THE AMOUNT OF OIL PRODUCED BY *Cymbopogon citratus* (LEMONGRASS) PLANTED IN DIFFERENT SOILS

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THE AMOUNT OF OIL PRODUCED BY *Cymbopogon citratus* (LEMONGRASS) PLANTED IN DIFFERENT SOILS

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The Amount of Oil Produced by *Cymbopogon citratus* (Lemongrass) Planted in Different Soils

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ABSTRACT

Lemongrass (*Cymbopogon citratus*) also known as tanglad has may uses in the medical, cosmetic, food and other industries because of its essential oils which contain citral which has antibacterial, antifungal and antioxidant properties. Thus, this study aimed to identify which lemongrass planted in the different soils we obtained from the four different provinces in Panay would yield the greatest amount of essential oil for a period of 60 days. After harvesting the plants were subjected to steam distillation to acquire the essential oil which was measured in mg/g of plant matter and the soils were measured for their pH, organic matter, potassium and phosphorus content. The results showed that the plants planted on soils from Aklan, Antique, Capiz and Iloilo yielded 24.6, 25.66, 23.2 and 23.86 mg/g plant matter respectively however there was no significant difference among the amounts. Therefore it is not significant to choose which soil the lemongrass will be planted on.

Keywords: Lemongrass, Essential oil, Soil Nutrients, Steam Distillation

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CHAPTER 1

INTRODUCTION

A. Background

Lemongrass (*Cymbopogon citratus*) also known as *tanglad* to Filipinos, has unique characteristics such as its smell, taste and others, because of these characteristics, it is used in different industries such as food, medical, perfumery and cosmetic industry. It has a citric aroma which is due to the content of its essential oils especially citral which comprises 75 to 85% of the oil (Lewinsohn and others 1998). It contains active ingredients such as the mycrene, effective as antibacterial or pain reliever. Its other active components are citronella, citronellol and geranilol.

The combination of higher mycrene and citral makes the lemon grass oil less irritating to the skin and thus a good ingredient for cosmetics maker. Its antibacterial ingredient on the other hand, can be used for pharmaceutical purposes (Café 2008).

The oil's importance plays quite a role in herbal medicines and treatments (NEDFi 2005), and because of this, there is a large demand for its oil, and there is a difficulty to supply the demand, because the only known way to increase production of the oil is to plant more lemongrass, which is time, space and money consuming and there is a lot of room for wastage. In 100 grams of plant mass, approximately 1% to 2% of it is oil (Villalobos 2009). Therefore, there is a need for a large amount of the plant to be used in order to extract enough of these essential oils to supply the needs of these different industries. The essential oils in the plant are very volatile substances, therefore increasing its difficulty in getting extracted (Villalobos 2009). According to Café (2008), 400kilograms of plant will yield around 1.9L oil in the rainy season and only around 1.5liters in the dry season.

The goal of this research is to test the effect of different soils from different provinces in Panay on the oil production of lemongrass. These four soil samples were tested to see which will make the plant produce a greater amount of oil.

B. Statement of the Problem

Which soil from the four different provinces in Panay is best suited for lemongrass (*Cymbopogon citratus*) to yield the most abundant essential oils?

C. Objectives

The objectives of this study are:

1. Determine the pH and nitrogen, potassium and phosphorus content of the soils from Aklan, Antique, Capiz and Iloilo before and after planting lemongrass (*Cymbopogon citratus*).
2. Compare the pH and remaining nitrogen, potassium and phosphorus in each soil with the amount of nitrogen, potassium and phosphorus measured before and after planting lemongrass (*Cymbopogon citratus*).
3. Determine the amount of oil produced by lemongrass (*Cymbopogon citratus*) planted on the four soils from the four different provinces of Panay.
4. Compare the amount of oil produced by lemongrass (*Cymbopogon citratus*) planted on the four soils from the four different provinces of Panay.

D. Significance of the Study

The demand for lemongrass essential oil has increased since the discovery of its different noteworthy properties. It is being used for its antimicrobial and antioxidant properties and in the food industry, perfumery and cosmetics (Café 2008)(NEDFi 2005).

The findings of the study will show the best soil among the four samples for growing lemongrass (*Cymbopogon citratus)*. The results can be used by farmers and can be used in further studies related to lemongrass' growth and its essential oil. Efficiency was maximized and it will decrease the production cost of essential oil from lemongrass.

This study will help a number of farming industries where lemongrass is not abundant such as places in temperate zones all over the world. Agriculturists were able to optimize the production of lemongrass essential oil.

E. Scope and Delimitations

The lemongrass bulbs were obtained from Domingo Babonas in Bgy. Polao, Dumangas. The lemongrass bulbs were planted in separate pots for decreased effect of the uncontrollable variables such as over-rooting, weeds and parasites. The planting, growing and harvesting of the lemongrass were done in the backyard of De Juan residence in Baluarte, Molo, Iloilo City.

The soil samples were collected from Brgy. Lezo, Kalibo, Aklan; Poblacion, Cuartero, Capiz; Guisian, Lauaan, Antique; and Joxon St., Arevalo, Iloilo City. These places were chosen thru convenience sampling.

Soil analysis was done by the staff of Bureau of Soils and Water Management, Department of Agriculture, which was assisted by the researchers. Soil analyses to be done will only be limited to pH, Colorimetric Method (as a substitute to nitrogen), Hot H_2SO_4 Method (for the determination of Exchangeable Potassium) and Olsen's Method (for determination of available phosphorus).

The steam distillation done in this study was patterned after a study conducted by Villalobos. The planting and harvesting methods of lemongrass were taken from an interview with Professor Hope Patricio of Central Philippine University, College of Agriculture. The study was done for four months. It started in April 2010 until August 2010. The extracting of essential oils of lemongrass, *Cymbopogon citratus* were done in Philippine Science High-school Western Visayas Campus.

F. Definition of Terms

Lemongrass – *Cymbopogon citratus,* is a common backyard plant to tropical areas, it is now widely used because of its oil and is being extracted for industrial use (Café 2008).

In this study, it was subjected to different fertilizers to see the effects on its oil content.

Essential oil – It is any oil extracted from plant material. In this study, it is the volatile substance giving lemongrass its lemon-like aroma. It is in high demand for its medicinal properties and scent (Microsoft Encarta 2009).

In this study, it was extracted from the lemongrass.

Steam distillation – A process of extracting essential oils from plants via pressurized steam passing through plant pores making the oils evaporative with the steam and condense into the next container. It is the process of separating or purifying a liquid by passing steam through it (Microsoft Encarta 2009).

In this study, it was used to extract the oil from lemongrass.

Soil – the term used to denote the top layer of land surface containing unconsolidated products of eroded rocks and organic decay, along with the bacteria and fungi (Microsoft Encarta 2009).

CHAPTER 2
REVIEW OF RELATED LITERATURE

A. Lemongrass (*Cymbopogon citratus*)

A1. Description

Lemongrass commonly known as "East Indian Lemongrass" is a perennial and multicut aromatic grass. The prefix 'lemon' owes to its typical lemon like odor, which is mainly due to the presence of citral, a cyclic monoterpene (NEDFi 2005).

Lemongrass, or "Tanglad" as it is locally called in the Philippines, is going main-stream as its oil is now being extracted for industrial use. The most abundant variety of lemongrass in the country is the West Indian variety or *Cymbopogon citratus* variety (Café 2009).

The plant itself is usually used as a stuffing for roasted chicken and pigs.

A2. Planting and Cultivation

Lemongrass requires a warm humid climate with plenty of sunshine and rainfall ranging from 1800 to 3000 mm. High temperature and sunshine are conducive to the development of oil in the plant. Its growing time is all year round and its oil production peak is after 3 months of planting (NEDFi 2005).

The NEDFi procedure for artificial cultivation of lemongrass requires an area of 45cm by 45cm or $2025cm^2$ for each plant.

Lemongrass flourishes in a wide variety of soils ranging from rich loams to poor laterite; also suitable to 'jhum fallow' or unseeded land, hill slopes and flood-free degraded land, best suited to well drain sandy loam. Water logged conditions should be avoided as they are unsuitable for its cultivation (NEDFi 2005).

N, P205 & K20-150: 60: 60 kg/ha/year should be applied along with adequate quantity of organic matter. Before planting, the field is thoroughly prepared and the full dose of phosphorus and potash is incorporated. The nitrogen is applied in six equal split doses at two monthly intervals. For economic use of fertilizers the soil should be analyzed first (NEDFi 2005).

Nitrogen optimizes plant growth and is essential in growth of foliage. Phosphorus hastens plant maturity for it stimulates root growth. Potassium increases the plant's resistance to harsh weather conditions and diseases; it also helps in the plants' food manufacturing process (T. G. C. 2007).

If the pH of the soil solution is increased above 5.5, Nitrogen (in the form of nitrate) is made available to plants. Phosphorus, on the other hand, is available to plants when soil pH is between 6.0 and 7.0. Nitrogen levels require a minimum of 0.5% to 1% to produce improved plant growth. Phosphorus levels require a minimum of 10 ppm to promote plant growth and a recommended level of 20 ppm to reduce deficiency symptoms. Potassium levels can go as low as 165 ppm with slight yield losses of about 10% and require at least 300 ppm to reduce yield loss to zero with no side-effects.

If the soil solution is too acidic plants cannot utilize N, P, K and other nutrients they need. In acidic soils, plants are more likely to take up toxic metals and some plants eventually die of toxicity (poisoning) (Spector 2001).

A3. Physical Characteristics

A lemongrass has two main parts: the leaves and the bulb. The leaves can be cut into two parts which are the leaf blade and the leaf sheath. The leaf blade is the edge of the leaf while the sheath is its body where most of its essential oil resides. The bulb holds the leaves altogether. It supports the whole plant because it is where the roots grow from. It contains oil also but in a smaller amount.

A4.Essential oils

Lemongrass essential oils contain active ingredients such as the mycrene which is effective as antibacterial or pain reliever. Its other active components are citronella, citronellol and geranilol. The lemon grass is sixty five to eighty five percent citral. The combination of higher mycrene and citral makes the lemon grass oil less irritating to the skin and thus a good ingredient for cosmetics maker. Its antibacterial ingredient can be used for pharmaceutical purposes (Café 2009).

Lemongrass oil is a good source of natural citral, which is used as a basic raw material for synthesis of β-ionone. β-ionone used for synthesis of a number of useful aromatic compounds and Vitamin-A. Lemongrass oil is used as a main substitute for 'Cod liver oil'. Citral itself is used in perfumery for various grades of soaps detergents, cosmetics and flavor agent for soft drinks. Consumption of Lemongrass in Ayurvedic preparation like Balm is also increasing. The present domestic requirement is about 150 MT/year and about 70 MT is exported every year. The total world production is estimated to 1300 MT/year (NEDFi 2005).

The essential oil in a plant has two types of function: protection and communication. It affords the host plant protection from pathogenic micro-organisms such as bacteria or fungi, and/or it deters herbivorous mammals from consuming the plant. The "fragrant cloud" surrounding the plant may attract a particular species of bee, for example, that will help the plant reproduce by cross-pollination when it visits similar plants in flower. Or as with mammals, insects that would otherwise eat the plant are deterred by the slowly vaporizing essential oil.

Consequently, it is not surprising to find that certain essential oil constituents are neurotoxic to specific insects, or act as insect repellents. Because essential oils have evolved to be so effective in deterring insects, natural crop protection sprays are being commercially developed. In other cases, the essential oil may mimic insect pheromones, fooling a male insect into believing it is homing in on a female of the same species. In a few instances, plants communicate with other plants of the same species through release of essential oil, warning of predators so that plants receiving the message will increase production of anti-feedant chemicals.

Many of the same chemical constituents that are found in essential oils are also biosynthesized by insects, and function as pheromones, communicating messages such as scent trail marking, gender identification or attack alerts. For many of the above reasons, essential oil constituents need to be volatile – they need to be released as and when needed, and they need to carry their "message" across space (Tisserand 2010).

B. Soil Analysis

B1. Olsen Method

The Olsen Method is used to measure the available phosphorus in a soil sample. 2.0 g of soil sample is weighed and placed in a 100 mL polyethylene bottle. 40 mL of extracting solutions will be added. The bottle will then be covered and shook at 200 or more opm for 30 minutes.

The extract will be filtered through Whatman No. 2 filter paper into a 125 mL Erlenmeyer flask. If the extract is not clear, it must be filtered again. A 5 mL aliquot will be transferred to a 50 mL Erlenmeyer flask. 15 mL of reagent B and agitate will be added so that thorough mixing occurs.

Development will take place in ten minutes. The colorimeter set at 882 nm wavelength will be read. For at least two hours, the color is stable. A standard curve by pipetting a 5 mL aliquot of each of the working standards will be prepared, developing color and reading intensity in the same manner as with the soil extracts. Ppm concentration in filtrate will be converted to concentration in the soil. To convert the following formula will be used:

$$\text{ppm P in soil} = \text{ppm P in filtrate} \times 20 \times \text{mcf}$$

Where mcf is the moisture correction factor

B2. Determination of Exchangeable Potassium (Hot H_2SO_4 Method)

An aliquot of 1, 4, 8, 16 and 20 mL of 250 ppm K will be pipette each into five 100-mL volumetric flasks. 0.1 N H_2SO_4 will be diluted to volume. K concentrations from 0, 10, 20, 30, 40 and 50 ppm will be covered by the standards. The % transmission will be read in a flame photometer. The K concentration will be plotted against the % transmission.

To determine the K in soil sample, 10 gm of soil will be weighed in a beaker. 25 mL of distilled water will be added and mixed. Then, 1 mL of concentrated H_2SO_4 will be added and the mixture will be stirred. For 30 minutes, the mixture will be left. Afterwards, it will be filter and washed with 0.1 N H_2SO_4 solution, 15 mL at a time into a 100-mL volumetric flasks to volume. The % transmission will be read in a flame photometer. Computation of results uses this formula:

$$\text{ppm K in soil sample} = \text{ppm K in solution} \times (100/10)$$

B3. Organic Matter Determination (Colorimetric Method)

0.25 g soil sample will be weighed in a beaker. Then 1.0 mL $K_2Cr_2O_7$ will be added using a burette. Afterwards, 10.0 mL of H_2SO_4 will be added. This mixture will be placed in a hot plate with a temperature ranging from 160^0C to 170^0C for 5 minutes. This will be allowed to cool down afterwards. 10.0 mL distilled water will be added to the mixture. When cool, 20 mL supernatant solution will be decanted into a 1×6 inches container.

B4. pH

An amount of 20 g of soil will be weighed into a polyethylene bottle.20 mL distilled water will be added and the bottle will be covered. For ten minutes, it will be shaken at 250 opm. It will be left for one hour. The pH meter will then be calibrated using the standard buffer solutions of pH 4.0 and pH 7.0. The sample suspension will be stirred and the electrode will be immersed in the upper part of the suspension. The pH will be read, to the nearest 0.1 pH unit, when reading has stabilized.

If only pH $CaCl_2$ is required, 20 grams of soil will be weighed into a polyethylene bottle. 40 mL of 0.1 M $CaCl_2.2H_2O$ solution will be added. It will then be shaken at 250 opm within 10 minutes and will be let stand for 30 minutes. The pH meter will then be calibrated using the standard buffer solutions of pH 4 and pH 7. The sample suspension will be stirred and the pH to the nearest 0.1 pH unit will be determined. The pH will be recorded once the reading has stabilized (Bureau of Soils and Water Management Laboratory Manual 2002).

C. Steam distillation

Steam distillation is a very useful method used in extracting essential oils from plants containing them. This process includes distilling in the presence of water. Steam works to volatize certain chemicals such that they boil and come with the water and later condenses then separated. Steam breaks open the walls where the essential oils reside, and then carries them with it (Talbotron 2007).

The plant containing the essential oil and water goes in the bottom of a big pot, with a cup placed on top. The lid is really the key component here; by simply turning the lid of the pot upside down, the vapors will condense and drip down from the center, collecting in the cup below. By filling the top of the lid with ice water, the vapors are condensed very efficiently (Talbotron 2007).

According to Villalobos (2009), the bulbs need to be cut to optimize the activity of the distillation. Figure 1 shows a diagram of a steam distillation set-up.

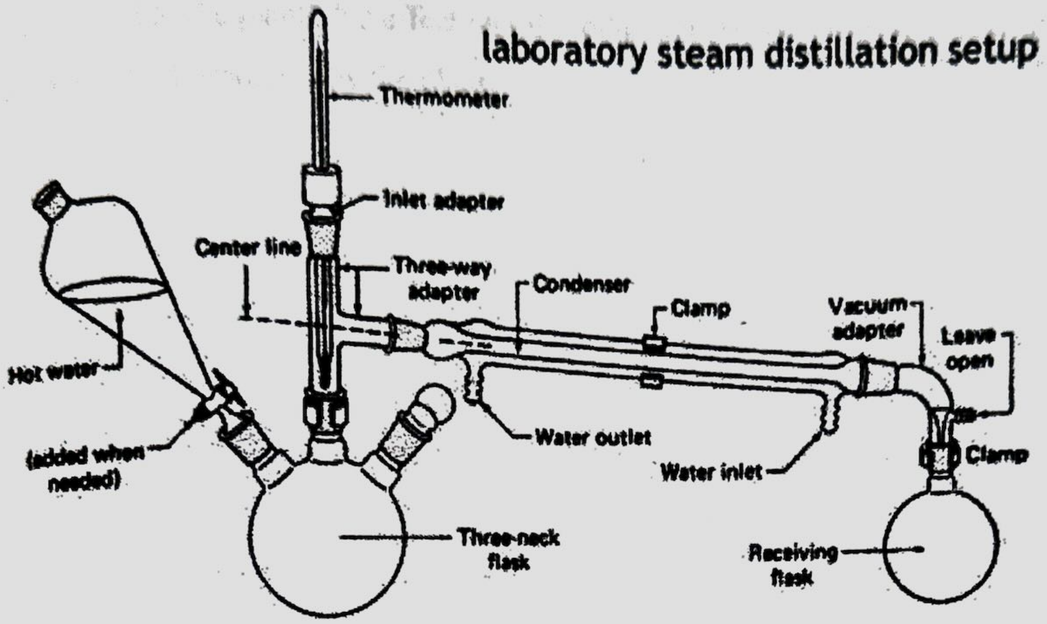

Figure 1. A steam distillation set-up

D. Related Studies

According to the study of Maria Isabella Sifola and G. Barbieri entitled "Growth, yield and essential oil content of three cultivars of basil grown under different levels of nitrogen in the field," "Nitrogen fertilization up to 300 kg ha^{-1} increased yield of above-ground and leaf fresh biomass, leaf essential oil yield, but it did not affect leaf-to-stem ratio, plant height and the number of branchings per plant. The increase in essential oil yield induced by N fertilization depended on an increase in both leaf essential oil concentration and leaf biomass. The increase in LAI with increasing N fertilization was due to an increase in leaf number per plant rather than in individual leaf expansion." Based on their findings, we can conclude that nitrogen, as one of the key components of plant growth, affects essential oil production in some plants such as basil (*Ocimum basilicum* L.) which might also hold true for lemongrass (*Cymbopogon citratus*).

According to the study of Valtcho D. Zheljazkov, Vasile Cerven, Charles L. Cantrell, Wayne M. Ebelhar and Thomas Horgan entitled "Effect of Nitrogen, Location, and Harvesting Stage on Peppermint Productivity, Oil Content, and Oil Composition," "Peppermint biomass yields were higher at Verona (8.12 $t \cdot ha^{-1}$) than at Stoneville (6.12 $t \cdot ha^{-1}$). However, the essential oil content was higher at Stoneville (1.1%) than at Verona (0.6%). Generally, N rate at 80 $kg \cdot ha^{-1}$ did not affect oil yield and composition compared with 0 $kg \cdot ha^{-1}$." Based on their findings, the decrease in essential percentage by caused by the increased dose of nitrogen introduced to the plant, this effect on oil production shows the influence of nitrogen to the amount of oil produced by the plant.

CHAPTER 3
METHODOLOGY

A. Overview of the Study

The amount of oil produced by lemongrass planted in four different soils from the four different provinces within Panay Island were measured and compared in this study. The oil was extracted from the plant through steam distillation before being compared.

The soil was obtained from four different provinces in mainland Panay namely Iloilo, Aklan, Capiz and Antique. Acquiring soil samples from these provinces were according to *Guide of Acquiring Soil Samples* from the Bureau of Soils and Water Management, Department of Agriculture.

The study was conducted in De Juan residence in Molo, Iloilo City starting the month of April to July 2010. It was divided into two parts, the planting phase and the extraction phase.

B. Materials

B.1. Equipment

- Receiving Flask
- Shovel
- Soil
- Beaker
- Lemongrass Bulbs
- Steel Tape
- Weighing Scale
- Hot Plate
- Graduated Cylinder
- Plaster of Paris
- Erlenmeyer Flask
- Pots
- Condenser
- U tube
- Distilling Flask
- Cork
- Rubber Stopper
- Clamp Iron
- Stand

C. Procedure

C.1. Soil Sampling

Soil samples were collected from the four different provinces in Panay Island. First all the materials above the soil were removed. The top layer of soil (15 cm) was removed before obtaining 2×5×15 cm block of soil was obtained; these steps were repeated at least ten times randomly within the area. Then, the soil obtained was mixed all together.

Then, all visible organic materials and other contents exceeding 2cm in diameter or size were removed manually. The rest were crushed by a mortar and pestle. The remaining fresh sample was then spread into a pan with height not exceeding 15mm in thickness until it is completely dry. The layer was divided into four quarters, two opposite quarters were discarded and the others were retained. These steps were repeated until the remaining soil sample is at least 1 kilogram.

C.2. Soil Analysis

The soil to be used for the pots was analyzed by the Bureau of Soils and Water Management to determine its Organic Mater, Phosphorous, Potassium and pH levels before and after planting.

C.2.a. Olsen's Method

The Olsen Method is used to measure the available phosphorus in a soil sample. 2.0 g of soil sample is weighed and placed in a 100 mL polyethylene bottle. 40 mL of extracting solutions were added. The bottle was then covered and shaken at 200 or more opm for 30 minutes.

The extract was filtered through Whatman No. 2 filter paper into a 125 mL Erlenmeyer flask. If the extract was not clear, it would be filtered again. A 5 mL aliquot was transferred to a 50 mL Erlenmeyer flask. 15 mL of reagent B and agitate were added so that thorough mixing occurs.

Development took place in ten minutes. The colorimeter set at 882 nm wavelength was read. For at least two hours, the color was stable. A standard curve by pipetting a 5 mL aliquot of each of the working standards was prepared, developing color and reading intensity in the same manner as with the soil extracts. Ppm concentration in filtrate was converted to concentration in the soil. To convert the following formula was used:

$$\text{ppm P in soil} = \text{ppm P in filtrate} \times 20 \times \text{mcf}$$

Where mcf is the moisture conversion factor

C.2.b. Determination of Exchangeable Potassium (Hot H_2SO_4 Method)

An aliquot of 1, 4, 8, 16 and 20 mL of 250 ppm K were pipette each into five 100-mL volumetric flasks. Afterwards, 0.1 N H_2SO_4 was diluted to volume. K concentratins from 0, 10, 20, 30, 40 and 50 ppm were covered by the standards. The % transmission was read in a flame photometer. The K concentration was plotted against the % transmission.

To determine the K in soil sample, 10 gm of soil was weighed in a beaker. An amount of 25 mL of distilled water was added and mixed. Then, 1 mL of concentrated H_2SO_4 was added and the mixture was stirred. For 30 minutes, the mixture was left. Afterwards, it was filtered and washed with 0.1 N H_2SO_4 solution, 15 mL at a time into a 100-mL volumetric flasks to volume. The % transmission was read in a flame photometer. Computation of results uses this formula:

$$\text{ppm K in soil sample} = \text{ppm K in solution} \times (100/10)$$

C.2.c. Organic Matter Determination (Colorimetric Method)

Soil sample weighing 0.25 g was weighed in a beaker. Then 1.0 mL $K_2Cr_2O_7$ was added using a burette. Afterwards, 10.0 mL of H_2SO_4 was added. This mixture was placed in a hot plate with a temperature ranging from 160^0C to 170^0C for 5 minutes. This was allowed to cool down afterwards. Then, 10.0 mL distilled water was added to the mixture. When cool, 20 mL supernatant solution was decanted into a 1×6 inches container.

C.2.d. pH

An amount of 20 g of soil was weighed into a polyethylene bottle. Then, 20 mL distilled water was added and the bottle was covered. For ten minutes, it was shaken at 250 opm. It was left for one hour. The pH meter was then calibrated using the standard buffer solutions of pH 4.0 and pH 7.0. The sample suspension was stirred and the electrode was immersed in the upper part of the suspension. The pH was read, to the nearest 0.1 pH unit, when reading had stabilized.

If only pH $CaCl_2$ was required, 20 grams of soil was weighed into a polyethylene bottle. 40 mL of 0.1 M $CaCl_2.2H_2O$ solution was added. It was shaken at 250 opm within 10 minutes and was let stand for 30 minutes. Then, the pH meter was calibrated using the standard buffer solutions of pH 4 and pH 7. The sample suspension was stirred and the pH to the nearest 0.1 pH unit was determined. The pH was recorded once the reading stabilized.

C.3. Acquiring of Materials

Lemongrass bulbs were acquired from existing lemongrass from the house of Mr. De Juan. The distilling set-up was obtained from PSHS WVC. The pots were obtained from the Iloilo Plastic Center.

C.4. Pot Set-up

Each pot was 30cm in diameter and 28cm high with an area of 2218.41cm² (recommended area is 2025cm² each plant). The pots were labeled and lined up randomly in a four by ten orientation.

C.5. Planting Preparation

Forty lemongrass bulbs were taken from Barrotac, Iloilo and selected through convenience sampling to ensure that the bulbs were at least the same size. Each bulb was cut so that each contained 2-3 tillers and the lower sheath was removed to expose young roots. The old roots were cut. The bulbs were randomly placed into the pots and the pots were randomly arranged.

C.6. Planting of Lemongrass

The selected lemongrass bulbs were placed in a yard located at Molo, Iloilo City. Each lemongrass bulb was planted 5-8 cm deep. The plant started sprouting in a week and became an established plant in 25-20 days. Each treatment was equally given the 300 mL of water a day, and was arranged randomly away from shade so that they each received the same amount of sunlight. The lemongrasses were given 150 mL at 8:00 am and at 6:00 pm each day, for 90 days or until harvest. Each plant was weeded at 25-30 days of age (Lemongrass has the weed suppression capacity afterwards).

C.7. Harvesting

The selected Lemongrasses were uprooted and were prepared for steam distillation. The rest of the soils from the harvested plants were returned to the garden after a sample was taken for the second nutrient evaluation.

C.8. Preparation of Plant Prior to Steam Distillation

The uprooted Lemongrass was washed thoroughly with water and weighed. It was then be air dried for seven days. Once dried it was weighed and cut into small pieces exposing as much surface area as possible. The bulbs were also divided into 4 parts to increase efficiency of oil extraction. They were then packed into zip lock bags until distillation.

C.9. Steam Distillation

The distillation set-up was prepared by putting the Erlenmeyer flask above the hot plate. The Erlenmeyer flask was connected to the distilling flask which contained the lemongrass using a U tube. The distilling flask was then connected to the condenser. The distilling flask was filled with the dried lemongrass. The hot plate was turned on to heat the Erlenmeyer flask and let the steam flow through the dried lemongrass. The steam then carried the oil to the condenser. The cool water was made to flow around the condenser to cool the steam floating in the device. The condensed oil floating was collected in the receiving flask and was immediately weighed after.

C.10. Disposal

The remaining plants were replanted into the yard. The remaining soil was buried. The samples that were used for steam distillation were thrown in the trash bins.

CHAPTER 4
RESULTS AND DISCUSSIONS

This study was conducted to determine which soil is best suited for the production of essential oil from lemongrass, *Cymbopogon citratus*. Our set-up contained 10 replicates for 4 treatments. The plants were grown during the summer, April to August 2010. The soil used was tested prior to planting for its organic matter, potassium, phosphorus content and its pH level to determine a significant effect on the oil content.The plants were harvested and cut into small pieces to expose the more surface area for faster release of essential oil. These cut leaves were distilled using the steam distillation set-up.

The objectives of this study are to: (a) Determine the pH and nitrogen, potassium and phosphorus content of each soil before and after planting lemongrass (*Cymbopogon citratus*). (b)Compare the pH and remaining nitrogen, potassium and phosphorus in each soil with the amount of nitrogen, potassium and phosphorus measured before and after planting lemongrass (*Cymbopogon citratus*). (c)Determine the amount of oil produced by lemongrass (*Cymbopogon citratus*) planted on the four soils from the four different provinces of Panay.(d)Compare the amount of oil produced by lemongrass (*Cymbopogon citratus*) planted on the four soils from the four different provinces of Panay.

Figure 2 shows the comparison of the pH levels of each soil. Results show that the soil from Iloilo is the least acidic having a pH of 7.8 and the soil from Capiz being the most acidic with the pH of 4.4. Based on what was stated in Chapter 2, a pH of 5.5 and above would make organic matter (in the form of nitrate) available to plants; and a pH between 6.0 and 7.0 will make phosphorus available for the plants. Only the soil from Capiz did not reach the pH requirement for organic matter and phosphorus which indicates that the lemongrass planted in this soil did not absorb organic matter and phosphorus from the soil.

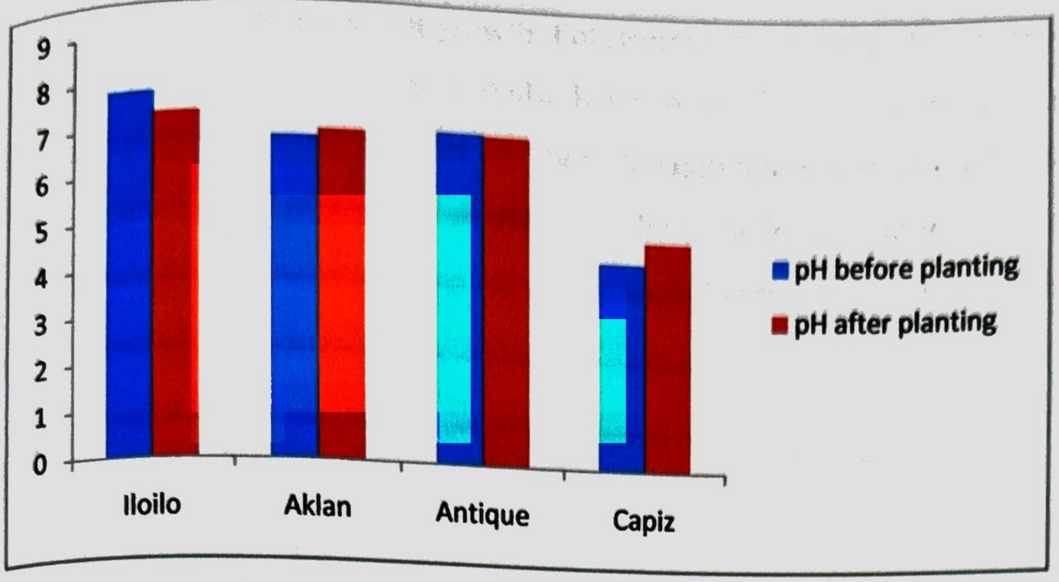

Figure 2: Comparison of pH levels.

Figure 3 shows the comparison of % organic matter of each soil sample. Results shows that the soil containing the most organic matter is the soil from Kalibo (3%) followed by the soil from Antique (2%) and then the soil from Capiz (1.5%). The soil containing the least organic matter was the sample from Iloilo (1%). Based in chapter 2, nitrogen optimizes plant growth and is essential in growth of foliage. All of the samples are above the minimum level needed for plant growth (0.5%), both before and after planting.

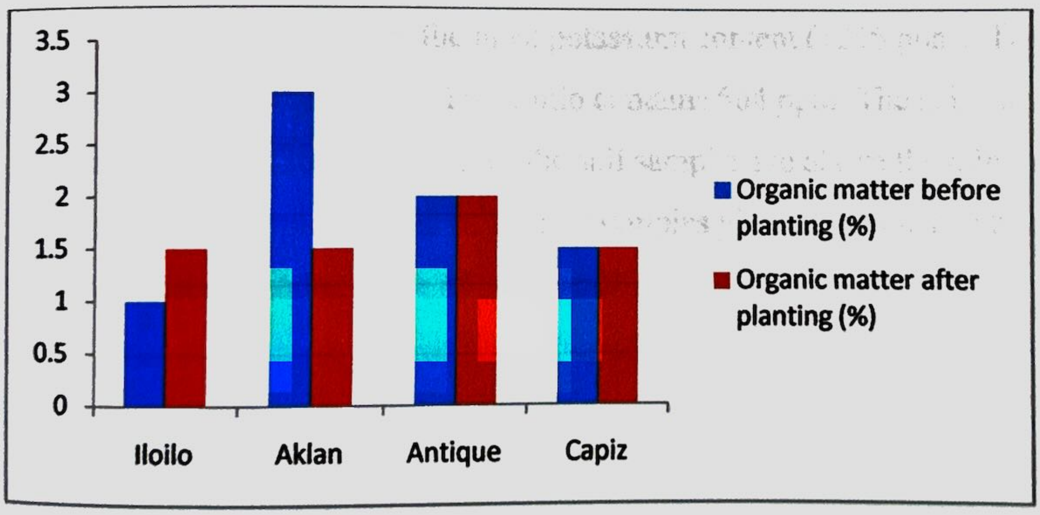

Figure 3: Comparison of Organic Matter levels of the soils from the four different sites

Figure 4 shows the comparison of phosphorus contained in each soil sample. Results show that the soil sample containing the most phosphorus is Capiz (20 ppm). The soil from Kalibo contains the least phosphorus (11 ppm). Based on chapter 2, phosphorus hastens plant maturity for it stimulates root growth. Potassium increases the plant's resistance to harsh weather conditions and diseases; it also helps in the plants' food manufacturing process (T. G. C. 2007). All of the soil samples are above the minimum amount needed for plant growth (10 ppm), although not all of the samples went above the level recommended to decrease deficiency symptoms such as slow maturity (20 ppm). Only the soil form Capiz reached 20 ppm before and only Aklan went above 20 after the planting.

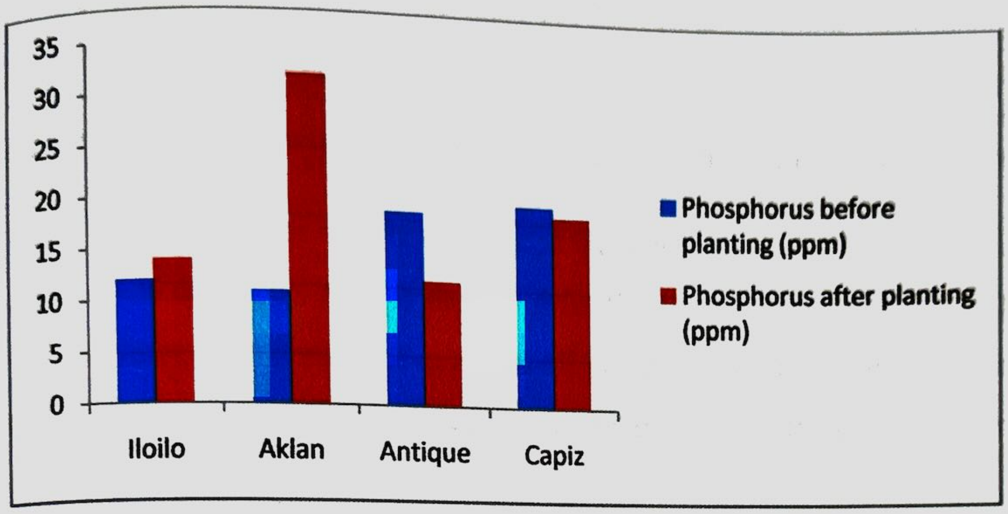

Figure 4: Comparison of Phosphorus levels of the soils from the four different sites

Figure 5 shows the comparison of potassium content by ppm. Results show that the sample form Kalibo contains the most potassium content (1256 ppm). The sample form Antique contains 936 ppm; the sample from Iloilo contains 504 ppm. The soil sample contains the least potassium content (360 ppm). All of the soil samples are above the minimum amount needed for plant growth (165 ppm) and all of the soil samples yielded zero losses because all levels were above the recommended value of 300 ppm.

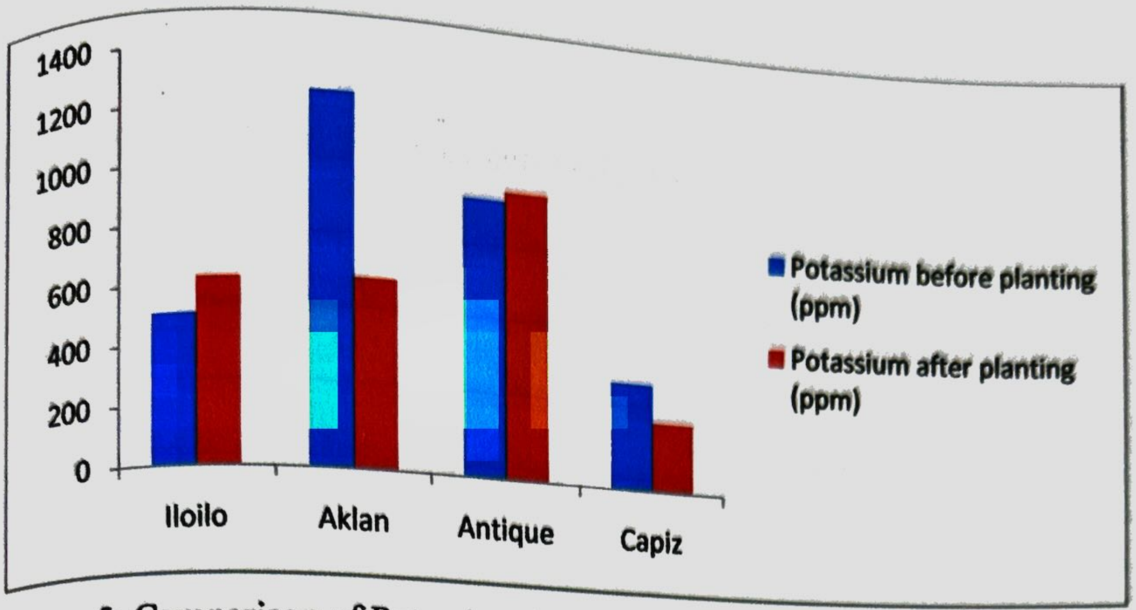

Figure 5: Comparison of Potassium levels of the soils from the four different sites

Table 1 shows that the soil that produced the most essential oil mass density is the sample from Antique (25.66 mg/g). Next is the soil form Kalibo (24.6mg/g), Iloilo (23.86mg/g) and the soil with the least mass density of essential oil is the sample from Capiz (23.2mg/g). Results show that there was no significant difference in the amount of oil from the other soils acquired from other provinces.

Table 1: The amount of essential oil extracted from each sample plant.

	Aklan (g)	Antique	Capiz	Iloilo
Amount of essential oil in plant (mg/g dry sample)	24.6	25.66	23.2	23.86

Based on these findings, each soil is capable of supporting plant life, although the soil from Capiz might have had difficulty in the early days of plant growth due to its acidic nature (the pH of the sample from Capiz is 4.4). The soil from Kalibo is rich in potassium and organic matter compared to the other soil samples, which should have increased the plants' resistance to harsh weather conditions and other physical properties such as leaf size and plant weight, there was no significant difference between the essential oil content of the four treatments.

Table 2: Statistical analysis for essential oil samples.

	Sum of Squares	df	Mean of squares	F	p (same)
Between groups	0.025425	3	0.008475	0.02324	0.9948
Within Groups	2.917	8	0.364725		

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary:

This study aimed to determine which of the lemongrass planted in four different soils could produce the greatest amount of essential oil. Specifically it aimed to:

1. Determine the pH and nitrogen, potassium and phosphorus content of each soil before and after planting lemongrass (*Cymbopogon citratus*).
2. Compare the pH and remaining nitrogen, potassium and phosphorus in each soil with the amount of nitrogen, potassium and phosphorus measured before and after planting lemongrass (*Cymbopogon citratus*).
3. Determine the amount of essential oil produced by lemongrass (*Cymbopogon citratus*) planted on the four soils from the four different provinces of Panay.
4. Compare the amount of essential oil produced by lemongrass (*Cymbopogon citratus*) planted on the four soils from the four different provinces of Panay.

The results showed that there is no significant difference between the amounts of essential oil produced by the lemongrass even if the soils varied in content.

Conclusion:

Since there is no significant difference in amount of essential oil extracted between the lemongrass, the compositions of the soil does not greatly affect the amount of essential oil produced or the difference between the compositions of the soil was not great enough to cause a significant change. The results also showed in both the Aklan and Antique soils that with the starting pH of 7 and up, which made phosphorus available and with an adequate amount of organic matter(2 and up) have produced more essential oil than the others, but in general, it did not affect the quality of the plant. All soils were not depleted of their nutrient levels even after planting so they're all still capable of supporting another set of plants. Therefore it does not matter where the lemongrass is being planted as long as the plant is kept under proper growing conditions.

Recommendations:

It is recommended for further studies to:

- Research about the other factors that might affect the amount of essential oil produced such as the climate, species of plant or precipitation.
- See if fertilizers might also be used along with the proper pH levels.
- Research further into the composition of the essential oil such as citral.

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APENDIX A

Raw Data

RESULTS OF SOIL ANALYSIS (PRIOR TO PLANTING)

Sources	pH	S.A. Wildes O.M. (%)	Olsen's P (ppm)	Hot H_2SO_4 K (ppm)
Iloilo	7.8	1	12	504
Antique	7	2	19	936
Aklan	6.8	3	11	1256
Capiz	4.4	1.5	20	360

RESULTS OF SOIL ANALYSIS (AFTER TO PLANTING)

Sources	pH	S.A. Wildes O.M. (%)	Olsen's P (ppm)	Hot H_2SO_4 K (ppm)
Iloilo	7.34	1.5	14	624
Antique	6.97	2	12.3	968
Aklan	6.94	1.5	32	632
Capiz	4.86	1.5	19	232

AMOUNT OF ESSENTIAL OIL EXTRACTED FROM EACH SAMPLE PLANT

Trials	Kalibo (g)	Antique (g)	Capiz (g)	Iloilo (g)
1	1.4	1.58	1.4	0.82
2	1.77	0.96	0.67	2.2
3	0.53	1.31	1.41	0.56
Average	1.23	1.283	1.16	1.193

APENDIX B

PLATES

Plate 1: Mixing of soils for each treatment

Plate 2: Labelling of each pot

Plate 3: Sieving of soil for each pot

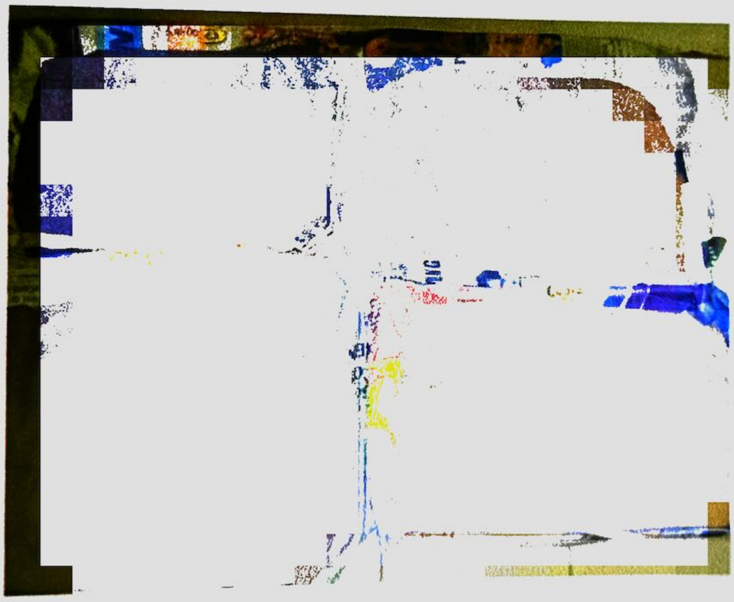

Plate 4: Drying of each soil prior to soil analysis

Plate 5: Weighing of the contents of each pot

Plate 6: Placing the properly weighed soil in each pot prior to plating

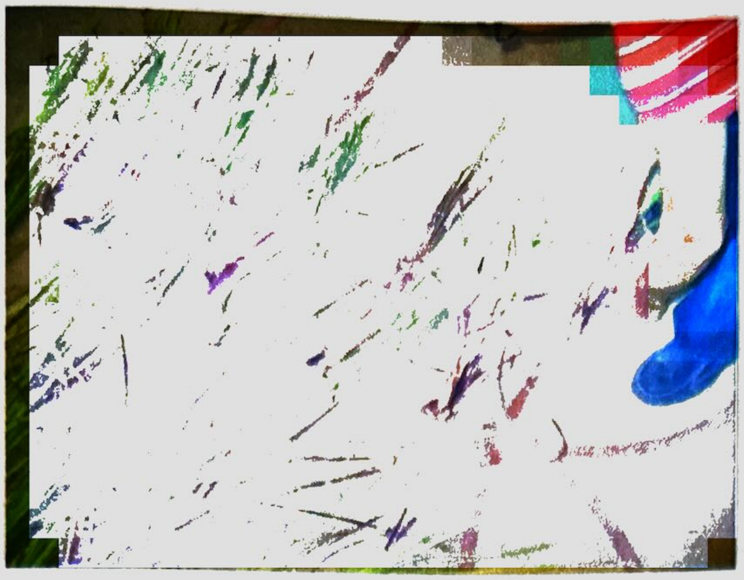

Plate 7: Preparing all the stalks

Plate 8: Planting all 40 plants

Plate 9: Watering of Lemongrass

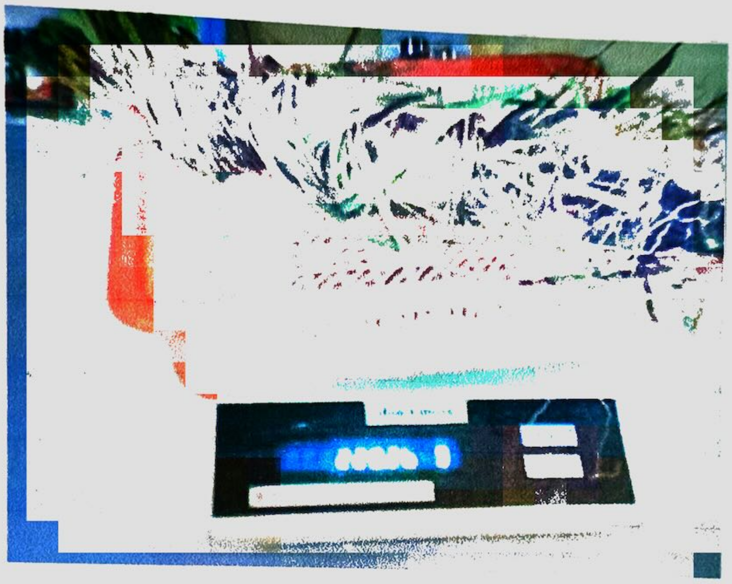

Plate 10: Measuring the fresh weight of the sampled plants

Plate 11: Weighing 50 grams of plant matter prior to distillation

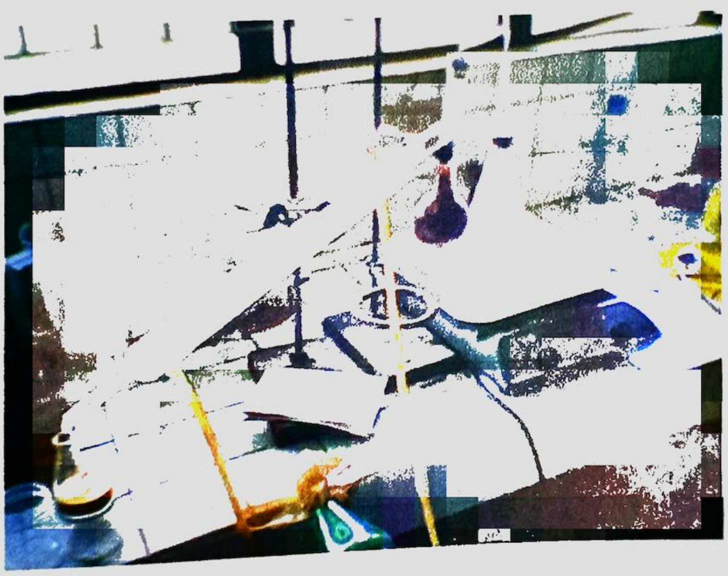

Plate 12: Steam distillation set-up

APENDIX C
LETTER TO SOIL TEST LABORATORY

Department of Science and Technology
PHILIPPINE SCIENCE HIGH SCHOOL WESTERN VISAYAS
Doña Lawa-an H. Lopez Campus
Bito-on, Jaro, Iloilo City

April 30, 2010

Ms. Helen J. Maquiling
Chief Soils Laboratory Services
Department of Agriculture RSUC
Parola Iloilo

Dear Ms. Maquiling,

Greetings!

We, Mark Elerey G. DeJuan, Benedict Eldred V. Dy and Renzil R. Lladonet, Fourth year students of Philippine Science High School Western Visayas, will be conducting a research entitled, **"Oil Content of Lemongrass (*Cymbopogon citratus*) Planted In Different Soils"**, as a requirement for our research class.

Our study requires the following analysis:
Organic Matter, Potassium and Phosphorus content of soil

These tests require materials that we do not possess at the school. We are humbly requesting for your permission for us to conduct our study in your laboratory located in Parola, Iloilo City.

Our school requires us to do the analysis ourselves with adult supervision. Should you grant our request, may we also ask permission to do the analysis ourselves? We understand that your laboratory assistants do not have pay for overtime work, so we are willing to offer an honorarium for their time.

Should you approve to the above mentioned request, may you text or call us with our given contact information.

APENDIX C

You may contact us through phone.
Call Philippine Science High School Western Visayas Campus: 329 2011
The student's contact details:

Mark Elerey G. DeJuan – 3361512
Benedict Eldred V. Dy – 09289357852
Renzil R. Lladonet – 09207746068

Hoping for your kind consideration.

Thank you very much!

Truly yours

MARK ELEREY G. DE JUAN

BENEDICT ELDRED V. DY

RENZIL R. LLADONET

Noted by:

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Special Science Teacher 1
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Dr. Josette T. Biyo
Director III
Philippine Science High-school – Western Visayas Campus