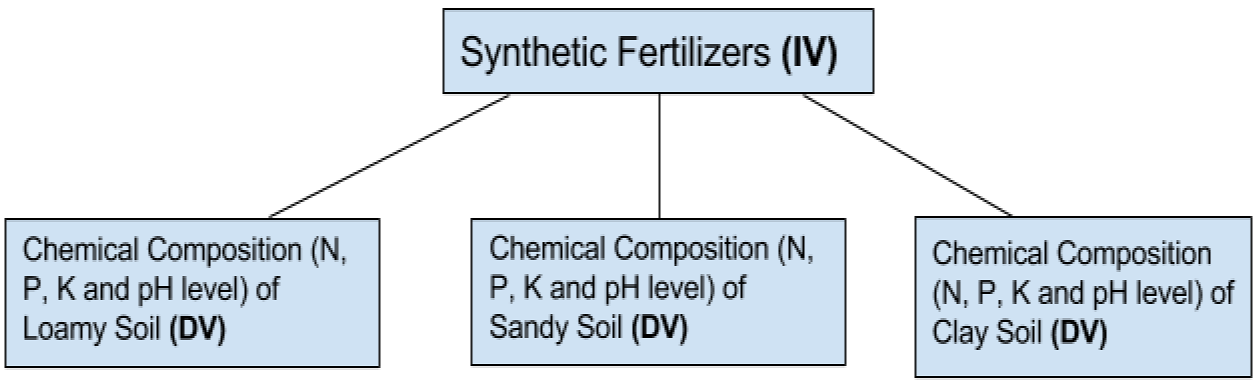


Figure 1.1 Conceptual Framework

According to The Organic Center (2013), a study published in the *Journal of Environmental Quality* stated that the long term usage of synthetic soil causes negative results in the structure of the soil. A 50 year old study conducted by the researchers in Kansas State have been conducting and observing the effects of the synthetic fertilizers to the properties of the soil. The application of nitrogen and phosphorus, which is contained in the synthetic fertilizers, increases the organic carbon in the soil as it decreases soil macroaggregates. Due to ammonium, the soil decreasing aggregates which causes it to separate. Though based from study of SFGATE (n.d.), synthetic fertilizers supplies quick nutrition. As Supported by Oregon State University (2008), synthetic fertilizers are made up of phosphorus, potassium, nitrogen and some sulfur can give out fast growing plants but there should be limits as this may affect the plants negatively as the this synthetic fertilizers is easily absorbed by the soil as this is usually cheaper than organic and more efficient in helping the growth of the plant.

The three basic farming soils have a pre tested to determine its chemical composition such as the levels of nitrogen, potassium, phosphorus and pH level before the application of the synthetic fertilizer. The treatment will consist of an addition of synthetic fertilizer and controlled distilled water and it will be measured its level of chemical composition and at the end of the experiment the soils will be tested to identify its significant relation to the synthetic fertilizers in terms of having a nutritious soil for faster plant growth to achieve suppose goals of the research project in order to contribute to two of the UNICEF goals by 2030.

III. Statement of the Problem

The purpose of this study is to discern the chemical components of synthetic fertilizer, and how this affects the biological and chemical composition of the different types of soil (clay, loam, and sand).

More specifically, it aims to accomplish the following:

1. What are the effects of Ramgo Complete Fertilizer to the pH, nitrogen, phosphorus, and potassium content of sandy, clay, and loamy type of soil?

2. Is there a significant change in the pH of sandy, clay, and loamy type of soil?
3. Is there a significant change in the nitrogen content of sandy, clay, and loamy type of soil?
4. Is there a significant change in the phosphorus content of sandy, clay, and loamy type of soil?
5. Is there a significant change in the potassium content of sandy, clay, and loamy type of soil?

IV. Significance of the Study

Understanding the effects of synthesized fertilizers on soil is undoubtedly essential in the further development and sustainability of agricultural based communities. Since this study aims to highlight the different kinds of effects synthetic fertilizers have on the composition, quality, and fertility of soil, it would be able to determine the rate of effectiveness and possible risks synthetic fertilizers may have on soil and potentially plant/crop growth. Similarly, data this study gathers may help farmers and agricultural institutions have a deeper understanding of synthetic fertilizers. It should also be noted that there are not much significant studies covering the matter therefore, this research provides new and applicable data.

In summary the study aims to provide (but not limit itself) the following applications to aid in other disciplines:

1) Provide scientific data on the effects that synthetic fertilizers have on the different types of soil and their chemical composition.
2) Determine the effectiveness of synthetic fertilizers in plant/crop growth.
3) Provide recommendations for future production, consumption and application in agriculturally based communities.
4) Help farmers and agricultural based communities have a deeper understanding of the effects of synthetic fertilizers.

V. Scope and Delimitations

Since this is a scientific research, the paper will be covering, analyzing, and presenting data gathered from experiments testing the effects of synthesized fertilizers on the chemical composition of different types of soil. Although there are many other types of soils most agriculturally-based communities use, this research does not cover the effects of synthesized fertilizer on other types of soil.

Due to the nature of the research, not much studies have been found regarding the effects of synthetic fertilizer on soil. With this in mind, this research can serve as a guide for future research on the topic. However, this also somewhat makes the framework or “background” of the research weak, or without basis.

Furthermore, the paper will only test on soil, and not on how the fertilizer may affect a certain plant. Other possible physical factors that may affect the results of the study, such as soil moisture, temperature, humidity etc. will not be tested. It should also be stated that, during experimentation, this experiment is expected to have a minimum of 5 pots per soil experiment to test the variables to prove valid the effects of the synthesized fertilizer. Through this, the experiments are conducted to assure the precision and accuracy of data, although it would be more ideal to have a larger sample size.

VI. Definition of Terms

1. Ammonium - derived from ammonia as it is a compound from the combination of hydrogen ion and ammonia. NH_4^+
2. Antioxidants - It oxidizes molecules in the body. This is composed of Beta-carotene, lutein, lycopene, selenium, vitamin A, vitamin C and vitamin E.
3. Cation Exchange Capacity (CEC)- This is a property of soil that indicates the soil's ability to retain nutrients and withstand changes in pH. Soils with more organic content (such as clay) tend to have a higher CEC as compared to carbon-poor soils such as sand (McCauley, 2005).
4. Nitrogen - Diatomic compound in which it is odorless and colorless.
5. Phosphorus - Nonmetallic element that is part of the nitrogen family. It glows in the dark, burns when it is exposed to air and poisonous.
6. Synthetic fertilizer - known also as “inorganic” or “chemical” fertilizers, in which it is made from chemicals such as nitrogen (in the form of ammonium), phosphorus

and potassium. Fertilizer is a substance that is added to promote the increase of fertility on soil and plant growth (Sustainable Baby Steps, 2009).

CHAPTER 2: REVIEW OF RELATED LITERATURE

I. Introduction

This review of related literature serves as an overview of several past studies contributing to the field of soil science, with the integration of the UNICEF Sustainable Development Goals. In relation to UNICEF SDG's, although soil science doesn't have much of a direct link to them, they contribute generally to the ecosystem, as defined by Keesstra (2016) as “services to society that ecosystems provide”. Despite the lack of research under this field, it is a significant topic as it contributes both directly or indirectly to nearly all land-related SDGs. With the main purpose of determining the effects of a synthetic fertilizer to different types of soils, this chapter first highlights the necessary nutrients, namely Nitrogen, Phosphorus and Potassium, which are needed in the soil as they contribute to both plant and microbial growth. Given these nutrients, an appropriate synthetic fertilizer (NPK/Complete fertilizer) emerged, and the effects of these, such as deficiencies and toxicities, were further explored in the chapter. The importance of pH was also discussed in relation to the nutrient availability of the soil. Lastly, the 3 different types of soil, namely Loam, Clay and Sand, were discussed chemically and physically on their ability of retaining the needed chemicals, and which among them, based from studies, is more favorable.

II. Body

Chemical Components found in Soil

Soil serves as an important component to the terrestrial ecosystems, as they contain not only the vital nutrients and chemicals that plants need for proper growth, but also they provide a habitat for microorganisms that play key functions in biogeochemical cycles such as decomposition of organic matter, nitrogen fixation and mineralization of nutrients (Tumer et al, 2013; Paul, 2015; Keesstra et al, 2016). Furthermore, as defined by the European Commission (EC, 2006), soil serves 7 main functions, namely:

1. Biomass production, including agriculture and forestry
2. Storing, filtering and transforming nutrients, substances and water
3. Biodiversity pool, such as habitats, species and genes
4. Physical and cultural environment for humans and human activities
5. Source of raw material
6. Acting as carbon pool
7. Archive of geological and archaeological heritage

In general, soil is a naturally occurring mixture of weathered minerals/inorganic matter, air, water, and other forms of organic matter (such as animals, plants and microbes) (Paul, 2015). Although the ratio of these 4 components vary depending on external and environmental factors (Anderson et al, 2001) , inorganic matter/minerals often make up the largest portion, taking about 45% of the soil composition (University of Hawai‘i - College of Tropical Agriculture and Human Resources, 2017) . Among these are the various macro and micro-nutrients vital for plant and microbial growth, with the primary nutrients being Phosphorus, Nitrogen and Potassium (referred as NPK), and the secondary, being Calcium Sulfur and Magnesium. Other elements such as Chlorine, Iron, Boron, Zinc and Manganese are considered micronutrients, although they only provide nourishment and nutrition to the plants in generally small and insignificant amounts as compared to the primary nutrients.

Element	Symbol	mg/kg	percent	Relative number of atoms
Nitrogen	N	15,000	1.5	1,000,000
Potassium	K	10,000	1.0	250,000
Calcium	Ca	5,000	0.5	125,000
Magnesium	Mg	2,000	0.2	80,000
Phosphorus	P	2,000	0.2	60,000
Sulfur	S	1,000	0.1	30,000
Chlorine	Cl	100	--	3,000
Iron	Fe	100	--	2,000
Boron	B	20	--	2,000
Manganese	Mn	50	--	1,000
Zinc	Zn	20	--	300
Copper	Cu	6	--	100
Molybdenum	Mo	0.1	--	1
Nickel	Ni	0.1	--	1

Figure 2.1: General concentrations of nutrients in soil

(Source: Barak, 1999)

In figure 2.1, it shows the typical concentration/ratio of elements in soil. As mentioned previously, the NPK elements, together with Calcium, Magnesium and Sulfur, are the elements often most present in soils.

An Overview of Fertilizers

Fertilizer is a substance that is added to promote the increase of fertility on soil and plant growth (Sustainable Baby Steps, 2009). As stated in a study by Natsheh, B. & Mousa, S. (2014), the utilization of fertilizer on soil manages the agricultural production well because it improves the quality of the plant and fertility of the soil. The nutrients collected from the fertilizer enhance the condition of the soil as well as the establishment of crops (Natsheh, B. & Mousa, S., 2014). There are two types of fertilizers: organic and inorganic. Organic fertilizers are most commonly composed of animal manure and/or crop residue. On the other hand, inorganic fertilizers are made up of mineral deposits or synthetic compounds. Organic fertilizers work over time to slowly develop a healthy, stable environment. While, inorganic fertilizers work rapidly for fast production of crops.

According to Maryland Cooperative Extension (2013), both organic and inorganic fertilizers give off the same nutrients needed by the plant, mainly: nitrogen, phosphorus, and potassium. Since inorganic fertilizer is already broken down in a light and digestible form, the soil is able to absorb the nutrients faster than that of an organic fertilizer. Due to this, inorganic fertilizers work more quickly because of the higher percentage of nutrients. However, excess in this type of fertilization may lead to the burning of the plants and the excessive building up of toxic salt concentrations which may lead to chemical imbalances that is no longer helpful to the plants (McCauley, 2005; Wallace, 1994). On the other side, organic fertilizers may take a bit longer than that of inorganic because it makes use of substances that are purely natural. However, this helps the plant’s environment by creating a healthy, natural habitat for the crops.

NPK/Complete Fertilizer and pH on their Effects on Soil

Complete fertilizer, or known as NPK is a type of synthetic/inorganic fertilizer with balanced amounts of Nitrogen, Phosphorus, and Potassium. Compared to other forms of inorganic fertilizer, NPK has equal amounts of the the 3 primary nutrients needed for proper plant growth.

Nitrogen, taken in as the form of ammonium $(NH4)+$ or nitrate $(NO3)-$ by plants, is the growth limiting nutrient and the most significant compared to Phosphorus and Potassium. It provides the main growth to plants, serves an important role to photosynthesis through chlorophyll, and contributes to nutrient availability (Razaq et al, 2017; Geiseller, 2014). In a study by Ma, Longnecker & Dracup (1997), soil with deficient amounts of nitrogen caused a delay in leaf emergence and flowering, which eventually affected yield potential. Further studies also observed lower plant height, chlorophyll content, and root size (Razaq et. al, 2017), as compared to plants treated with optimal amounts of N. Similarly, Phosphorus mainly contributes to root development, plant metabolism and plant quality (Grant et al, 2011; Razaq, 2017). For plants, it is uptaken in the form of phosphate ($H2PO4$)-. Optimal amount of P must be properly as measured as based from previous researches, deficient amounts of P often lead to reduced growth, darker colored leaves, and imbalances (Li, 2010), whereas an excess amount would lead to toxicity (Hawkins et al, 2008). Potassium (K+), although it is not as significant, serves a role in the overall growth and quality of the plant through metabolic activities. Since it doesn't affect plants easily, it has shown consistent results in plant and fruit production even at higher concentrations (Johnson & Decoteau, 1996).

Just like plants, based from previous studies, the levels of pH in the soil, as well as the presence of NPK, may highly affect the microbial biomass living in the soil itself. In a study by Fierer and Jackson (2006), it was stated how pH was the best predictor for soil microbial presence/diversity, with results concluding that soils with neutral/almost neutral pH contain more microbial biodiversity as compared to acidic soils.

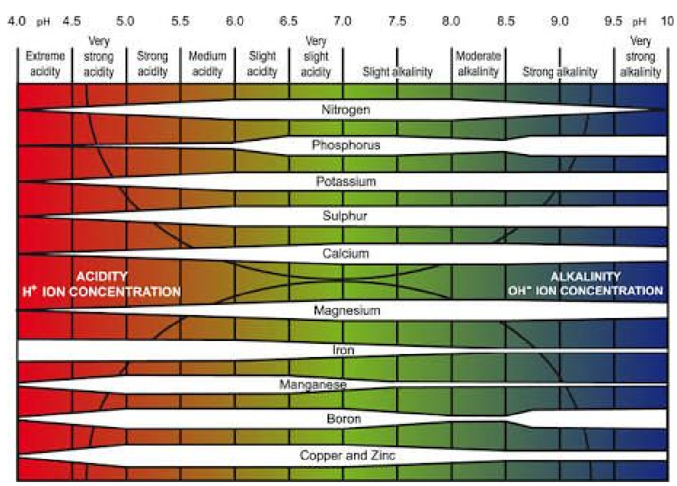


Figure 2.2: The varying nutrient availability levels based from soil pH

(Source: Cornell University, 2010)

Studies have shown that the pH of the soil highly affects its NPK content, thus affecting the rate of soil activity (Allison & Martiny, 2008; Fierer & Jackson, 2006). In figure 2.2, it shows the nutrient availability based from each pH level, and that most of which thrive best in neutral soils. Inversely, although given this statement, it was also shown that nutrient content of the soil itself was a factor that affected its pH. Deficient or excessive amount of nutrients, especially in Nitrogen, may result also to a lack or excess amount of Hydrogen ions, thus changing the soil's overall pH. (Ministry of Agriculture, 2015)

In line with this, according to to Allison and Martiny (2008), 84% of 38 studies show the high sensitivity of microbes towards the levels of NPK nutrients in the soil. Nitrogen, specifically in the form of ammonium, is the most preferred source for bacteria and fungi (Merrick & Edwards, 1995), although when applied at high rates may interfere with their growth and cause toxicity (Muller, 2006). Further studies coincide with this and also show that an increase in nitrogen generally causes a decrease in soil microbial biomass, mainly due to the acidification caused to the soil (Liu et al, 2013; Berthrong et al, 2012). Compared to Nitrogen, which is the limiting growth nutrient, levels of Phosphorus and Potassium generally have positive results to microbial activity even at high concentrations. In a study by Liu et al (2013), after adding Phosphorus, soil respiration increased, which may imply a more thrived and active microbial community in long-term due to the presence of P.

Looking into the situation chemically, the varying reactions of the soil from the different nutrients may be due to their positive/negative charge. Since soil is generally an anion due to its organic content, nutrients with a positive charge, such as K+, Ca+ --, would be attracted to the soil, thus retaining its nutrient content. In the other hand, nutrients with a negative charge such as (NO3)- repel with the soil, making them more mobile and prone to leaching (Cornell University Cooperative Extension, 2007) The probability of leaching to occur mainly depend on the type of soil. The Cation Exchange Capacity (CEC) refers to the soil's ability to retain nutrients. Soils with more clay and organic content, such as clay, have a higher CEC, making them better at holding both cation and anion nutrients. This may be observed with its physical properties as it is more finely grained and dense. Soils with lesser organic content, such as sand, have a low CEC, making its retention of nutrients, especially cations, very low. Oppositely, it is coarsely grained and dry in terms of physical properties (McCauley, 2005). Although nitrate (NO3)- is a key nutrient for plants, being an anion, it can easily leach out in sandy soils, or cause toxicity when retained at high concentrations in clay soils. With that, it is important to know both the type of soil being used and the amount of nutrients needed for each soil to ensure efficiency in soil fertility.

Given all these effects from the levels of NPK and pH in the soil, it is significant to have soil tested, as it determines whether there is a deficiency or excessive amount of certain components, which each serve their own contributions, whether it would be to plants or to the microbes.

Nitrogen, Phosphorus, Potassium and pH Analysis Methods on Soil

Based from previous studies, there are several ways to measure NPK and pH levels, although for this research, a soil testing kit will be utilized for better convenience and efficiency with time.

The soil testing kit includes capsules for each component of NPK and pH, and results can be determined through a colorimetric system. When applied to a sample of soil and mixed with water, a change in color will occur. The kit provides color ranges for different amounts of nutrients present and will serve as a reference for all the tests.

Alternative methods for measuring pH would be through the use of litmus paper, baking soda and vinegar or a digital probe. Using litmus paper is the one of the most common and easiest methods, although specific levels acidity/alkalinity can’t be determined, especially with a simple red/blue paper (Black, 2017). To measure the pH level of soil the method of using baking soda and vinegar in which 2 spoonfuls of soil separately inserted in the containers, adding ½ cup of vinegar to the soil. If it fizzes up then the pH level is in between 7-8 and if it does not fizz, add distilled water until the soil muddy then add ½ cup of baking soda and if it fizzes then the pH level is in between

5-6. (Shelle n.d.). Just like the litmus paper, this method isn’t as accurate as specific levels can’t be determined.

Measuring NPK is a lot more complex and will require specific chemicals and equipments. This includes methods such as anion-exchange chromatography for N (Nowotny, 2009), Dickman and Bray’s method for P (vlab.amrita.edu, 2013), electrolytic solution and free energy change of exchange for measuring K (Feigenbaum & Hagin, 1967) . Although given that, levels of these nutrients may be determined simply based from the level of pH in the soil, as they are highly depended on it (Allison & Martiny, 2008).

III. Synthesis

In summary, the findings show that inorganic fertilizer is efficient in terms of increasing soil fertility, despite the possible negative effects towards the environment at high concentrations. Levels of Nitrogen, Phosphorus and Potassium (NPK) are known to be the most significant nutrients in the soil and can easily affect both plant and microbial activity, either positively or negatively. These nutrients, especially Nitrogen, may also affect the soil's pH, which based from the past researches have mentioned it being a significant indicator of plant and microbial activity as well (Allison & Martiny, 2008; Li, 2010; Razaq, 2017). Other than the chemicals itself, the soils ability to retain nutrients, known as Cation Exchange Capacity, plays an important role to the soil as well as it could be able to maximize or minimize the uptake of nutrients by the organisms depending the type of soil (McCauley, 2005; Cornell University Cooperative Extension, 2007) With clay soil having a higher CEC compared to sand, it may be inferred that clay may be more beneficial in terms of retaining nutrients, although possible negative situations such as toxicity or acidification may occur when not treated properly. Overall, it is key to know the type of soil, the nutrients being used, the concentration of nutrients and other external factors, to maximize the soil's fertility and contribution towards the growth of its surrounding organisms.

CHAPTER 3: METHODOLOGY

This research paper aims to identify the effects that may arise to the chemical composition of different types of soils when dealing with synthetic fertilizer or more commonly known as inorganic fertilizer. The researchers will focus mainly on the chemical composition of the soil itself, specifically: phosphorus, nitrogen, and potassium. This way, being able to identify how a type of soil reacts to the chemicals of a synthetic fertilizer. In this chapter, various elements are discussed in order to establish a proper and logical way of collecting data given that the researchers will be using the experimental research design for this study. Information regarding the setup, procedure, and methods of collecting data in a systematic and organized manner is evident in this chapter as it acts as the framework for expounding and predicting a certain phenomenon from the collected data.

I. Research design

With the main purpose of determining the effects of synthetic fertilizer towards the composition and quality of different types of soil over a given period, this study utilized the Experimental research design as its framework. According to Barnes & Dearing (2015), the purpose of the experimental design is to "test hypotheses and explain how an independent variable influences a dependent variable". Specifically, the researchers will be utilizing a Quasi experimental/pretest-posttest method, wherein the variables will be measured before and after the treatment. In this study, the chemical fertilizer and soil types served as the independent variables, while the the chemical composition/quality of the different soils served as the dependent variable. Through the use of an experiment, the researchers may be able discover and verify the cause-and-effect relationship between the variables.

As defined by Ross (2004), experimental studies rely mainly on standardized procedures, as they all the conditions were kept constant except variable being experimented (independent variable) The standardized setup is to ensure highly accurate and valid results, as well as reduced biases (Tappen, 2011), and risks of encountering extraneous factors, discrepancies and inconsistencies with the collected data (Ross, 2004). Specifically for this research, it is key to eliminate as much extraneous factors as possible in order to directly conclude the effectiveness of the independent variable to the dependent, under the given circumstances.

II. Research Locale and Set up

The experiment was carried out for 2 weeks during the wet season in the suburban community of Lindenwood, Barangay Tunasan, Muntinlupa City. The plantation is composed of three types of soil which are sandy, loamy and clay. The experimented soil and synthetic fertilizer will not be exposed to rainfall as water is a controlled variable of the experiment. The location of the experiment has an average humidity of 81% with the average temperature of 27 ^{0}C with the sea elevation at 38 m.

In terms of collecting the levels of pH, N,P and K from each sample, the experiment was done in De La Salle Zobel - Vermosa Chemistry laboratory.

III. Research Instruments/Materials

This kit is used to assess the primary nutrients as well as pH levels of soil. The kit includes the following instruments,

5 test tubes	Eye dropper
1 test tube rack	Tin strips
Solutions: B, C, C1, D, D1, E, CPR, BTB, BCG, lime requirement, distilled water	Instruction manual

Clay Pots

A clay pot provides a suitable container for soil and a healthy environment for plants as the porosity of clay allows air and moisture to penetrate the sides of the pot.

These will be used to contain the different types of soil to which the experiment conducts on.

Types of Soil

The experiment will be conducted on the following (3) three types of soil,

- *Loamy Soil*

According to Lerner (2000), Loamy soil is composed mostly of sand and is considered an optimal soil for gardening and agricultural purposes as it preserves nutrients and water whilst allowing water to flow and drain away.

Loam is found in a majority of farms and regions around the world.

- *Sandy Soil*

Sandy soils (as the name suggests) are mostly composed of sand. Sandy soils are ideal for crops such as watermelons, peaches and peanuts. Similar to *Loamy Soil*, they have excellent drainage characteristics which make them convenient to use for intensive farming.

- *Clay Soil*

Clay soils are smooth and dense. They are very rich in plant nutrients which makes them ideal for agricultural purposes. Against a humid climate, clay soils hold water very well and can be a fitting type of soil to use during the summer.

Distilled Water

To simulate rainfall, distilled water is used to dampen the soil and further see the effects of the fertilizer in a simulated controlled natural environment.

IV. Data Collection Procedure

As stated for the research design of an experimental research, an experiment will be done to determine the effect of synthetic fertilizer towards three different types of soil commonly used when farming. This experiment took place in Lindenwood Residences, Barangay Tunasan, provided that it is within the area and promotes urban farming. Additional experiments were also conducted in the De La Salle Zobel-Vermosa Campus laboratories. With the usage of Ramgo Complete Fertilizer, the three different types of soil namely, loamy, sandy and clay soil, soil test kit and clay pots for the experiment.

Each of the 3 soils will have 5 samples/pots (a total of 15 samples). Each pot will contain 1.5 kg of the soil. The elements, Phosphorus, Nitrogen and Potassium will be recorded through the Soil Test Kit that consists of four types of tests, one that measures the pH Level, N-Test (Nitrogen), P-Test (Phosphorus) and K-Test (Potassium). A pretest measuring the 4 contents will be performed first.

Figure 3.1: Instructions for collecting N,P,K and pH Levels of Soil

(Refer to appendix for corresponding color chart)

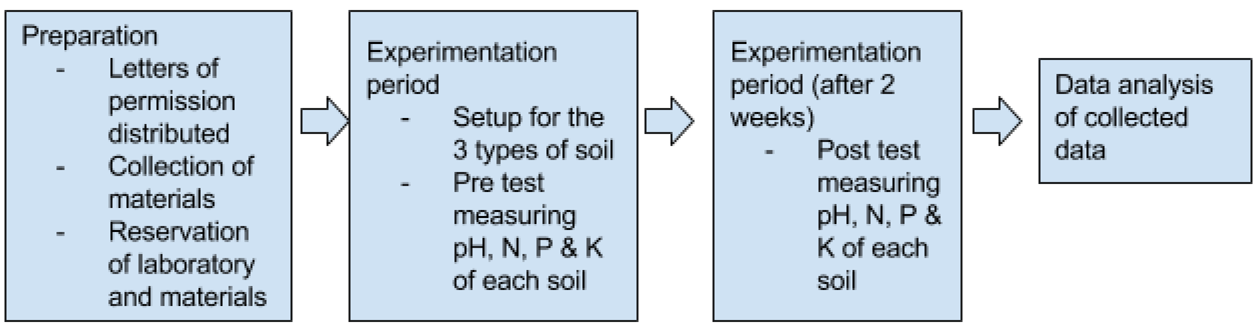
<table>
<tr>
<td>NITROGEN (N)
1. Fill the test tube with soil sample up to scratch mark
2. Add 16 drops of solution B
3. Mix well by swirling the tube 30 times
4. Rest for 5 minutes, and then repeat step 3
5. Let sample stand for 30 minutes</td>
<td>PHOSPHORUS (P)
1. Fill the test tube with soil sample up to scratch mark
2. Add 16 drops of solution C and 2 drops of solution C1
3. Mix well by swirling the tube for 1 minute
4. Rest for 3 minutes, and then repeat step 3
5. Let sample stand for 5 minutes
6. W/o disturbing the soil, stir the solution slowly with the tin strip for 2 minutes</td>
</tr>
<tr>
<td>POTASSIUM (K)
1. Fill the test tube with soil sample up to scratch mark
2. Add 16 drops of solution D and 4 drops of solution D1
3. Mix well by swirling the tube for 1 minute</td>
<td>SOIL pH
1. Fill the test tube with soil sample up to scratch mark
2. Add 7 drops of CPR
3. Mix well by swirling the tube 20 times
4. Rest for 2 minutes, and then repeat step 3</td>
</tr>
</table>

4. Rest for 3 minutes, and then repeat step 3 5. Let sample stand for 5 minutes 6. Insert a dropper with 0.6 ml of solution E (2 cm above the solution) and slowly add the solution one drop at a time. DO NOT SHAKE 7. Let stand for 2 minutes a. Distinct cloudy yellowish layer on top of the orange layer indicates sufficient K. b. No distinct cloudy layer on top of the orange layer indicates deficient K.	5. Let sample stand for 5 minutes a. If soil is greater than 6, repeat steps 1-5 using BTB instead of CPR b. If soil is less than 5, repeat steps 1-5 using BCG instead of CPR

Once finished, 1 tablespoon of fertilizer and 100 ml of water will be added to each of the soil samples. 2 weeks will be allotted for the fertilizer to settle in the soil. In between the 2 weeks, another 100ml of water will be added to moisten the soil. Once the 2 weeks of the experimentation period is over, a post test measuring the 4 contents will be performed again. Results from the pretest and posttest will be recorded and analyzed to answer each of the research questions.

The time frame used for the activity took course for 2 weeks,with a pretest done before adding the fertilizer and a posttest done after the experimentation period. The purpose is to compare the nutrients found in each soils, and further determine which type of soil is the most convenient when farming. In this research, each recorded data will be compared and analyzed to put emphasis on the UNICEF sustainable goal, Responsible Consumption and Production and the promotion of urban farming.

Flowchart



Ethical Considerations & Safety Precautions

1. Have proper supervision when conducting the experiment
2. Wear proper safety gear
3. Practice proper disposal of used materials
4. Familiarize yourself with the experiment
5. Maintain proper observation of results

V. Statistical Treatment/Formulas

As the experiment has one independent variable (synthetic fertilizer) and three dependent variables (chemical composition of soil) in the form of three distinct soil types (clay, loam, and sand), the most apt methods of acquiring data are through:

1. The mean/average of the pH levels across the 3 types of soil (in order to compare a soil pH before and after applying Ramgo Complete Fertilizer)
2. Percentage (analyze the descriptive changes (NPK content) of the soils)
3. T-test (analyze correlation between the pH levels of the 3 types of soil)
4. Chi-square test (to analyze the correlation, if any, between the nutrient contents (NPK) across the 3 types of soil)

Additionally, the research will utilize the SPSS Statistics program to compute for the aforementioned statistics. With these methods being utilized, the research would be able to answer the research questions:

1. What are the effects of Ramgo Complete Fertilizer to the pH, nitrogen, phosphorus, and potassium content of sandy, clay, and loamy type of soil?
2. Is there a significant change in the pH of sandy, clay, and loamy type of soil?
3. Is there a significant change in the nitrogen content of sandy, clay, and loamy type of soil?

4. Is there a significant change in the phosphorus content of sandy, clay, and loamy type of soil?
5. Is there a significant change in the potassium content of sandy, clay, and loamy type of soil?

CHAPTER 4: DATA ANALYSIS AND INTERPRETATION

This chapter will present the data gathered from the experiment on the composition of the three soil types. It will do so by including tables that show the following:

1. The mean/average of each of the soils type components before and after Ramgo Complete Fertilizer was applied
2. The percentages displaying the effects of the NPK nutrients before and after adding fertilizer.
3. Level of significance between the pH levels of the 3 soils before and after adding the fertilizer. (t-test)
4. The comparison and level of correlation between each soil type according to the NPK levels (Chi-Sqaure test)

In analysing the data, the research will utilize the SPSS Statistics program in order to accurately explicate the aforementioned data. In order to show the aforementioned data, the research will focus on the mean/average, t-test values, Chi-square test, and ANOVA values from the SPSS Statistics program.

Research Question 1: What are the effects of Ramgo Complete Fertilizer to the pH, nitrogen, phosphorus, and potassium content of sandy, clay, and loamy type of soil?

Table 4.1: Mean of Pre Test and Post Test pH of Sandy, Clay and Loamy soil

	Pre Test			Post Test		
Types of Soil	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Sandy	5	7.5200	0.17889	5	6.6000	0.20000
Clay	5	6.5200	0.17889	5	6.1600	0.21909
Loamy	5	7.3200	0.17889	5	6.7200	0.17889

Pre-test values showed that the Sandy type of soil provided the highest mean among the three soils at 7.52. This was followed by loam at 7.32, and lastly clay at 6.52. All types of soil had the same standard deviation (0.17889) before adding the fertilizer. Based from these pre-test results, it shows that the sandy and loamy soils were actually slightly basic (7.5 and 7.3 respectively), whereas only the clay soil was slightly acidic (6.5). According to McKenzie (2003), although each plant may have their own preferred pH range of soil, ideally, for growing most plants, the most desirable or optimal pH range of the soil would be between 6.5 to 7.0 or, a neutral to slightly acidic soil, implying that clay soil. in this case, is more preferred.

After the application of the fertilizer, the standard deviation of the clay and sand increased from 0.17889 to 0.2 and 0.17889 to 0.21909 respectively, signifying a wider range of results. The standard deviation of loam however remained the same throughout. Furthermore, all the 3 soils decreased in pH, indicating more acidic soil as an effect of the fertilizer. The mean value of pH of the Sandy type of soil decreased from 7.52 to 6.6, which was the highest, as it dropped down 12.2% when the fertilizer was added. The clay type of soil, after the fertilizer was added, also exhibited a decline in the mean value of pH from 6.52 to 6.16, a 5.5% decline from its original value. The Loamy type of soil, also showed a decreased mean value from 7.32 to 6.72, which is 8.2% lower. Comparing before and after, sandy soil was shown to have the highest decline in pH, from 7.5 to 6.5 (12.2%), followed by loamy from 7.3 to 6.7(8.2%), and lastly clay from 6.5 to 6.2 (5.5%). Based from this, it can be seen that the concept of Cation Exchange Capacity (CEC) was observed. According to Ketterings, Reid & Rao (2007) and McCauley (2005), CEC is defined as the soil's ability to retain cationic nutrients, as well as its pH. Sand is known to have a low CEC, making it more susceptible to changes in pH, while clay is known to have a high CEC, making it able to withstand harsh changes in pH. Since plants are very specific with the soil's pH range (McCauley, 2017), the addition of fertilizer to sandy soil isn't really seen as advantageous as it altered its pH by a whole unit (7.5 to 6.5) in just 2 weeks. A change in pH this big in a short amount of time would not be good for a plant's overall growth. Oppositely, after adding the fertilizer, clay's pH decreased only by a little, thus making it more preferable, as the soil's level of acidity will still remain quite manageable for the plant. Finally, loam is seen to be just in between the clay and sand's conditions.

Table 4.2: Effect of Ramgo Complete Fertilizer on Various Soils' NPK Levels

Element Tested[1]		Pre-Test			Post-Test			Observed Change
	Soil	%Low	%Med	%High	%Low	%Med	%High	
Nitrogen	Sandy	100%	0%	0%	100%	0%	0%	No Change
	Clay	0%	100%	0%	0%	40%	60%	Increase
	Loamy	80%	20%	0%	60%	40%	0%	Decrease
Phosphorus	Sandy	20%	0%	80%	0%	20%	80%	Increase
	Clay	0%	40%	60%	0%	40%	60%	No Change
	Loamy	40%	60%	0%	40%	60%	0%	No Change

Element Tested[1]		Pre-Test		Post-Test		Observed Change
	Soil	%Deficient	%Sufficient	%Deficient	%Sufficient	
Potassium	Sandy	40%	60%	40%	60%	No Change
	Clay	20%	80%	0%	100%	Increase
	Loamy	0%	100%	20%	80%	Decrease

[1]A total of 5 samples was done for each soil types for Pre- and Post-Tests.

Based from the table above, it was observed that Ramgo Complete Fertilizer increased the Nitrogen levels of Clay, but decreased for Loamy soil. There were no changes in Nitrogen levels for Sandy soil. In terms of Phosphorus levels, there were no effects of the fertilizer to the Clay and Loamy soil as the pre and post test had the same results.The sandy soil however did show an increase in Phosphorus after adding the fertilizer. Lastly, the Potassium levels varied throughout all 3 types of soil. Clay showed an increase in Potassium content, Loamy showed a decrease, while Sandy showed no change before and after the addition of the fertilizer. From these results, the concept of CEC still applies. Clay, having a higher CEC means that it has a larger capacity for holding cationic nutrients such as Nitrogen (in the form of ammonium) and Potassium ions, whereas sand, having a low CEC, can only hold onto small amounts of cationic nutrients. The results from this study show exactly that, as clay soil showed an increase in Nitrogen and Potassium, while sand had no changes in the levels of Nitrogen and Potassium. It may be inferred that because the clay has a large capacity, it was still able to attract more Nitrogen and Potassium, whereas the sand couldn't accept any more cations as it may have possibly reached its full capacity. Loam however, being a mix of different types of soil, showed mixed results, having an increase in Nitrogen, decrease in Potassium, and no changes in Phosphorus.

Research Question 2: Is there a significant change in the pH of sandy, clay, and loamy type of soil?

Table 4.3: T-test between the Sandy Soil's pH Levels before and after adding Fertilizer

		Levene's Test for Equality of Variances		t – Test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
pH	Equal variances assumed	.262	.622	7.667	8	.000
	Equal variances not assumed			7.667	7.902	.000

The tests above were conducted at a 95% significance level (critical value=0.05). This paper tests the null hypothesis that the pH means for Pre- and Post-Test scenarios are equal. However, to use the t-test for this, the variances must be checked if equal. The Levene's Test above shows that the null hypothesis (that the variances are equal) cannot be rejected since the significance 0.622 is not less than the critical value. Hence, the researchers proceeded with the t-test.

The results of the t-test in the table above indicates a two-tailed significance 0.000, which is less than the critical alpha. Hence, the hypothesis that the means of Pre-Test and Post-Test are equal was rejected. Given such, there is a statistically-significant difference between the means of the Pre- and Post-Test pH levels of sandy soil.

Table 4.4 t – Test between pretest and posttest of pH of the Clay Soil

	Type of Soil	Levene's Test for Equality of Variances		t – Test for Equality of Means		
Sandy Soil		F	Sig.	t	df	Sig. (2-tailed)
pH	Equal variances assumed	1.440	.264	2.846	8	.022
	Equal variances not assumed			2.846	7.692	.022

Similar to table 4.3, since the Levene test had a sig. value (0.264) greater than the assigned critical value of 0.05, the t-test was then proceeded. From here, a significance value of 0.022 was obtained. Since it is less, than 0.05, it is concluded that there is a statistically-significant difference between the means of the Pre- and Post-Test pH levels of the clay soil.

Table 4.5 t – Test between pretest and posttest of pH of the Loam Soil

	Type of Soil	Levene's Test for Equality of Variances		t – Test for Equality of Means		
Sandy Soil		F	Sig.	t	df	Sig. (2-tailed)
pH	Equal variances assumed	.000	1.000	5.303	8	.001
	Equal variances not assumed			5.303	8.000	.001

Similar to the previous tables, since the Levene test had a sig. value (1.00) greater than the assigned critical value of 0.05, the t-test was then proceeded. From here, a significance value of 0.001 was obtained. Being less than the critical value, it is concluded that there is a statistically-significant difference between the means of the Pre- and Post-Test pH levels of the loam soil.

Research Question 3: Is there a significant change in the nitrogen content of sandy, clay, and loamy type of soil?

Table 4.6: Nitrogen Content among the 3 Types of Soil

Crosstab

Count

		NitrogenContent			Total
		Low	Medium	High	
TypesOfSoil	Sandy	5	0	0	5
	Clay	0	2	3	5
	Loamy	3	2	0	5
Total		8	4	3	15

Table 4.7: Significance of the Association of the Fertilizer to Nitrogen Content of the 3 Soils

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.750[a]	4	.013
Likelihood Ratio	16.828	4	.002
Linear-by-Linear Association	.600	1	.439
N of Valid Cases	15		

a. 9 cells (100.0%) have expected count less than 5. The minimum expected count is 1.00.

A chi-square test for significance of the association of Ramgo Complete Fertilizer (in terms of Pre- and Post-Test scenarios) to Nitrogen content of all three soil types was then conducted at 95% confidence level . From the SPSS output above, it is seen that the Pearson Chi-Square statistic obtained has a two-sided significance of 0.013, which is less than the given critical value of 0.05, and thus, leading to rejection of the null hypothesis that this association is just a result of sampling error.

Therefore, it may be concluded that at 95% confidence level, the addition of the said fertilizer to the three soil types collectively has a statistically-significant change in the soil's Nitrogen content.

Research Question 4: Is there a significant change in the phosphorus content of sandy, clay, and loamy type of soil?

Table 4.8: Phosphorus Content among the 3 Types of Soil

Crosstab

Count

		PhosphorusContent			Total
		Low	Medium	High	
TypesOfSoil	Sandy	0	1	4	5
	Clay	0	2	3	5
	Loamy	2	3	0	5
Total		2	6	7	15

Table 4.9: Significance of the Association of the Fertilizer to Phosphorus Content of the 3 Soils

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.714[a]	4	.069
Likelihood Ratio	11.261	4	.024
Linear-by-Linear Association	6.873	1	.009
N of Valid Cases	15		

a. 9 cells (100.0%) have expected count less than 5. The minimum expected count is .67.

A chi-square test was also conducted for significance of the association of the same fertilizer (in terms of Pre- and Post-Test scenarios) to Phosphorus content of all three soil types at 95% confidence level. From the SPSS output above, it can be seen that the Pearson Chi-Square statistic obtained has a two-sided significance of 0.069, which is not less than our critical value of 0.05. This leads to acceptance of the null hypothesis that this association is just a result of sampling error.

Thus, it is concluded that at 95% confidence level, the addition of the said fertilizer to the three soil types collectively does NOT result to a statistically-significant change in the soil's Phosphorus content.

Research Question 5: Is there a significant change in the potassium content of sandy, clay, and loamy type of soil?

Table 4.10: Potassium Content among the 3 Types of Soil

Crosstab

Count

		PotassiumContent		Total
		Sufficient	Deficient	
TypesOfSoil	Sandy	3	2	5
	Clay	5	0	5
	Loamy	4	1	5
Total		12	3	15

Table 4.11: Significance of the Association of the Fertilizer to Potassium Content of the 3 Soils

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.500[a]	2	.287
Likelihood Ratio	3.278	2	.194
Linear-by-Linear Association	.583	1	.445
N of Valid Cases	15		

a. 6 cells (100.0%) have expected count less than 5. The minimum expected count is 1.00.

Finally, another chi-square test was conducted for significance of the association of the same fertilizer (in terms of Pre- and Post-Test scenarios) to Potassium content of all three soil types at 95% confidence level. From the SPSS output above, it is seen that the Pearson Chi-Square statistic obtained has a two-sided significance of 0.287, which is not less than our critical value of 0.05. This leads to acceptance of the null hypothesis that this association is just a result of sampling error.

Thus, we conclude at 95% confidence level that addition of the said fertilizer to the three soil types collectively does NOT result to a statistically-significant change in the soil's Potassium content.

Based from data tables 4.3-4.11, it was observed that there were statistically significant changes (whether positive or negative manner) from both the Nitrogen and pH levels before and after the addition of fertilizer to all 3 types of soil. According to McCauley (2017), these 2 components are strong indicators of the soil quality, and knowing that they changed significantly may indicate a significant change in the soil quality as well. For the pH, it may be assumed as a significant decrease as looking back at table 4.1, it showed that all the soil's pH decreased, with sand having the highest decline, followed by loam, and lastly clay. This may be seen as something advantageous, yet it also may be disadvantageous, depending on the situation. It may be advantageous if the soil in the situation requires or is in need of a lower pH (possibly if the soil is basic), with the intent of having an environment fertile and habitable to plants, as plants normally thrive at a soil pH of 6.5-7 (McKenzie, 2003). In the other hand, it may be disadvantageous if there is no intent to lower the soil's pH or if there are plants already growing in the soil. A significant change in pH may make the soil more acidic than it needs to be, and if already inhabited by plants, may cause growth problems to these plants and hinder them from obtaining their needed nutrients (McKenzie, 2003; Williamson, 2012). Moving on to Nitrogen, clay and loam showed an increase, while only sand remained the same before and after the addition of the fertilizer. This may assume that the the N levels of the soils on average, significantly increased due to the fertilizer. Similarly, this may be seen as both an advantage and disadvantage depending on how much Nitrogen was present in the pre-test, as it may increase the fertility of Nitrogen-poor soil, but at the same time, may cause soil toxicity if added to an already highly concentrated soil (Allison, 1957).

Conversely, the Phosphorus and Potassium levels had no significant change, implying that the fertilizer doesn't affect the P and K levels as much as N and pH, across all the types of soil. Potassium, being a cation, was received at different amounts depending on the soil's Cation Exchange Capacity. Clay had an increase, loam decreased, and sand remained the same. Due to these varying results, it may have made the overall significance across all soil types, null. Phosphorus, in the other hand is known as an immobile nutrient (McCauley, 2005). Despite this, there were no significant differences, possibly due to some Phosphorus that may have leached out when the soil was watered. With that, this may explain why there were no significant changes in terms of Phosphorus throughout all the soils.

CHAPTER FIVE: CONCLUSION

This chapter summarizes the data gathered and analyzed by presenting the main points of the experiment and research, as well as drawing conclusions from these findings. This chapter also includes recommendations for future researchers seeking to study the topic.

Conclusion

1. Overall, the Ramgo complete fertilizer did alter the chemical composition (by means of pH, N, P, K) of the 3 types of soil, with varying results depending on the soil type. Clay soil showed an increase in the cationic nutrients, Nitrogen and Potassium (% and % respectively), but had no changes in Potassium, an anionic nutrient. Oppositely, sandy soil had no changes in the two cationic nutrients, but had an increase in the anionic nutrient (by %). Finally, loam soil had a mixed result , having increased levels in Nitrogen (by %), decreased levels of Potassium (by %), and no changes in Phosphorus. In terms of pH level, it was observed that all 3 soil types decreased in pH and became more acidic after the addition of the fertilizer, with sand having the highest drop, followed by loam, and lastly clay. From these varying results, it may be inferred that a soil property known as the Cation Exchange Capacity played a part in the soils' varying capacities or abilities to retain nutrients and withstand changes in pH. Clay soil, which is known to have a high CEC, showed to be the more superior in terms of retaining nutrients as well as regulating pH, qualities ideal for most plant soil,

thus, it may be concluded that in a situation of growing plants in general, in terms of holding as much nutrients and maintaining pH, clay soil would be the most efficient to the plant after the application of fertilizer, and should be preferred over sand and loam.

2. The data shows an observable decrease in pH levels among the three soil types after the Ramgo Complete Fertilizer was applied, in that each became slightly more acidic in nature. Sandy soil decreased in pH by 12.2%, clay soil decreased by 5.5%, and loamy soil decreased by 8.2%. These changes can be attributed to the various chemicals and elements being added to the respective soil types. Based on this observation, it can be confirmed that, after adding Ramgo Complete Fertilizer, the pH levels of change significantly. In this research's case, the pH levels decreased. These results may be seen as both an advantage and disadvantage, depending on the soil's original pH level before adding the fertilizer. It may neutralize basic soils to make it more habitable and fertile to plants, but it may also make soils more acidic than it should be, and cause growth problems to the plants inhabiting it.

3. The data shows that, while sandy soil observed no observable change in terms of nitrogen levels after Ramgo Complete Fertilizer was applied, clay and loamy soil observed statistically significant change, in that both types of soil had an increase in nitrogen content. Collectively, it can be concluded that adding Ramgo

Complete Fertilizer does change the soil’s nitrogen levels in a significant degree. Similar to the pH, this may be seen as an advantage and disadvantage depending on the soil’s initial Nitrogen content, as it may increase the fertility of Nitrogen-poor soil, but at the same time, may cause soil toxicity if added to Nitrogen-concentrated soil.

4. While sandy soil showed an observable increase of phosphorus levels after Ramgo Complete Fertilizer was added, clay and loamy soil observed no similar changes after the fertilizer was added. Statistically, phosphorus levels showed no significant change after Ramgo Complete Fertilizer was added. It can then be concluded that the aforementioned fertilizer does not change the phosphorus levels of of the three soil types in any statistically significant manner. Although Phosphorus is known as an immobile nutrient in the soil, there were no significant changes observed overall to the soils after the addition of the fertilizer. Despite being immobile, it still may have been possible for some P to leach out, especially when water was added. With that, it may explain why there was no observable significance.

5. The data shows no signs of change in the potassium levels of sandy soil after Ramgo Complete Fertilizer was applied. Clay and loamy soil experienced an increase and decrease, respectively, in potassium levels after the fertilizer was applied. In conclusion, Ramgo Complete Fertilizer did not cause a statistically

significant change in the soil types' potassium content. In relation to CEC, potassium showed different concentrations across the 3 soils, depending on the soil's CEC. Clay, with a high CEC, received more potassium, while sand, having a low CEC, maintained its potassium content. Loam, being a mix of other soils, showed a decrease in potassium content. Due to all these varying results, it may have caused an overall null significance.

Recommendations

Through this study, the researchers were able to observe the varying nutrient and pH levels across each type of soil, before and after adding the Ramgo Complete fertilizer. With this, the researchers believe this may contribute to future studies, mainly under the fields of soil science. One main contribution this research may serve is a reference source for growing plants. Knowing how each soil reacts (in terms of NPK and pH content) after the addition of fertilizer, this may help determine the best soil for specific types of plants, by aligning the plant's needs and the soils' varying abilities in retaining its pH and nutrients.

Given the results obtained through this study, the researchers also recommend several research concepts that may be considered or done in future studies:

1. The nutrients effects on plants- The researchers also would suggest further studying how the differing levels of nutrients found the 3 types of soil may affect the growth of a certain type of plant. This may determine how that certain plant reacts to the varying chemical components in the 3 types of soil in terms of its growth.
2. Measure other nutrients/minerals such as magnesium, iron, calcium etc. - Nutrients such as magnesium, iron and calcium, are known to also have significant benefits to the soil. Instead of measuring N,P,K of the soils, the researchers would suggest considering these nutrients instead.
3. Measure physical components of the soil as well - It may also be useful to consider the physical components of the 3 soils such as density, moisture etc. in order to fully determine the what would be ideal soil for growing plants in terms of both physical and chemical components.
4. Larger sample size- A larger sample size of each type of soil will ensure more accurate and reliable results in terms of pH, N, P, and K levels.
5. Longer experimentation period- This research will still look into the long term effects of the synthetic fertilizer towards the levels of pH, N, P and K, and will study the possible chemical reactions that occur in the soil with longer exposure to the fertilizer.

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APPENDIX

Appendix A

Raw Data

November 27-29, 2017 : Pre-test

Soil Sample S (Sand) C (Clay) L (Loamy)	pH Level (4.0 - 7.6)	N (Low, Med, High)	P (Low, Med, High)	K (Sufficient, Deficient)
S1	7.2	Low	Low	Sufficient
S2	7.6	Low	High	Sufficient
S3	7.6	Low	High	Sufficient
S4	7.6	Low	High	Deficient
S5	7.6	Low	High	Deficient
C1	6.4	Medium	Medium	Sufficient
C2	6.4	Medium	High	Sufficient
C3	6.8	Medium	High	Deficient
C4	6.4	Medium	Medium	Sufficient
C5	6.6	Medium	High	Sufficient
L1	7.2	Low	Medium	Sufficient
L2	7.2	Low	Low	Sufficient
L3	7.6	Medium	Medium	Sufficient
L4	7.4	Low	Low	Sufficient
L5	7.2	Low	Medium	Sufficient

APPENDIX A

December 4, 2017 : Post test

Soil Sample	pH (4.0- 7.6)	N (Low, Medium, High)	P (Low, Medium, High)	K (Sufficient, Deficient)
S1	6.4	Low	High	Deficient
S2	6.8	Low	High	Sufficient
S3	6.8	Low	High	Sufficient
S4	6.6	Low	Medium	Deficient
S5	6.4	Low	High	Sufficient
C1	6	Medium	Medium	Sufficient
C2	6.4	Medium	High	Sufficient
C3	6	High	Medium	Sufficient
C4	6	High	High	Sufficient
C5	6.4	High	High	Sufficient
L1	7	Low	Low	Sufficient
L2	6.6	Medium	Medium	Sufficient
L3	6.6	Medium	Medium	Deficient
L4	6.8	Low	Low	Sufficient
L5	6.6	Low	Medium	Sufficient

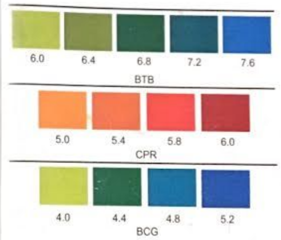
APPENDIX B

POTASSIUM TEST

1. Fill the test tube up to the scratch mark with soil sample.
2. Add 16 drops (or 1ml) of solution D and 4 drops of solution D_1.
3. Mix well by gently swirling the tube for about 1 minute.
4. Repeat step 3 after about 3 minutes and let stand for 5 minutes or until the soil particles have settled at the bottom of the tube.
5. Add solution E as follows:
   a. slowly insert the dropper containing 0.6ml of solution E inside the test tube so that its tip is about 2 cm above the solution.
   b. slowly add the 0.6ml solution E one drop at a time.
   c. DO NOT MIX OR SHAKE THE SOLUTION.
6. Let it stand for 2 minutes. Then observe the appearance of a cloudy yellow layer on top of the orange solution. A DISTINCT CLOUDY YELLOWISH LAYER indicates that the soil has SUFFICIENT AVAILABLE POTASSIUM. There is no need to apply potassium fertilizer.
7. If NO distinct cloudy yellowish layer appears on top of the orange solution, the soil is DEFICIENT in available potassium. Refer to the table on FERTILIZER RECOMMENDATIONS FOR DIFFERENT CROPS.

SOIL pH

1. Fill the test tube with soil sample up to the scratch mark.
2. Add 7 drops of CPR pH indicator dye.
3. Mix by gently swirling the test tube 20 times.
4. Repeat step 3 after about two minutes and let the test tube stand for 5 minutes.
5. To get the pH of the soil with the corresponding color chart of pH indicator dye used.
6. If soil pH is equal to or greater than 6 repeat steps 1 to 5 using BTB instead of CPR. However, if soil pH is less than or equal to 5 repeat steps 1 to 5 using BCG instead of CPR.
7. Wash test tube with tap water and then rinse with distilled water.

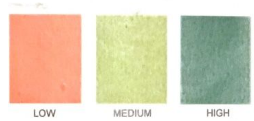


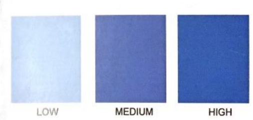
NITROGEN TEST

1. Fill the test tube with soil sample up to the scratch mark.
2. Add 16 drops (or 1ml) of solution B.
3. Mix well by gently swirling the tube 30 times.
4. Repeat step 3 after about 5 minutes and let the test tube stand for 30 minutes.
5. Match the color of the resulting solution on top of the soil with the color chart below and take note if the soil is low, medium, or high in available nitrogen.
6. Refer to the table of FERTILIZER RECOMMENDATION FOR DIFFERENT CROPS.
7. Wash the test tube with tap water and then rinse with distilled water

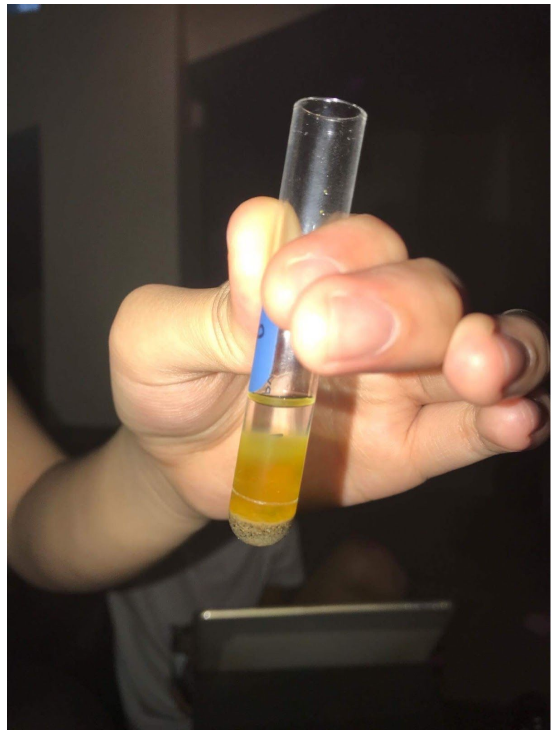
PHOSPHORUS TEST

1. Fill the test tube with soil sample up to the scratch mark.
2. Add 16 drops (or 1ml) of solution C and 2 drops of solution C_1.
3. Mix well by gently swirling the tube for about 1 minute.
4. Repeat step 3 after about 3 minutes and let the test tube stand for 5 minutes.
5. Without disturbing the soil, stir the solution slowly with the tin strip for one minute. Repeat this step after about two minutes.
   (Note: The tin strip attached to the plastic can still be used for another set of four samples provided that analyses are done on the same day. Rinse the tin strip with distilled water after each analysis.)
6. Match the blue color below and take note if the soil is low, medium, or high in available phosphorus.
7. Refer to the table on FERTILIZATION RECOMMENDATIONS FOR DIFFERENT CROPS.
8. Wash test blue with tap water and then rinse with distilled water.





APPENDIX C




DE LA SALLE