Analysis of Soil Properties and Soil Fertility in the Marigold Plot at Varee Chiang Mai School

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Lastly I sincerely hope that this research will be useful to those who are interested in agriculture and the environment and can be applied to improve soil quality for future cultivation.

Abstract

Soil is a natural resource that plays an important role in ecosystems and agriculture because it is a source of nutrients and a medium for the absorption of nutrients by plants. The purpose of this study was to analyze the soil properties and soil fertility in marigold flower plots. Varee Chiang Mai School focuses on the study of physical properties such as structure, color, adhesion, temperature, and moisture of soil, as well as chemical properties such as pH and macronutrient content (nitrogen, phosphorus, and potassium).

The study was conducted by collecting soil samples from marigold plots and conducting analysis according to the GLOBE Program standards. (N, P, K) Soil pH Meter and Soil Temperature and Moisture Meter. The results showed that the soil in the study area had a pH value in the range of 6.5-6.9, which is suitable for plant to grow. However, it has been found that the nitrogen and phosphorus content in the soil is low, which may be a limited factor for plant growth.

Based on the results of this research, it is recommended that add soil organic matter such as compost and manure to increase nitrogen and phosphorus content, as well as improve soil and water management to maintain optimal soil moisture. This study can be used as a guide to improve soil quality and promote more efficient cultivation of marigolds.

Keywords: soil properties, soil fertility, pH, macronutrients (N, P, K)

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Chapter 1

Background and significance

1.1 Background and significance of the problem

Soil is a natural resource that is of great importance for the survival of humans and other living things on Earth. Whether it is the use of soil in agriculture. Growing plants for food Soil quality monitoring is an important process to assess the suitability of soils for various applications such as crop cultivation, construction, and environmental conservation. Soil quality analysis can be performed in both physical and chemical aspects, including monitoring the soil structure, soil color, etc. soil fixation, soil temperature, Soil moisture, soil acidity-base, and soil fertility (nitrogen (N), phosphorus (P) and potassium (K)). This can be used to improve soil quality and raise awareness among students and school staff about the importance of soil and natural resource conservation.

1.2 Research Questions

1)How the physical and chemical properties of soil affect soil fertility?

2) How can soil quality be improved to be suitable for crop cultivation?

1.3 Research Hypothesis

1) The acid-base (pH) value of the soil affects the fertility of the soil.

2) Soil moisture affects soil temperature.

3) Dark soils tend to be more fertile than lighter soils.

4) The soil retention ability affects the water and air permeability in the soil.

5) Macronutrients (N, P, K) in the soil are influenced by environmental factors such as organic matter and soil pH.

1.4 Objectives of the research

1) To analyze the physical properties of the soil, including soil structure, soil color, soil adhesion, soil temperature, and soil moisture

2) To analyze the chemical properties of the soil, including soil acidity-base and soil fertility (nitrogen, phosphorus and potassium values),

3) To evaluate the suitability of the soil in the study area for agricultural use and environmental conservation.

1.5 Expected results from the research

1) Scientific data on soil quality in schools

2) Students gain knowledge and skills in soil analysis

3) Schools can use the data in green space improvement planning.

1.6 Scope of research

1) Study Area

Flower garden at Varee Chiang Mai School 59 Moo 6 Mahidol Road Latitude: 18.7596 °N Longitude: 99.0138 °E

2) Relevant factors to be studied and measured.

2.1) Physical properties of the soil:

- Soil structure
- Soil color
- Soil fixation
- Soil temperature
- soil moisture;

2.2) Chemical properties of soil:

- Acidity-base (pH) of the soil
- Soil fertility by measuring the amount of macronutrients such as nitrogen (N), phosphorus (P), and potassium (K).

3) Period of research

- January 2025 to February 2025

1.7 Research Planning

1) Determine the study point.

Determine the soil sampling point in the area of Varee Chiang Mai School. Experimental agricultural plots of schools. It is an area used to grow experimental plants for students, which is expected to be high in organic matter and the soil is maintained.

2) Materials and equipment (specify the type/model of the tool used)

2.1) Materials and equipment for collecting soil samples

- A shovel is used to dig up soil samples from each area.

- Plastic ziplock bag for inserting soil samples from each point.
- Labels for specifying soil sample information, such as the date of collection.

storage area

- rubber gloves to prevent contamination of the soil and cleanliness of hands.

2.2) Instruments used to analyze soil quality

- Munsell Soil Color Chart for measuring soil color
- Soil pH Meter (Model HI98103) for measuring soil acidity-base
- Digital Soil Thermometer (Model TP101) for measuring soil temperature.
- Soil Moisture Meter (THG-200) for measuring soil moisture levels.
- Soil Nutrient Test Kit (N, P, K Test Kit No. 1609) for measuring macronutrient values including nitrogen (N), phosphorus (P) and potassium (K)
- Soil Sieve Set for Inspection Structure and anchoring of the soil

3) How to conduct research

Step 1 Soil Sampling

- Use a shovel to scoop up the soil from each point. about 10-15 cm deep;
- Collect about 500 g of soil. and put it in a ziplock bag.
- Label the soil sample and record the coordinates of the sampling point.

Step 2: Soil Quality Analysis

Physical Analysis

- Soil structure inspected with a soil sieve
- Soil color using the Munsell Soil Color Chart to compare the color of each soil sample.
- Soil adhesion is tested by pinching the soil and observing coagulation.
- Soil temperature uses a needle thermometer.
- Soil Moisture Meter

Chemical Analysis

- Acidity-base (pH) using a Soil pH Meter to check the pH of the soil.
- Macronutrient content (N, P, K) using the NPK Test Kit

Step 3: Data Analysis

- Compare the results of soil inspection.
- Analyze the relationship between soil properties and environmental factors.
- Summarize the results and present guidelines for improving soil quality.

Table 1.1 Stages of operation

procedure	period	Main Activities	Expected Results
1. Define the scope and objectives	Week 1 Jan 2025	Study theory, plan work.	The scope and objectives of the research were obtained.
2. Prepare equipment and tools	Week 2 Jan 2025	Procurement and training of tools	Ready for soil inspection
3. Collect soil samples.	Week 3 Jan 2025	Collect samples from different areas.	Soil samples were obtained from the study area.
4. Soil Quality Analysis	Week of January 4 – Week of February 1 2568	Check the physical and chemical properties of the soil.	Qualitative information on the soil is obtained.
5. Analyze and summarize the data	Week 2 – 3 Feb 2568	Analyze data correlations	Conclusions are drawn about the quality of the soil.
6. Prepare a report and present the research results.	Week 4 Feb 2568	Write reports, present your work.	A complete research report has been obtained.

1.8 References

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Chapter 2

Related Documents and Research

2.1 Related Documents

The study of the physical and chemical properties of soils is a widely studied topic in soil science and agriculture, as soil is an important factor affecting plant growth and agricultural productivity. In this chapter, papers and research related to soil properties are presented. As the basis for this study, the research conducted a comparative study on the effect of the ratio of soil to soil fertility on the growth of marigolds. The research team studied and reviewed the following relevant research theoretical documents:

1) Meaning of soil

2) Soil composition

3) Physical properties of soils

4) Chemical properties of the soil.

2.1.1 Meaning of soil

Soils are natural materials formed by the decay of rocks and minerals through complex geological and biological processes, consisting of minerals, organic matter, water, and air, which form a system that can support the growth of plants and soil organisms. Soils have important functions in ecosystems, such as being a nutrient store for plants, a medium for water and air transfer, and a habitat for small organisms such as microorganisms. The main factors that affect the formation are:

1) Parent material is the source of minerals that form the basis of the soil.

2) Climate: Temperature and rainfall affect the rate of rock decay.

3) Organisms: Microorganisms, plant roots, and soil animals play a role in the decomposition of organic matter.

4) Topography: The characteristics of the area affect the accumulation and erosion of soil.

5) Time: The process of soil formation requires a long time to develop proper physical and chemical properties.

Soil can be easily divided into 3 types: sandy, loamy, and clay. Each type of soil has different characteristics. Whether it is particles, These affect the suitability of different crops.

1) Loam Soil: Loam soil is fine, crumbly, moderately lumpy, and is a mesohybrid soil that is a combination of sandy and clay soils with a balanced ratio of half to half with good drainage, can hold about a certain amount of water, is suitable for cultivation, can retain moisture well, is a source of food accumulation that is complementary, and has high calcium.

Figure 2.1 Loam

Source : https://www.istockphoto.com/th

Accessed on February 12, 2025

2) Sandy soil contains more than 85 percent sand. It has a rather pestle touch. With almost all sand components, it causes a lack of nutrients in some areas. It drains well, does not hold water very well, and is very lightweight.

Figure 2.2 sandy soil

Source: http://119.46.166.126/digitalschool

accessed on February 12, 2025

3) Clay soil is the highest definition soil. Soft and sticky to the touch, when dry, the soil transforms from sticky to dry, cracked. It is the largest weight of each type of soil, retains water very well, moisture and air are difficult to permeate, have great elasticity, absorb nutrients well.

Figure 2.3 clay

Source : https://smegp-digitalid-dev.thaisme.one/product/613ba0a0b350cd489fb6d418

accessed on February 12, 2025

As for the separation of soil types from these 3 types, it can be separated from the texture that is clearly visible. If you try to catch and survey the soil. If the soil is loose and highly moist, it is loamy, but if the soil is light and has a lot of sand, it is sandy soil. Finally, if the soil has a lot of weight, it is sticky and soft in the hand. As for the suitability of each plant, it depends on what conditions the plant can grow well.

2.1.2 Soil Component

However, each area will have different soil differences because the minerals are distributed throughout the area, but what each soil has in common is the composition of the soil, which can be divided into 4 components as follows

1) Water: 25 percent of the water is inserted in the gap between the soil grains. It can directly affect the growth of plants and is the culprit in always increasing the moisture of the soil. This keeps the soil moist and temperature, always friendly to the plant.

2) 25% of air is the gases in the soil molecules, which if there is no water, there will be no air because these two things are directly dependent on each other. The most common gases in soil are nitrogen (N2), oxygen (O2), carbon dioxide (CO2).

3) Organic matter: 5 percent: Of course, organic matter is a substance formed by the deposition of various organisms, no matter how small or large. Scientifically, we call this decomposition process "humus", which is a nutrient that can affect the properties and characteristics of the soil, including carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, and sulfur.

2.1.3 Physical properties of the soil

2.1.3.1 Soil structure

Soil structure refers to the arrangement of soil particles such as sand, sediment, and clay, as well as the gaps between them. The soil structure affects drainage. Soil structure is divided into several types, such as:

- Granular structure is suitable for growing plants because of its drainage and good air.
- The platy structure is poorly drained, often found in compacted soil.
- Blocky structures are found in clay soils. High adhesion
- Prismatic structures are found in poorly drained subsoils.

1) Soil structure analysis method

1.1) Observation with the naked eye Check the soil cohesion characteristics, for example, soil with a spherical structure (Granular) will look like small nodules, suitable for growing plants.

1.2) Soil Decomposition Test Take the soil and grind it and observe its decomposition. If the soil breaks down into small lumps, then it has a good structure.

1.3) Using measuring instruments such as the Soil Structure Kit to measure soil density and voids.

2.1.3.2 Soil color

Each area of soil has a different color, such as black, brown, yellow, red, or gray, as well as different color spots, depending on the type of minerals that make up the soil, the environment in which the soil is formed, the period of development, or other materials present in the soil. The characteristics of clay paint are as follows:

- Black, dark brown or dark soil.

Most often it is a soil with high fertility because it is mixed with a lot of organic matter. In some cases, the darkening of the soil may be the result of the influence of other factors that control soil formation in addition to the large amount of organic matter in the soil, such as soil that develops from soil origin materials that decay and decompose from rocks that contain dark minerals such as volcanic rocks and have a short development period, or soils with high manganese minerals can also produce dark soils.

- yellow or red soil

The yellow or red color of the soil is mainly the oxide color of iron and aluminum, indicating that the land is highly developed. It is a well-drained soil but usually has low fertility. Yellow soil indicates that the soil contains iron oxides with water as a component. Red clay is a soil with no iron or aluminum oxide as a composition.

- white or light gray soil;

The light color of the soil may indicate that the soil is formed from the soil origin material, which decomposes from rocks with faint minerals. It may be a soil that has undergone a severe leaching process so that all nutrients useful for plants are washed away, or it may be light in color due to the accumulation of lime, gypsum, or various types of salts in the soil cross-section.

- gray or blue soil;

The land is gray, gray, blue, or blue. It indicates that the soil has been in a state of waterlogging for a long time, such as rice paddies in lowland areas or mangrove forest areas that are always flooded. Poor drainage and ventilation conditions It causes a compound of iron that is gray or blue.

1) Soil color analysis method

1.1) Using the Munsell Soil Color Chart: Compare Soil Color with Color Chart

1.2) Observation with the naked eye, observing the color of the soil in dry and wet conditions.

- black or dark brown soils with a high content of organic matter;
- red or yellow soils contain iron oxide;

2.1.3.3 Soil Retention

Soil cohesion refers to the force that binds soil particles together into a single mass, which is caused by the physical, chemical, and biological reactions of various elements in

the soil. This bonding force affects soil properties, such as water permeability, compaction, and the ability to support plant roots.

- Plant growth affects plant rooting and water absorption.
- Groundwater flow affects the soil's ability to hold and drain water.
- Soil stability Prevents erosion and erosion of the soil surface.
- Engineering Utilization It affects the stability of infrastructure such as buildings, roads, and dams.

1) The types of soil fixation can be divided into 3 main levels:

1.1) Loose soil, low adhesion

Very few soil particles clump together, with high gaps between particles. It allows water and air to move well, and is found in sandy soils. Loamy and soil with low organic matter.

1.2) Moderate Cohesion Soil – Fixation of Nevus

Soil particles are quite clumped together. There is a balance between water permeability and adhesion of plant roots, it is found more often in clay loamy soils. Soil with moderate organic matter.

1.3) Strongly Cohesive Soil

Soil particles are very tightly clung together. It has a high resistance to water erosion, but plant roots can be difficult to grow, they are found in clay soils.

2) Soil sequestration analysis method according to GLOBE Thailand

2.1) Hand Test: Pinch the soil to check the state of the soil.

- Solid soil, dry and easily broken.
- Plastic clay can be molded into shapes.
- Liquid soil flows when there is a lot of water.

2.1.3.4 Soil temperature

Soil temperature is the level of soil heat measured in different soil layers, which affects physical, chemical, and biological processes in the soil, such as plant growth, microbial function, and nutrient absorption by plant roots. It is a factor that affects seed germination, photosynthesis and degradation of organic matter.

1) Factors affecting soil temperature

1.1) Soil heat gain and loss

- Solar heat is the main source of energy that causes changes in soil temperature.

- Thermal conductivity of the soil. dense soils, such as clay; It can retain heat better than sandy soils.

- Heat loss through radiation. Radiation cooling: The soil cools down when there is no sunlight, such as at night.

1.2) Physical characteristics of the soil

- Soil color Dark soils absorb more heat than light-colored soils.

- soil porosity; soils with a lot of gaps, such as loam. Better cooling

- The amount of water in the soil. Soils with high moisture absorb and dissipate heat more slowly than dry soils.

1.3) Soil depth

- The temperature of the surface soil changes rapidly with air temperature.

- Deep soils have a more stable temperature than surface soils because they are less affected by weather conditions.

2) How to measure soil temperature

2.1) Soil Thermometer

- It is a device that is used to measure the temperature of the soil directly.

- Easy to use, just pin it into the soil you want to measure.

- Suitable for measuring temperature at shallow levels (5-10 cm)

2.2) Digital Soil Probe

- Electronic sensors are used to detect soil temperature.

- It has high accuracy and can record temperature data in real time.

3) Effects of soil temperature on plants

- Soil temperature is too high. Plant roots may be damaged. Decreased absorption of nutrients.

- Too low soil temperature (<10°C) slows down root growth and affects the photosynthesis process.

2.1.3.5 Soil moisture

Soil moisture refers to the amount of water within the soil gap, which plays an important role in physical, chemical, and biological processes in the soil, such as water absorption by plant roots. Soil moisture is an important factor affecting plant growth because plants need water as a medium for photosynthesis and absorb nutrients dissolved in water.

1) Factors affecting soil moisture

1.1) Soil Texture and Soil Porosity

-clay Clay soil can hold a lot of water but drain slowly. This causes water retention and can cause hypoxia in plants.

- Loamy soils Loam Soil has a moderate level of water retention, suitable for cultivation.

- Sandy soil drains very quickly. This causes low soil moisture and can easily dehydrate plants.

1.2) Rainfall and irrigation

- Direct rainfall will be an important source of water that increases soil moisture.

- Irrigation systems such as drip irrigation and sprinkler irrigation have an effect on maintaining soil moisture.

1.3) Temperature and Evaporation Rate

- High temperature Increase the rate of evaporation of water from the soil, making the soil dry faster.

- Low temperature It reduces evaporation and helps the soil retain moisture for longer.

2) Soil moisture measurement

2.1) Prepare soil samples Collect soil samples from the desired depth.

2.2) Use a Soil Moisture Meter to pin the measuring instrument into the soil and take the moisture reading.

2.3) Use the Gravimetric Method, dry the soil at 105°C for 24 hours and weigh it before and after baking to calculate the amount of water lost.

2.1.4 Chemical properties of soil

2.1.4.1 Soil acidity-base (pH)

The pH of the soil is an indicator of the acid-base level of the soil. The pH value is measured by the level of hydrogen ions (H^+) and hydrogen ions (OH^-) in the water in the

soil, the pH value is in the range of 0-14, where the pH is < 7, the soil is acidic, the soil is pH = 7, the soil is neutral, the soil is > pH 7, and the soil is alkaline.

1) Factors affecting soil pH

1.1) Geological and mineral composition of soil

Soils formed by granite usually have a low (acidic) pH. Soils formed by limestone usually have a high pH (alkaline).

1.2) Rainfall and nutrient leaching

Areas with a lot of rain Soils are often acidic due to leaching of minerals such as calcium (Ca) and magnesium (Mg).

1.3) Microbial reactions and degradation of organic matter

Soil microorganisms release organic acids such as carbonic and humic acids, which lower the soil pH .

1.4) Use of fertilizers and agrochemicals

- Ammonium sulfate $(NH_4)_2SO_4$ ⟶ fertilizer acidifies the soil.
- Manure and compost ⟶ help adjust the pH to the right range.
- The use of lime ($CaCO_3$) ⟶ helps to increase the pH of acidic soils.

1.5) Accumulation of salt in the soil

Areas with shallow groundwater and high water evaporation often have a buildup of sodium ions (Na^+), making the soil alkaline.

2) How to measure soil pH

2.1) How to measure soil pH Using a pH Meter

- Take a soil sample about 20 Put in a container.
- Add 40 milliliters of distilled water. Stir well.
- Pin the probe of the pH meter into the soil solution.
- Wait until the value is constant, then read the pH.

2.2) GLOBE Thailand Standard Method

- Collect soil samples from depth. 10-15 Cm.
- Use a calibrated soil pH test kit.
- Mix the soil with a special solution that allows for more accurate pH measurements.
- Compare the resulting color with the pH scale.

2.1.4.2 Soil fertility

Soil fertility refers to the ability of the soil to provide nutrients necessary for plant growth. The ability of the soil to store and release nutrients. The activity of microorganisms that help decompose organic matter and release nutrients essential to plants are nitrogen (N), phosphorus (P), and potassium (K), which are often referred to collectively as N-P-K values and are the main components of agricultural fertilizers.

1) **Soil nitrogen forms**

1.1) Ammonium (NH_4^+) is found in soils that decompose organic matter.

1.2) Nitrates (NO_3^-) are the easiest form for plants to use.

1.3) Nitrite (NO_2^-) is a form that is found during a short period of time during the nitrogen transition process.

1.4) Organic nitrogen is found in undecomposed plant and animal remains.

2) Forms of phosphorus in the soil.

2.1) Water-soluble phosphorus is easily absorbed by plants.

2.2) Phosphorus that binds to other elements such as aluminum and plant iron is difficult to absorb.

2.3) Organic phosphorus is present in plant and animal waste.

3) Forms of potassium in the soil

3.1) Water-soluble potassium is easily absorbed by plants.

3.2) Potassium adsorbed on soil particles requires charge exchange to be released.

3.3) Potassium contained in clay minerals is released slowly.

4) How to analyze N, P, K values in soil

4.4) Collect soil samples from a depth of 10-15 cm.

4.2) Prepare a clay solution by mixing 10 grams of soil with 50 milliliters of distilled water.

4.3) Use a test kit, drop the test substance and compare the color change with the N, P, K value table.

4.4) Record the results and analyze the results

2.2 Related Research

Dr. Somchai Jaidee (2017) studied the physical and chemical properties of soil in agricultural areas in Chiang Mai Province, focusing on the analysis of soil structure, soil color, moisture, and pH levels. The research found that most agricultural soils have a granular structure, which is

suitable for water drainage and aeration. The soil pH ranged from 6.0 to 7.0, which is ideal for plant cultivation.

Dr. Sureeporn Saengthong (2019) investigated the use of organic fertilizers to improve soil quality for marigold cultivation. The research found that the application of organic fertilizers significantly increased the levels of nitrogen and phosphorus in the soil. Soils treated with organic fertilizers showed improved soil structure and enhanced marigold growth.

Dr. Noppadon Wattana (2018) studied the effect of soil moisture on plant growth, focusing on the relationship between soil moisture and plant growth rates. The research found that optimal soil moisture (approximately 60-70% of the soil's water-holding capacity) promoted the best plant growth. Excessive or insufficient moisture negatively affected the plant's nutrient absorption.

Dr. Apichat Jaikwang (2020) examined the levels of essential nutrients (nitrogen, phosphorus, and potassium) in soil for economic crop cultivation. The research found that most soils in the study area had low levels of nitrogen and phosphorus but moderate levels of potassium. The study recommended supplementing fertilizers containing nitrogen and phosphorus to enhance soil fertility.

Dr. Wilaiwan Suksawat (2021) studied the relationship between soil color and soil fertility using the Munsell Soil Color Chart. The research found that soils with darker colors (e.g., black or dark brown) tended to have higher fertility due to higher organic matter content. Soils with lighter colors (e.g., gray or white) often had lower fertility.

Chapter 3

Research Methods

The study of soil in marigold plots aims to analyze the physical and chemical characteristics of the soil that affect the growth of marigolds. This study will focus on soil sampling. Soil structure analysis Soil color Soil fixation Soil texture, soil tempe rature, soil moisture, acidity-base value, and K P N of the soil to use the information obtained to improve the soil condition to be suitable for planting marigolds.

This study used a manual method. GLOBE Protocols for Pedosphere (Soil), this is an international standard for soil studies.

3.1 Sample

Soil in the marigold plot of Waree Chiang Mai School Nong Hoi Subdistrict Mueang District, Chiang Mai

3.2 Research Location

3.2.1 Marigold Plot at Varee Chiang Mai School

3.2.2 Science Laboratory Building 7, Varee Chiang Mai School

3.3 Soil sampling

Soil sampling is done using a shovel to dig up the soil from the point where the sample is to be collected. Dig to a depth of about 10-20 centimeters by digging in rows or in a way that is spread throughout the area, ensuring that each excavation will keep the soil clean from external contamination such as stones, plant debris, or unrelated things.

3.3.1 Materials and equipment

1) Shovel

2) Zipper lock bag

3) glove

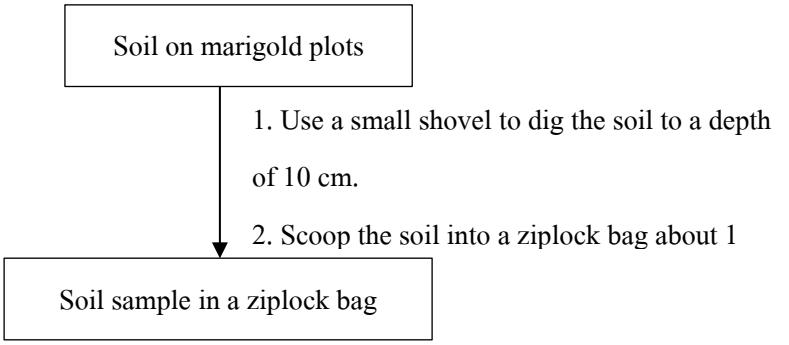


Figure 3.1 shows the procedure for measuring soil structure.

3.4 Soil structure analysis

Soil structure refers to the arrangement of soil particles, which affects the drainage and ventilation of the soil. The method of analyzing the soil structure is as follows.

3.4.1 Materials and equipment

1) Equipment for collecting soil samples.

2) Sample diagram of soil structure

3.4.1 Soil structure measurement method

1) Collect soil samples by various methods used to study soil characteristics. Record basic information such as the environment.

2) Place the soil of the undisturbed specimen on the hand. Observe the soil in hand in detail and observe the structure of the soil, which has many forms of soil structure, as shown in the soil structure diagram.

3) Measure the size, shape, and record the data in the measurement data sheet.

4) Frequency of data collection 1 time at each study point.

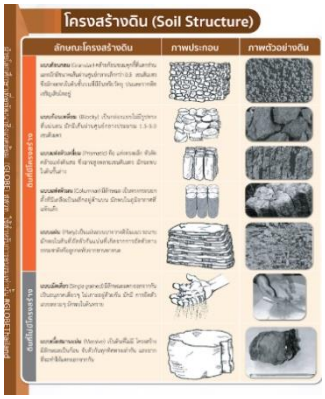


Figure 3.2 Soil structure

Source: https://globefamily.ipst.ac.th/globe-protocols

accessed on February 8, 2025

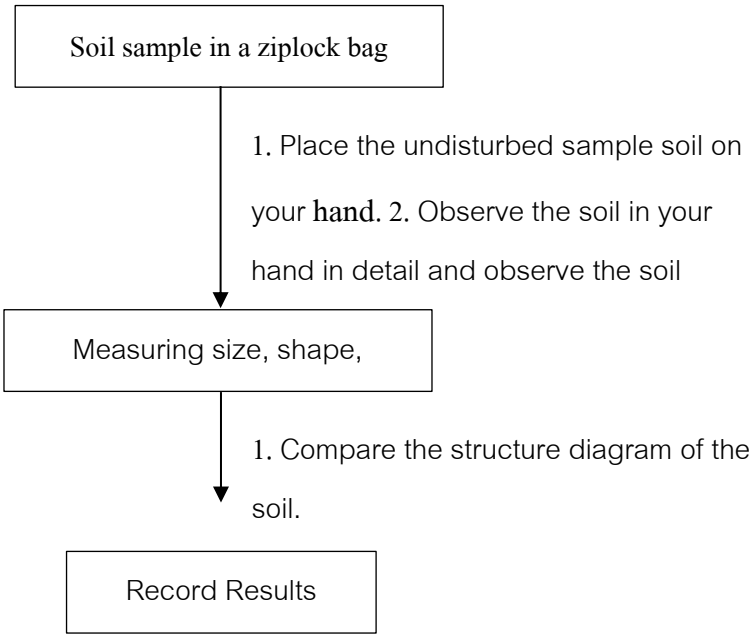


Figure 3.3 shows the process of soil sampling.

3.5 Soil color analysis

The color of the soil indicates the chemical coating on the particles of the soil. Soil organic matter content and soil moisture content To compare soil color, based on Munsell's principle, the method of analyzing soil color is as follows:

3.5.1 Materials and equipment

1) Munsell Soil Color Chart

2) Soil sample

3) Sprinkler

3.5.2 How to measure soil color

1) Take soil grains from each layer of soil sample and observe them and record in the data sheet whether the soil grains are moist, dry, or wet. If it is dry, moisten the soil a little by spraying water from the prepared bottle.

2) Stand with the sunlight shining through your shoulder to the soil color calibration book and the soil sample being measured.

3) Divide the soil into 2 parts

4) Record the soil color value in the data record sheet.

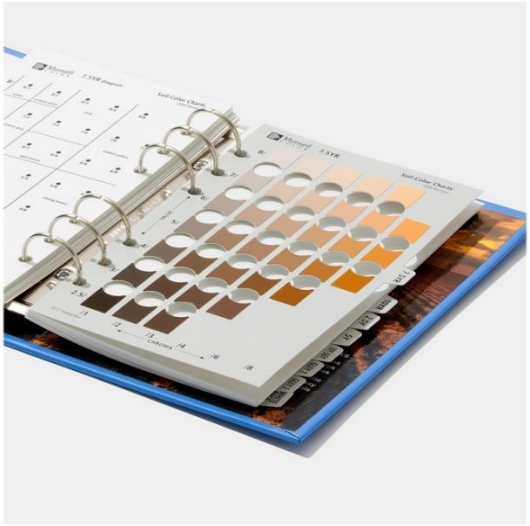


Figure 3.4 Munsell Soil Color ChartSource

Source : https://www.tcg-plus.com/product/soil-color-book/

accessed on February 8, 2025

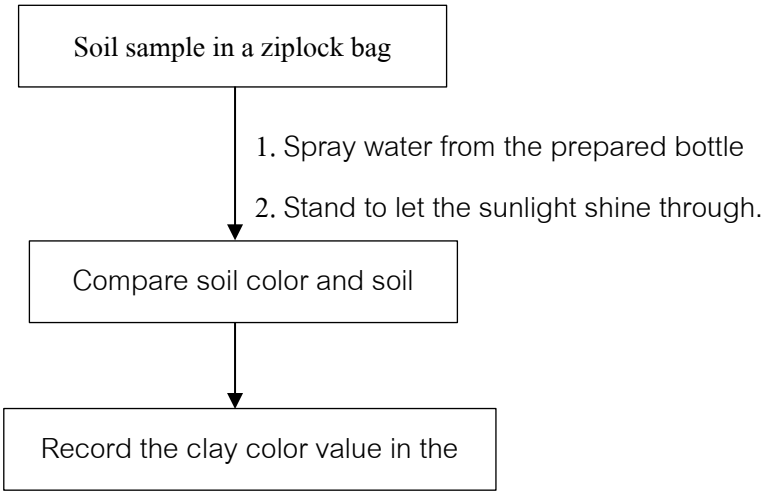


Figure 3.5 shows the procedure for analyzing soil color.

3.6 Soil adhesion analysis

Soil adhesion refers to the behavior of the soil in response to external forces. Therefore, the response of this force changes with the humidity level. Therefore, the assessment of soil adhesion is carried out when the soil has several levels of moisture, the analysis method is as follows.

3.6.1 Materials and equipment

1) Equipment for collecting soil samples

2) Soil bonding comparison plates

3.6.2 How to measure soil adhesion

1) Remove the soil grains from the topsoil, if the soil is dry, moisten the soil layer by spraying water and then pull out the soil grains to observe the soil adhesion.

2) Pick up the soil grain between your thumb and index finger, gently squeeze the soil tablet.

3) Record the characteristics of soil adhesion in one of the data sheets.

Figure 3.6 Soil adhesion comparison diagram

source: https://globefamily.ipst.ac.th/globe-protocols

accessed on February 8, 2025

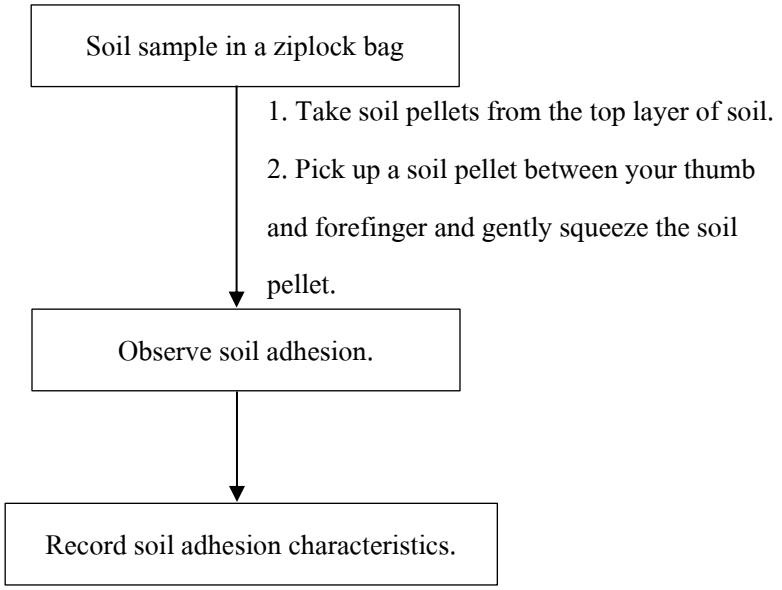


Figure 3.7 shows the procedure for analyzing soil adhesion.

3.7 Soil Temperature Measurement

Soil temperature is directly related to atmospheric temperature. Soil acts as a thermal insulation between what is underground and the atmosphere, and the temperature of the soil is usually lower than the temperature of the air, and the deeper it goes, the less the temperature difference affects the growth of plants, including the time of bud breakage or leaf fall, and the rate of organic decomposition. Here's how to analyze it:

3.7.1 Materials and equipment

Needle Soil Thermometer

3.7.2 How to measure soil temperature

1) Pin the thermometer into the soil about 10-15 centimeters deep

2) Wait until the temperature value stabilizes for 1-2 minutes

3) Record the soil temperature in the data log sheet.

figure 3.8 needle soil thermometer

Source: https://www.tools.in.th/temperature-monitoring-device/needle-thermometer/

accessed on February 8, 2025

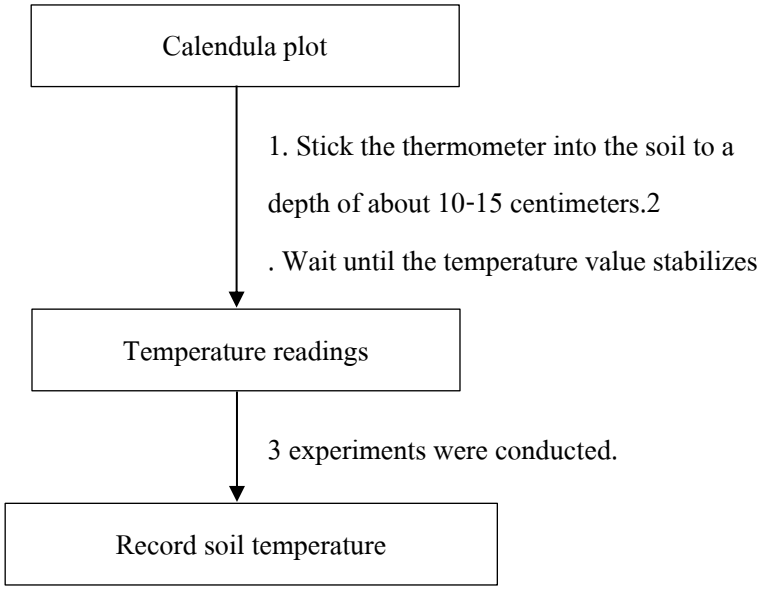


Figure 3.9 shows the procedure for measuring soil temperature.

3.8 Soil moisture measurement

Soil moisture has an effect on the relationship with soil moisture, which is the amount of water in the soil that plants can use, and the use of soil nutrients must be in the form of ions, which aremediated by soil water, moisture is the amount of water reserves in the soil, the soil is like a sponge, so the soil helps prevent flooding by storing water in the soil. Soil moisture is related to relative humidity in the air, with soil water evaporating into the atmosphere, causing the relative humidity of the air to rise. Here's how to analyze it:

3.8.1 Materials and equipment

of needle soil moisture meter

3.8.2 How to measure soil moisture

1) Select the point where the soil moisture needs to be measured

2) Pin the needle of the soil moisture meter into the soil, embroidering it to a depth of about 5-10 centimeters,

3) Wait until the value displayed on the meter screen is stable, about 10-30 seconds.

4) Record the resulting humidity value.

Figure 3.10 Needle Soil Moisture and pH Meter

Source: https://www.tools.in.th/temperature-monitoring-device/needle-thermometer/

accessed on February 8, 2025

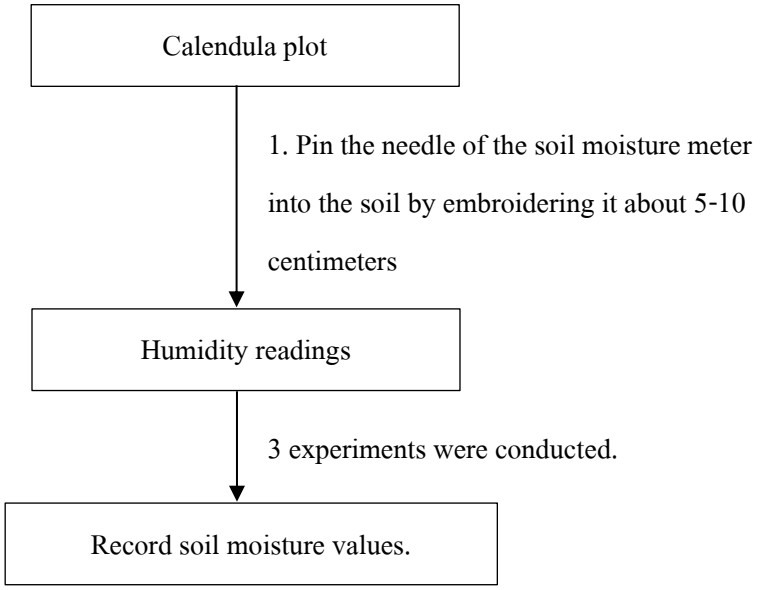


Figure 3.11 shows the procedure for measuring soil temperature.

3.9 Soil Acidity-Base Measurement

Measuring soil acidity-base (pH) is an important step in soil study and agricultural land management, as soil acid-base values have a direct impact on plant growth. Nutrient absorption and microbial activity in the soil. Here's how to analyze it:

3.9.1 Needle Soil

pH Meter Materials and Equipment

3.9.2 Soil Acidity-Base Measurement Method

1) Select the point where the soil pH needs to be measured,

2) Pin the needle of the soil pH meter into the soil, about 5-10 centimeters

3) Wait for 1-2 minutes for the meter to show the true pH of the soil

4) Read the pH from the scale displayed on the meter.

5) Record the pH value obtained

Figure 3.12 Soil pH Meter

Source : https://www.jetmt.com/product/30341

accessed on February 8, 2025

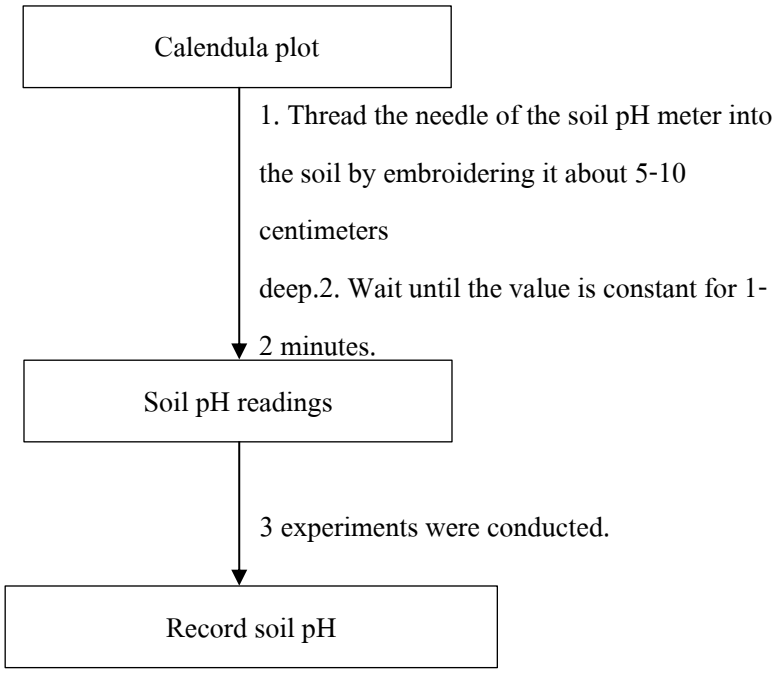


Figure 3.13 shows the procedure for measuring soil temperature.

3.10 Soil Fertility Measurement

Soil fertility, this is indicated by the amount of macronutrients that are made up in the soil, such as nitrogen (N), phosphorus (P) and potassium (K), which are the most important macronutrients that plants need. Here's how to analyze it:

3.9.1 Materials and

1) Equipment Dried and sifted sample soil

2) Distilled water

3) Teaspoon

4) Cup holder or test tube

5) Soil Characteristics Measurement Data Sheet

6) Soil Fertility Test Kit with Test Substance to Determine the N, P and K Values of Soil

3.9.2 Soil Acidity-Base Measurement Method

3.9.2.1 Preparation of the soil solution

1) Weigh a sample of dry and sifted soil, 20 g and pour it into a beaker.

2) Add 20 distilled water to get a soil:water ratio equal to 1:1.

3) Use a glass stick to stir for 30 seconds and let it rest for 3 minutes. Do this 5 times.

4) When the soil has been stirred 5 times. Leave it until the soil in the beaker settles, you can see clear water on the side of the beaker.

3.9.2.2 Measurement of soil fertility with soil test kit (nitrate ($NO3^-$)-nitrogen in soil)

1) Use a pipette to suck up 2.5 ml of the clay solution, put it into the test tube.

2) Add 1 sachet of H 3895-N reagent to the soil solution.

3) Close the test tube lid and shake for about 30 seconds to dissolve the chemical.

4) Compare the resulting pink color to the nitrate content color comparison plate.

3.9.2.3 Determination of soil fertility with a soil test kit (phosphorus ($P2O5$) in soil)

1) Use a pipette to suck up 2.5ml of clay solution, put it into the test tube.

2) Add 1 sachet of HI 3895-P reagent to the soil solution.

3) Close the test tube lid and shake for about 30 seconds to dissolve the chemical.

4) Compare the blue color formed with the phosphorus content color comparison plate.

3.9.2.4 Soil Fertility Measurement with Soil Test Kit (Potassium (K2O) in Soil)

1) Use a pipette to suck up 0.5 ml of clay solution, put it into the test tube.

2) Add distilled water to a total volume of 2.5 milliliters.

3) Add 1 sachet of HI 3895-K reagent to the soil solution.

4) Close the lid of the test tube and shake for about 30 seconds to dissolve the chemical.

5) Compare the turbidity with the potassium content comparison plate.

Figure 3.14 Soil fertility test kit with test substance to determine the N, P and K values of soilSource

Source: https://www.tools.in.th/product/hi3895-2/

accessed on February 8, 2025

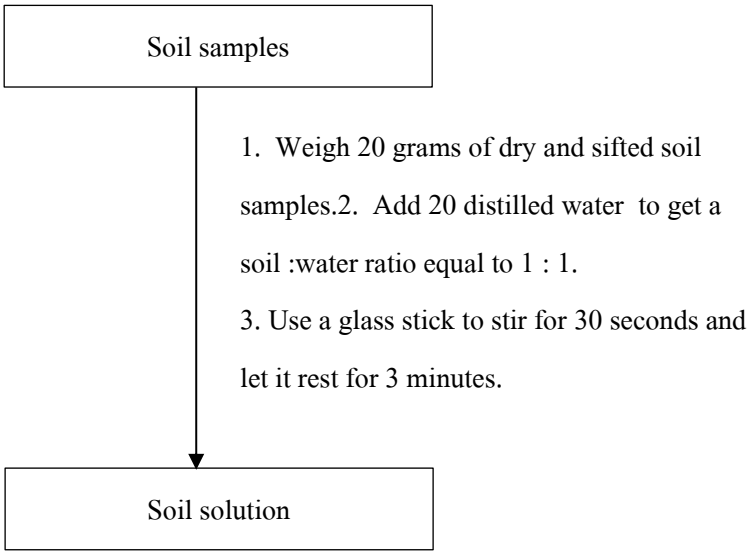


Figure 3.15 shows the process of preparing the soil solution.

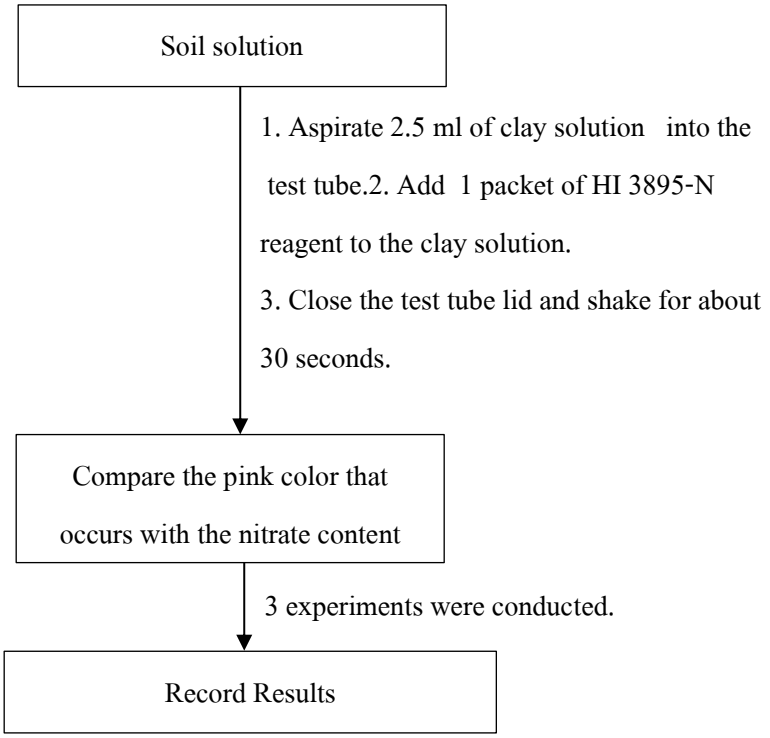


Figure 3.16 shows the procedure for measuring soil fertility. With Soil Test Kit (Nitrate (NO_3^-) nitrogen in the soil).

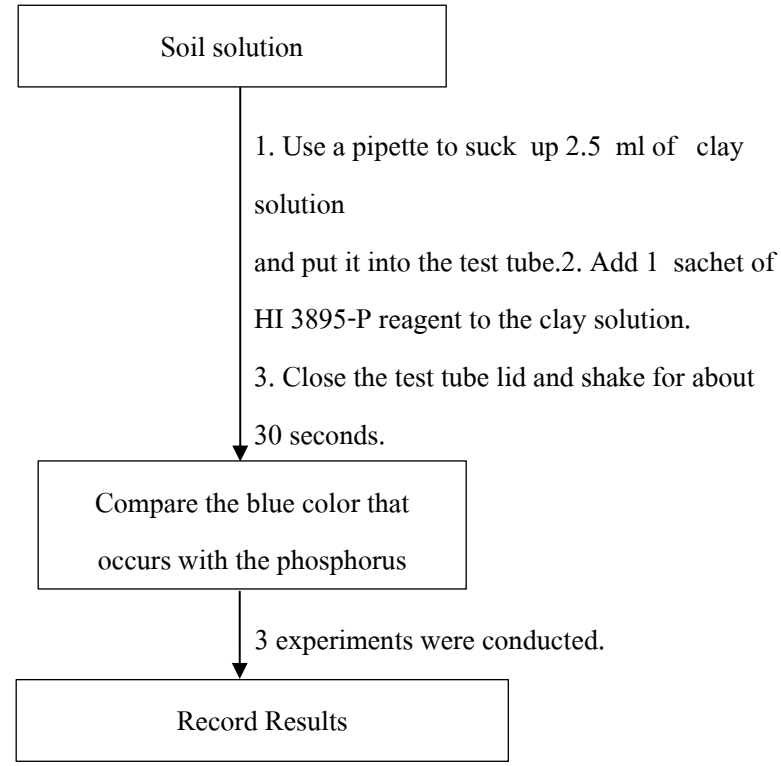


Figure 3.17 shows the procedure for measuring soil fertility with a soil test kit (phosphorus (P_2O_5) in soil).

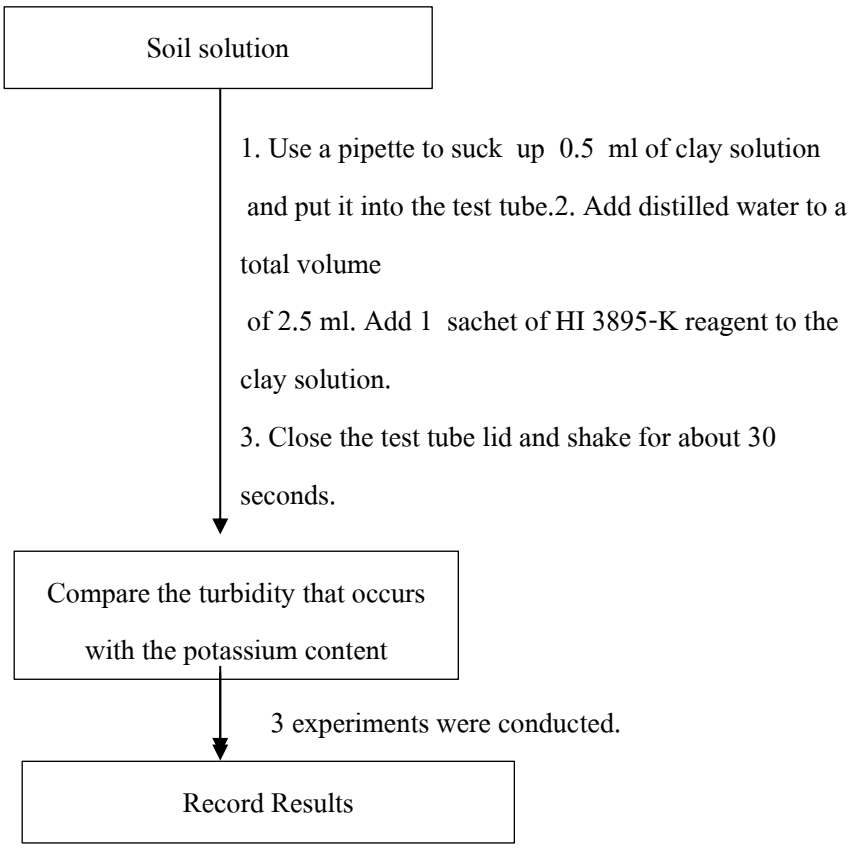


Figure 3.18 Soil Fertility Measurement with Soil Test Kit (Potassium (K_2O) in Soil)

Chapter 4

Results and Discussion of Research Results

The purpose of this study was to analyze the physical and chemical properties of the soil in the marigold flower plot of Varee Chiang Mai School. The focus is on assessing the suitability of the soil for marigold cultivation and using the information obtained to improve the soil condition to be suitable for plant growth. The study found several interesting results, which can be summarized and discussed as follows:

4.1 Results of analysis of the physical properties of the soil

4.1.1 Soil structure

Based on the analysis of soil structure. It was found that the soil in the marigold plot had a different structure in each sample, as shown in Table 4.1.

Table 4.1 shows the physical characteristics of soil structure measurements in soil samples 1 , 2 and 3.

Soil samples	Soil structure
1	Square
2	Round
3	Round

Remark: Samples were collected at 4:00 p.m. on February 11, 2025.

According to the analysis of physical properties, the soil structure of sample 1 has a blocky structure, which is often found in poorly drained soils and may affect plant growth because air and water cannot circulate freely. Examples 2 and 3 have a nodular soil structure. This is a structure that is suitable for drainage and air in the soil. This soil structure allows plant roots to grow well and also helps to absorb water and nutrients efficiently. Nodular soil structures are ideal for growing crops, as they provide the soil with good drainage and air. While the nocturnal soil

structure can affect plant growth if the soil is not improved. Therefore, adding organic matter, such as compost or manure, can help improve the soil structure even more optimally.

4.1.2 Soil color

Based on the analysis of soil color. It was found that the soil in each marigold plot in the same plot was different from sample to sample. As shown in Table 4.2.

Table 4.2 shows the physical characteristics of soil color measurements in soil samples1, 2 and 3.

Soil samples	Soil color scale
1	10 YR 2/2
2	10 YR 3/3
3	10 YR 2/2

Remark: Samples were collected at 4:00 p.m. on February 11, 2025.

From the use of the clay color comparison book. The Munsell Soil Color Chart found that the soil color in most marigold plots was 10 YR 2/2 and 10 YR 3/3, indicating that the soil had a high organic content. Dark soil colors are often associated with soil fertility, as organic matter is an important source of nutrients needed for plant growth. A dark soil color indicates soil fertility, as organic matter is an important factor in helping to increase soil nutrients. However, soil color alone cannot indicate the fertility of the entire soil. Other factors need to be considered, such as pH and nutrient content in the soil.

4.1.3 Soil Fixation

Soil adhesion analysis showed that the soil had different adhesion for each sample. As shown in Table 4.3, measure soil adhesion.

Table 4.3 shows the physical characteristics of soil adhesion measurements in soil samples 1 , 2 and 3.

Soil samples	Soil fixation
1	solid
2	Ruan Sui
3	Ruan Sui

Remark: Samples were collected at 4:00 p.m. on February 11, 2025.

Based on the analysis of physical properties, it was found that the soil adhesion of sample 1 has a tight soil adhesion, which may affect the drainage and air in the soil. While tightly anchored soil can affect plant growth. Adding organic matter can help improve soil retention even more optimally.

4.1.4 Soil temperature

Soil temperature analysis showed that the soil had different temperatures for each sample, as shown in Table 4.3.

Table 4.4 shows the physical characteristics of soil temperature measurements in soil samples 1 , 2, and 3.

Soil samples	Soil temperature (degrees Celsius)
1	27
2	28
3	27
average	27.33

Remark: Samples were collected at 4:00 p.m. on February 11, 2025.

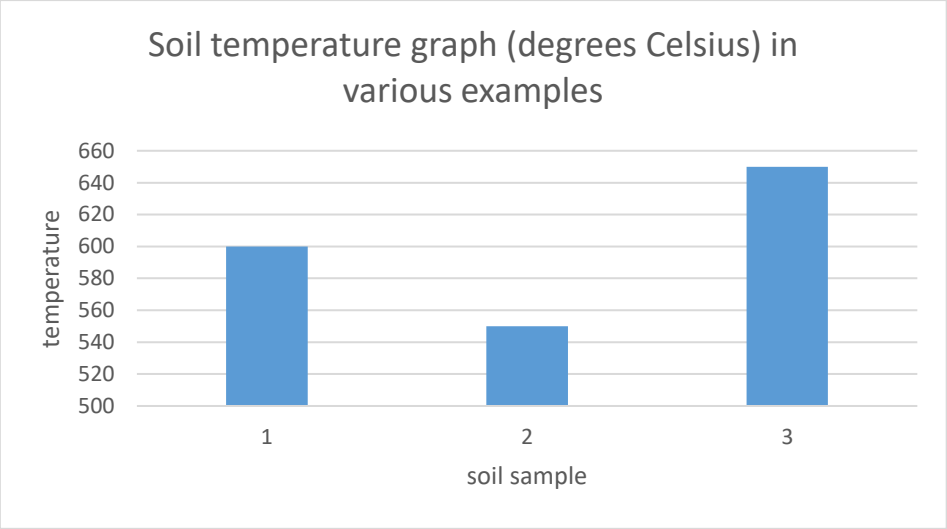


Figure 4.1 Graph showing soil temperature (degrees Celsius) in various samples.

The measured soil temperature is in the range of 27-28 degrees Celsius, as shown in the soil temperature measurement table. This is the ideal temperature for marigolds to grow. Excessive soil temperature can affect the degradation of organic matter and the activity of soil microorganisms. While too low a temperature may slow down plant growth, the right soil temperature promotes plant growth and soil microbial activity. However, soil temperature should be monitored regularly to prevent changes that could affect plant growth.

4.1.5 Soil moisture

Soil moisture is in the range of 27-28 grams per cubic meter, as shown in Table 4.5

Table 4.5 shows the physical characteristics of soil moisture measurements in soil sample 1, 2 and 3

Soil samples	soil moisture (g per cubic meter).
1	600
2	550
3	650
average	600

Remark: Samples were collected at 4:00 p.m. on February 11, 2025.

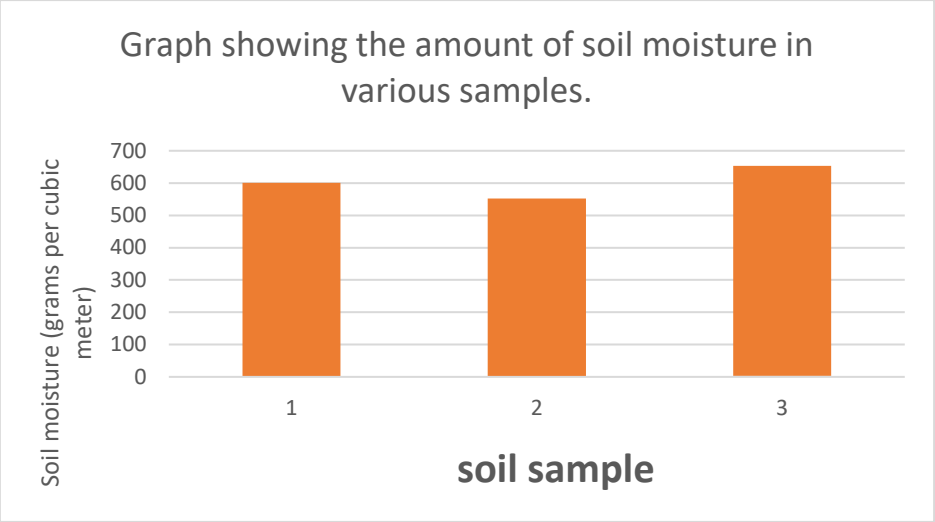


Figure 4.2 Graph showing the amount of soil moisture in different samples.

Soil moisture ranges from 550 to 650 grams per cubic meter, as shown in the soil moisture measurement table. Adequate soil moisture allows plants to absorb water and nutrients efficiently, proper soil moisture is an important factor that promotes plant growth. However, some soils have been found to be too low in moisture, which can affect plant growth if not managed properly.

4.2 Results of analysis of the chemical properties of the soil

4.2.1 Acidity-base (pH) of the soil

From the measurement of soil pH, it was found that the pH value was in the range of 6.5-6.9 as shown in Table 4.6.

Table 4.6 shows the acid-base (pH) chemical characteristics of the soil in soil samples 1, 2 and 3.

Soil samples	pH
1	6.9
2	6.8
3	6.5
average	6.73

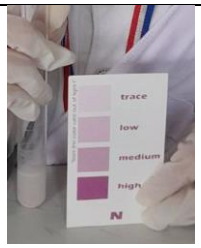
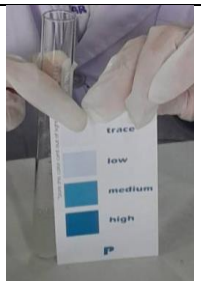
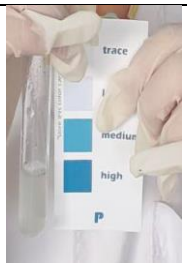
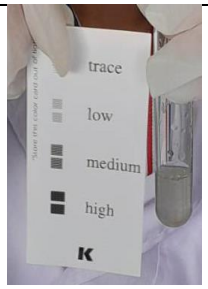
Remark: Samples were collected at 4:00 p.m. on February 11, 2025.

From the measurement of soil pH, it was found that the pH value was in the range of 6.5-6.9 as shown in the table of soil acid-base measurement. This pH level allows plants to absorb nutrients efficiently and also promotes the activity of soil microorganisms that help in the decomposition of valuable organic matter. Optimal pH allows plants to absorb nutrients well. However, the pH should be monitored regularly to prevent any changes that could affect plant growth.

4.2.2 Soil fertility

Soil fertility analysis showed that the soil values of nitrogen (N), phosphorus (P), and potassium (K) varied from sample to sample, as shown in Table 4.7.

Table 4.7 shows the values of nitrogen (N), phosphorus (P), and potassium (K).

Soil minerals	**Soil samples**		
	1	**2**	**3**
Nitrogen (N)			
Phosphorus (P)			
Potassium (K)			

Remark: Samples were collected at 4:00 p.m. on February 11, 2025.

Table 4.8 shows the chemical properties of nitrogen (N), phosphorus (P), and potassium (K) of the soils in soil samples 1, 2, and 3.

Soil minerals	Soil samples	level
Nitrogen (N)	1	Very low
	2	Very low
	3	Very low
Phosphorus (P)	1	low
	2	low
	3	low
Potassium (K)	1	moderate
	2	moderate
	3	moderate

Analysis of soil macronutrients including nitrogen (N), phosphorus (P), and potassium (K) showed that nitrogen (N) levels were very low, as shown in the table recording the levels of N, which is an important element for the growth of phosphorus leaves and stems. (P) is at a low level, as shown in the table recording the P value, which is an important element for root development, and potassium (K) is at a moderate level, as shown in the table recording the K value , which is an important element for strengthening plants and helping to resist diseases.

Chapter 5

Summary of Research Results and Recommendations

The purpose of this study was to analyze the physical and chemical properties of the soil in the marigold flower plot of Wari Chiang Mai School. The focus is on assessing the suitability of the soil for marigold cultivation and using the information obtained to improve the soil condition to be suitable for plant growth. The study found several interesting results, which can be summarized and discussed as follows:

5.1 Research conclusions

From this study, the research results can be summarized as follows:

5.1.1 Physical properties of the soil

1) The soil structure in the marigold plot has a different structure for each sample, with sample 1 having a blocky structure which may affect drainage and air in the soil, while examples 2 and 3 have a granular structure which is suitable for drainage and air in the soil.

2) Soil color: The soil color in most marigold plots is 10 YR 2/2 and 10 YR 3/3 colors, which indicates that the soil has a high organic matter content. Dark soil colors are often associated with soil fertility, as organic matter is an important source of nutrients needed for plant growth.

3) Soil Adhesion: Soil retention in Sample 1 is tight, which can affect soil drainage and air, while Samples 2 and 3 have loamy soil retention, which is ideal for growing crops, as the soil drains well and retains a decent level of moisture.

4) Soil temperature: The measured soil temperature is in the range of 27-28 degrees Celsius, which is the ideal temperature for the growth of marigolds. While too low a temperature may slow down plant growth.

5) Soil moisture: Soil moisture is in the range of 550-650 grams per cubic meter, which is the right level for growing marigolds.

5.1.2 Chemical properties of the soil

1) Soil Acidity-Base (pH): The pH of the soil is in the range of 6.5-6.9, which is the optimal range for growing marigolds.

2) Soil fertility: Analysis of soil macronutrients, including nitrogen (N), phosphorus (P), and potassium (K), found that nitrogen (N) was very low, phosphorus (P) was low, and potassium (K) was moderate.

5.2 Suggestion

1) Soil structure improvement should add organic matter to the soil to improve the soil structure and increase soil fertility.

2) Water management should be equipped with a drip irrigation system or a suitable irrigation system to maintain the soil moisture at an optimal level.

3) Nutrient supplementation should be supplemented with nitrogen and phosphorus containing fertilizers to increase soil fertility.

4) Regular pH monitoring, The soil pH should be monitored regularly to prevent changes that may affect plant growth.

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Appendix

Appendix A

Table of Results

Based on the physical and chemical properties of the soil, as shown in Table A.1 – A.2

A.1 Results of Physical Properties Analysis of Soil

Table A.1 shows the physical characteristics of soil structure measurements in soil samples 1, 2 and 3.

Soil samples	Soil structure
1	Square
2	Round
3	Round

Table A.2 shows the physical characteristics of soil color measurements in soil samples 1, 2 and 3.

Soil samples	Soil color scale
1	10 YR 2/2
2	10 YR 3/3
3	10 YR 2/2

Table A.3 shows the physical characteristics of soil adhesion measurements in soil samples 1, 2 and 3.

Soil samples	Soil fixation
1	solid
2	Ruan Sui
3	Ruan Sui

Table A.3 shows the physical characteristics of soil temperature measurements in soil samples 1, 2 and 3.

Soil samples	Soil temperature (degrees Celsius)
1	27
2	28
3	27
average	27.33

Table A.5 shows the physical characteristics of soil moisture in soil samples 1, 2 and 3.

Soil samples	soil moisture (g per cubic meter).
1	600
2	550
3	650
average	600

A.2 Results of analysis of chemical properties of soil

Table A.6 shows the acid-base (pH) chemical characteristics of the soil in soil samples 1, 2 and 3.

Soil samples	pH
1	6.9
2	6.8
3	6.5
average	6.73

Table A.7 shows the chemical characteristics of nitrogen (N), phosphorus (P), and potassium (K) of the soil in soil samples 1, 2, and 3.

Soil minerals	**Soil samples**	**level**
Nitrogen (N)	1	Very low
	2	Very low
	3	Very low
Phosphorus (P)	1	low
	2	low
	3	low
Potassium (K)	1	moderate
	2	moderate
	3	moderate

Appendix Illustration of research

B.1 Study of Physical Properties of Soil

figure B.1.1 Soil Sample Collection

figure B.1.2 Soil Sample 1

figure B.1.3 Soil Sample 2

figure B.1.4 Soil Sample 3

figure B.1.5 Structural Analysis soil

Figure B.1.6 Analyze the color of the soil.

figure B.1.7 Soil Adhesion Analysis

figure B.1.8 Soil Temperature Analysis

Figure B.1.9 Moisture Analysis soil

B.2 Study on Chemical Properties of Soil

Figure B.2.1 Analysis of pH in soil

figure B.2.2 Soil Sample Baking

figure B.2.3 Soil Sample Grinding

Figure B.2.4 Take a soil sample into a tube to prepare the soil solution.

figure B.2.5 Put water in a straw to prepare the substance.

figure B.2.6 Shake well

figure B.2.7 Leave the soil to settle.

figure B.2.8 Aspirate the clay solution into the test tube.

Figure B.2.9 Dropping test solution for N, P K.

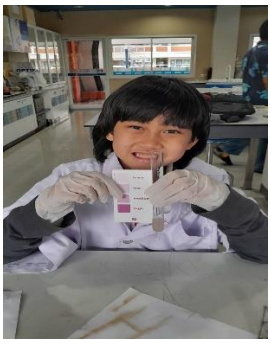

Figure B.2.10 Comparing colors to quantify N values

figure B.2.12 Comparing colors for quantity P value

figure B.2.3 Comparing colors for quantity K Value

B.3 Experimental equipment

figure B.3.1 Shovel

figure B.3.2 Ziplock Bag

figure B.3.3 Soil Moisture Meter

figure B.3.4 pH Meter

figure B.3.5 Soil Thermometer

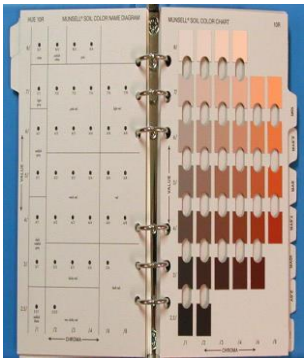

figure B.3.6 Munsell Soil Colour Chart

figure B.3.7 Test Tube

figure B.3.8 Beaker

figure B.3.9 Soil solution preparation tube

figure B.3.10 Pipette

figure B.3.11 Three-way sucking

figure B.3.12 Spoon

figure B.3.13 Test Tube Sieve

figure B.3.14 Test Kit for N P K