



**A Study of the Physical and Chemical Soil Quality
in the Phaya Kham Irrigation Canal Area, Mueang District, Chiang
Mai Province, to Assess Its Suitability for Agricultural Use**

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Abstract

This research aimed to analyze the physical and chemical properties of soil along the Phaya Kham irrigation canal in Mueang District, Chiang Mai Province, and to assess its suitability for agricultural use. Soil samples were collected from three sampling sites at a depth of 10–15 centimeters and analyzed following the standard GLOBE Protocol.

The results of the physical property analysis indicated that most soil samples exhibited a granular structure, which allows good water drainage and aeration, while some locations showed a blocky structure. The soil color ranged from 7.5 YR 2.5/2 to 3/2, indicating dark-colored soil with a high organic matter content. Soil consistency was generally friable. The average soil temperature was 25.4 °C, and the average soil moisture content was 600 g/m³, conditions considered favorable for plant growth.

The chemical analysis revealed that the average soil pH was 6.73, which is classified as neutral and highly suitable for crop cultivation. However, nutrient fertility analysis showed that nitrogen (N) levels were very low, while phosphorus (P) and potassium (K) levels were at moderate levels.

In conclusion, the soil in the study area exhibits favorable physical characteristics and an appropriate pH level but is deficient in certain essential nutrients. Therefore, it is recommended that soil quality be improved through the application of organic fertilizers that increase nitrogen and phosphorus levels to enhance soil fertility and promote optimal growth of marigold plants.

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Chapter 1

Introduction

1.1 Background and Significance of the Problem

At present, Chiang Mai Province is experiencing rapid urbanization. Many agricultural areas have been converted into residential zones and commercial buildings. As a result, the Phaya Kham irrigation canal has increasingly been subjected to wastewater and contamination from human activities, including household chemicals, sewage, and solid waste. These factors directly affect water quality and the accumulation of sediment along the canal banks. Soil, which was once a relatively pristine resource, may undergo changes in both its physical and chemical properties, such as alterations in soil structure, unsuitable soil pH levels, or the excessive or insufficient accumulation of essential nutrients.

Therefore, soil quality assessment is a crucial and necessary process for evaluating the suitability of soil for agricultural use, particularly for small-scale farmers and riverside communities that continue to rely on the surrounding soil and water resources for growing vegetables for household consumption. Soil quality analysis can be conducted by examining both physical and chemical properties, including soil structure, soil color, soil consistency, soil temperature, soil moisture, soil acidity–alkalinity (pH), and soil fertility (nitrogen (N), phosphorus (P), and potassium (K)). Such analyses provide insight into the current condition of the soil and determine whether it remains safe and suitable for cultivation.

Recognizing the importance of this issue, the research team conducted a study entitled “*A Study of the Physical and Chemical Soil Quality in the Phayakham Irrigation Canal Area, Mueang District, Chiang Mai Province.*” The objective of this study was to examine and measure soil quality according to academic standards in order to obtain accurate and reliable scientific data. The findings are expected to be beneficial for land-use planning, soil quality improvement for agricultural purposes, and environmental monitoring within the community, as well as to raise awareness of the conservation of soil and water resources in the Phayakham irrigation canal for long-term sustainability.

1.2 Research Questions

1. How do the physical and chemical properties of soil affect soil fertility?
2. How can soil quality be improved to make it suitable for plant cultivation?

1.3 Research Hypotheses

1. Soil acidity–alkalinity (pH) affects soil fertility.
2. Soil moisture influences soil temperature.
3. Dark-colored soils tend to be more fertile than light-colored soils.
4. Soil consistency affects the permeability of water and air in the soil.
5. The availability of major nutrients (N, P, and K) in soil is influenced by environmental factors such as organic matter and soil pH.

1.4 Objectives of the Research

1. To analyze the physical properties of soil, including soil structure, soil color, soil consistency, soil temperature, and soil moisture.
2. To analyze the chemical properties of soil, including soil acidity–alkalinity and soil fertility (nitrogen, phosphorus, and potassium levels).
3. To assess the suitability of the soil in the study area for agricultural use and environmental conservation

1.5 Expected Outcomes of the Research

1. Scientific data on soil quality in the Phaya Kham irrigation canal area will be obtained.
2. Students will gain knowledge and skills in soil analysis.
3. The community can use the findings to plan and improve soil quality for agricultural purposes.

1.6 Scope of the Research

1. Study Area

The study area was the Phaya Kham irrigation canal near Varea Chiang Mai School, located at 59 Moo 6, Mahidol Road, Nong Hoi Subdistrict, Mueang District, Chiang Mai Province 50000, Thailand. The site is situated at latitude 18.7596° N and longitude 99.0138° E.

2. Factors Investigated

The research focused on measuring and analyzing relevant physical and chemical factors related to soil quality.

2.1) **Physical Properties of Soil:**

- Soil structure
- Soil color
- Soil consistency
- Soil temperature
- Soil moisture

2.2) **Chemical Properties of Soil:**

- Soil acidity–alkalinity (pH)
- Soil fertility, measured by the levels of major nutrients, including nitrogen (N), phosphorus (P), and potassium (K)

3. **Research Period:**

- November 2025 to December 2025

1.7 Research Planning

1. **Selection of Study Sites**

Soil sampling sites were designated outside the Varee Chiang Mai School area, along the banks of the Phaya Kham irrigation canal in Mueang District, Chiang Mai Province. The selected area is used for crop cultivation and is expected to have a high organic matter content and well-managed soil conditions.

2. **Materials and Equipment (including types/models of instruments used)**

2.1 **Materials and Equipment for Soil Sampling**

- Shovel, used for collecting soil samples from each site
- Ziplock plastic bags, used for storing soil samples from each sampling point
- Labels, used for recording sample information such as collection date and location
- Rubber gloves, used to prevent soil contamination and to maintain hand hygiene

2.2 **Instruments Used for Soil Quality Analysis**

- Munsell Soil Color Chart, used for measuring soil color
- Soil pH Meter (Model HI98103), used for measuring soil acidity–alkalinity (pH)
- Digital Soil Thermometer (Model TP101), used for measuring soil temperature
- Soil Moisture Meter (Model THG-200), used for measuring soil moisture levels
- Soil Nutrient Test Kit (N, P, K Test Kit, Model Rapitest 1609), used for measuring major nutrient levels, including nitrogen (N), phosphorus (P), and potassium (K)

3. **Soil sieve set**, used for examining soil structure and soil consistency

Research Procedures

Step 1: Soil Sample Collection

- Soil samples were collected from each sampling point using a shovel at a depth of approximately 10–15 cm.
- Approximately 500 grams of soil were collected from each site and placed in zip lock plastic bags.
- Each soil sample was labeled, and the geographic coordinates of the sampling location were recorded.

Step 2: Soil Quality Analysis

Physical Analysis

- Soil structure was examined using a soil sieve set.
- Soil color was determined by comparing each sample with the Munsell Soil Color Chart.
- Soil consistency was tested by squeezing the soil and observing its aggregation.
- Soil temperature was measured using a probe-type soil thermometer.
- Soil moisture was measured using a soil moisture meter.

Chemical Analysis

- Soil acidity–alkalinity (pH) was measured using a soil pH meter.
- The levels of major nutrients (N, P, and K) were measured using an NPK test kit.

Step 3: Data Analysis

- The soil analysis results were compared across samples.
- Relationships between soil properties and environmental factors were analyzed.
- Conclusions were drawn, and recommendations for improving soil quality were presented.

Table 1.1 Research Procedures

Procedure	Time Period	Main Activities	Expected Outcomes
1. Define the Scope and Objectives	Week 1, November 2025	Study theoretical concepts and plan the project.	Defined the scope and objectives of the research.
2. Preparation of Equipment and Tools	Week 2, November 2025	Procure and practice using the equipment	Ready for soil testing
3. Soil Sampling	Week 3, November 2025	Collect samples from different areas	ได้ตัวอย่างดินจากพื้นที่ศึกษา
4. Soil Quality Analysis	Week 4, November 2025	Examine the physical and chemical properties of the soil	Qualitative soil data obtained
5. Data Analysis and Summary	Weeks 5–6, December 2025	Analyze relationships among the data	Conclusions regarding soil quality
6. Report Preparation and Research Presentation	Weeks 7–8, December 2025	Write the report and present the findings	Completed research report

1.8 References

1. GLOBE Thailand. (2021). *Manual for Soil Quality Study Based on the GLOBE Program Guidelines*. Retrieved from <https://www.globe.gov>
2. Food and Agriculture Organization of the United Nations (FAO). (2020). *The State of the World's Land and Water Resources for Food and Agriculture 2020 (SOLAW 2020)*. Retrieved from <https://www.fao.org>
3. Land Development Department. (2021). *Guidelines for the Analysis of Soil Properties for Agricultural Purposes*. Bangkok: Ministry of Agriculture and Cooperatives.
4. USDA Natural Resources Conservation Service (NRCS). (2019). *Soil Quality Indicators and Their Interpretation*. Retrieved from <https://www.nrcs.usda.gov>
5. Munsell Color. (2018). *Soil Color Charts for Soil Classification*. Retrieved from <https://www.munsell.com>

Chapter 2

Related Documents and Research

2.1 Related Documents

The study of the physical and chemical properties of soil has been widely conducted in the fields of soil science and agriculture, as soil is a crucial factor influencing plant growth and agricultural productivity. This chapter presents documents and research related to soil properties, soil analysis, and soil quality improvement as a foundation for the present study.

This research, entitled “*A Study of the Physical and Chemical Soil Quality in the Phaya Kham Irrigation Canal Area, Mueang District, Chiang Mai Province,*” aims to investigate the suitability of the soil for agricultural use. The researchers reviewed and examined relevant theoretical documents and previous studies as follows:

1. Definition of soil
2. Soil components
3. Physical properties of soil
4. Chemical properties of soil

2.1.1 Definition of Soil

Soil is a natural material formed from the weathering and decomposition of rocks and minerals through complex geological and biological processes. It consists of minerals, organic matter, water, and air, forming a system capable of supporting the growth of plants and soil organisms. Soil plays an essential role in ecosystems, such as serving as a reservoir of nutrients for plants, acting as a medium for the movement of water and air, and providing habitat for small organisms, such as microorganisms.

The process of soil formation takes hundreds to thousands of years. The major factors influencing soil formation include:

1. **Parent material** – the primary source of minerals that form the basis of soil.
2. **Climate** – temperature and rainfall affect the rate of rock weathering.
3. **Organisms** – microorganisms, plant roots, and soil animals play roles in the decomposition of organic matter.
4. **Topography** – landforms influence soil accumulation and erosion.
5. **Time** – soil formation requires long periods to develop suitable physical and chemical properties.

Soil can be simply classified into three main types: sandy soil, loam soil, and clay soil. Each soil type has distinct characteristics in terms of particle size, composition, soil texture, pore space, and fertility. These characteristics influence the suitability of each soil type for different kinds of crop cultivation.

1. **Loam Soil**

Loam soil has a fine, crumbly texture and can moderately form aggregates. It is a balanced mixture of sandy soil and clay soil in approximately equal proportions. Loam soil has good drainage while retaining an adequate amount of water, making it highly suitable for cultivation. It is capable of retaining moisture effectively and serves as a fertile reservoir of nutrients. Additionally, loam soil contains a high level of calcium.



Figure 2.1 Loam Soil

Source: <https://www.istockphoto.com/th>
Accessed on January 12, 2026

2. **Sandy Soil**

Sandy soil consists of more than 85 percent sand, giving it a relatively coarse texture. Due to its predominantly sandy composition, this type of soil often lacks nutrients in certain areas. It has a coarse structure, loosens easily, and provides excellent drainage; however, it has a low water-holding capacity. Sandy soil is very lightweight and therefore less capable of retaining moisture and nutrients compared to other soil types.



Figure 2.1 Sandy Soil

Source:

http://119.46.166.126/digitalschool/p4/sc4_1/lesson3/content1/more/gallery/gallery01.php
Accessed on January 12, 2026

3. Clay Soil

Clay soil has the finest texture among all soil types. It has a soft and sticky feel and adheres to the hands when wet. When dry, clay soil hardens and develops cracks. It is the heaviest type of soil and has a very high water-holding capacity. However, moisture and air penetrate the soil with difficulty. Clay soil is highly elastic and has a strong ability to absorb and retain nutrients.



Figure 2.1 Clay Soil

Source: <https://smegp-digitalid-dev.thaisme.one/product/613ba0a0b350cd489fb6d418>
Accessed on January 12, 2026

The three soil types can be distinguished by their clearly observable textures through handling and examination. If the soil is crumbly and has high moisture content, it is classified as loam soil. If the soil is lightweight and contains a large amount of sand particles, it is sandy soil. Finally, if the soil is heavy, soft, and sticky to the touch, it is clay soil. The suitability of each soil type for plant cultivation depends on the ability of specific plant species to grow and develop well under particular soil conditions.

2.1.2 Soil Components

Soil is formed from the accumulation of weathered mineral materials. However, soils vary from one location to another due to differences in mineral distribution. Despite these variations, soils in all areas share common components. Soil can be divided into four main components as follows:

1. **Water (25%)**

Water occupies the pore spaces between soil particles. It directly affects plant growth and plays a key role in maintaining soil moisture. Water helps keep the soil moist and regulates soil temperature, creating conditions favorable for plant growth.

2. **Air (25%)**

Air consists of various gases present within soil pores. In the absence of water, air cannot be retained in the soil, as these two components are directly interrelated. Loam soil, which has a higher degree of porosity than other soil types, allows better aeration. The major gases commonly found in soil include nitrogen (N₂), oxygen (O₂), and carbon dioxide (CO₂).

3. Organic Matter (5%)

Organic matter is derived from the accumulation and decomposition of living organisms, regardless of their size. In scientific terms, this decomposition process is known as humus, which is an important source of nutrients that influences the properties and characteristics of soil. Organic matter is composed mainly of carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), and sulfur (S).

2.1.3 Physical Properties of Soil

2.1.3.1 Soil Structure

Soil structure refers to the arrangement of soil particles, such as sand, silt, and clay, as well as the pore spaces between these particles. Soil structure affects water drainage, aeration, and plant growth. Soil structure can be classified into several types, including:

- Granular structure – suitable for plant cultivation due to good water and air permeability.
- Platy structure – characterized by poor drainage and commonly found in compacted soils.
- Blocky structure – commonly found in clay soils and exhibits high cohesion.
- Prismatic structure – typically found in subsoil layers with poor drainage.

1) Methods for Analyzing Soil Structure

1.1) Visual observation – examining soil aggregation characteristics. For example, soil with a granular structure appears as small, rounded aggregates and is suitable for plant cultivation.

1.2) Soil disintegration test – soil samples are crushed and observed for fragmentation. If the soil breaks into small aggregates, it indicates a good soil structure.

1.3) Use of measuring instruments – tools such as a Soil Structure Kit are used to measure soil density and pore spaces.

2.1.3.2 Soil Color

Soils in different areas exhibit various colors, such as black, brown, yellow, red, or gray, including mottled patterns. Soil color depends on the types of minerals present, environmental conditions during soil formation, the duration of soil development, and other materials contained in the soil. The characteristics of soil color can be described as follows:

- **Black, dark brown, or dark-colored soils**
These soils are generally highly fertile due to their high organic matter content, especially in the topsoil layer. However, in some cases, dark soil color may result from other soil-forming factors besides organic matter content. For example, soils developed from parent materials derived from dark-colored rocks, such as volcanic rocks, with a relatively short development period, or soils with high manganese content, can also exhibit dark coloration.
- **Yellow or red soils**
The yellow or red coloration of soil is mainly due to iron and aluminum oxides. This indicates that the soil is highly developed, having undergone prolonged weathering and leaching processes. Such soils generally have good drainage but tend to be low in fertility. Yellow soils contain hydrated iron oxides, whereas red soils contain iron or aluminum oxides without water as a component.
- **White or light gray soils**
Light-colored soils may indicate soils derived from parent materials composed largely of light-colored minerals, such as granite or certain types of sandstone. Alternatively, they may result from intense leaching processes that remove most plant-available nutrients. Light coloration may also be caused by the accumulation of lime, gypsum, or various salts within the soil profile. These soils are generally low in fertility.
- **Gray or bluish soils**
Gray, grayish-blue, or blue soils indicate prolonged waterlogged conditions, such as paddy soils in lowland areas or soils in mangrove forests that are regularly inundated by seawater. These soils have poor drainage and aeration, leading to the formation of iron compounds with gray or bluish coloration.

1) Methods for Analyzing Soil Color

1.1) **Use of the Munsell Soil Color Chart** – soil color is compared with standard color charts.

1.2) **Visual observation** – soil color is observed under both dry and moist conditions.

- Dark or dark brown soils indicate high organic matter content.
- Red or yellow soils indicate the presence of iron oxides.

2.1.3.3 Soil Cohesion

Soil cohesion refers to the force that binds soil particles together into a single mass. This force results from physical, chemical, and biological interactions among soil components. Soil cohesion influences various soil properties, including water permeability, compaction, and the ability to support plant roots. Soil cohesion is important in several aspects, including:

- **Plant growth** – affects root penetration and water uptake.
- **Subsurface water movement** – influences the soil's capacity to retain and drain water.
- **Soil stability** – helps prevent soil collapse and surface erosion.
- **Engineering applications** – affects the stability of infrastructure such as buildings, roads, and dams.

1) Types of Soil Cohesion

Soil cohesion can be classified into three main levels:

1.1) Loose soil (low cohesion)

Soil particles are weakly bonded, resulting in high pore space that allows water and air to move freely. This type of soil is commonly found in sandy soils, loamy soils, and soils with low organic matter content.

1.2) Moderately cohesive soil (moderate cohesion)

Soil particles are moderately bonded, providing a balance between water permeability and root anchorage. This type of soil is commonly found in clay loam soils and soils with moderate organic matter content.

1.3) Strongly cohesive soil (high cohesion)

Soil particles are tightly bonded, resulting in slow drainage and high resistance to water erosion. However, plant roots may have difficulty penetrating such soils. This type of soil is commonly found in clay soils.

2) Methods for Analyzing Soil Cohesion (GLOBE Thailand)

2.1) **Hand test** – soil is squeezed by hand to determine its condition:

- **Solid** – dry soil that breaks easily.
- **Plastic** – soil can be molded into shapes.
- **Liquid** – soil flows when excessive water is present.

2.1.3.4 Soil Temperature

Soil temperature refers to the level of heat measured at different soil depths. It affects physical, chemical, and biological processes in the soil, such as plant growth, microbial activity, and nutrient uptake by plant roots. Soil temperature plays a crucial role in determining the environmental conditions for plants and soil organisms, influencing seed germination, photosynthesis, and the decomposition of organic matter.

1) Factors Affecting Soil Temperature

1.1) Heat gain and heat loss of soil

- **Solar radiation** – the primary energy source causing changes in soil temperature.
- **Thermal conductivity of soil** – soils with higher density, such as clay soils, retain heat better than sandy soils.
- **Radiative cooling** – soil cools down in the absence of sunlight, such as during nighttime.

1.2) Physical characteristics of soil

- **Soil color** – dark-colored soils absorb more heat than light-colored soils.
- **Soil porosity** – soils with high pore space, such as loam soils, dissipate heat more efficiently.
- **Soil water content** – moist soils absorb and release heat more slowly than dry soils.

1.3) Soil depth

- Soil temperature at the surface fluctuates rapidly in response to air temperature.
- Deeper soil layers have more stable temperatures due to reduced exposure to atmospheric conditions.

2) *Methods for Measuring Soil Temperature*

2.1) **Soil thermometer**

- A device used to measure soil temperature directly.
- Easy to use by inserting it into the soil.
- Suitable for measuring shallow depths (5–10 cm).

2.2) **Digital soil probe**

- Uses electronic sensors to detect soil temperature.
- Provides high accuracy and allows real-time data recording.

3) *Effects of Soil Temperature on Plants*

- Excessively high soil temperature ($>35^{\circ}\text{C}$) may damage plant roots and reduce nutrient uptake.
- Excessively low soil temperature ($<10^{\circ}\text{C}$) slows root growth and affects photosynthesis.

2.1.3.5 Soil Moisture

Soil moisture refers to the amount of water present within soil pores. It plays a vital role in physical, chemical, and biological processes in the soil, such as water absorption by plant roots, nutrient dissolution and transport, and microbial activity. Soil moisture is a key factor influencing plant growth, as water is essential for photosynthesis and nutrient uptake.

1) *Factors Affecting Soil Moisture*

1.1) **Soil texture and soil porosity**

- **Clay soil** – has high water-holding capacity but poor drainage, which may cause oxygen deficiency for plants.
- **Loam soil** – has moderate water-holding capacity and is suitable for cultivation.
- **Sandy soil** – drains water rapidly, resulting in low soil moisture and increased risk of drought stress.

1.2) **Rainfall and irrigation**

- Rainfall is a primary source of soil moisture.
- Irrigation systems such as drip irrigation and sprinkler irrigation influence soil moisture retention.

1.3) Temperature and evaporation rate

- High temperatures increase evaporation, causing soil to dry more quickly.
- Low temperatures reduce evaporation and help maintain soil moisture.

2) Measurement of Soil Moisture

2.1) Soil sampling – collecting soil samples from the desired depth.

2.2) Soil moisture meter – inserting the device into the soil to measure moisture content.

2.3) Gravimetric method – drying soil samples at 105°C for 24 hours and calculating moisture loss based on weight differences before and after drying.

2.1.4 Chemical Properties of Soil

2.1.4.1 Soil pH

Soil pH indicates the acidity or alkalinity of soil and affects nutrient solubility, nutrient uptake by plants, and microbial activity. Soil pH is determined by the concentration of hydrogen ions (H^+) and hydroxide ions (OH^-) in soil water. The pH scale ranges from 0 to 14: $pH < 7$ indicates acidic soil, $pH = 7$ indicates neutral soil, and $pH > 7$ indicates alkaline soil.

1) Factors Affecting Soil pH

1.1) Geological and mineral composition

- Soils derived from granite tend to be acidic.
- Soils derived from limestone tend to be alkaline.

1.2) Rainfall and nutrient leaching

- High rainfall promotes leaching of calcium (Ca) and magnesium (Mg), leading to acidic soils.
- Arid regions tend to have alkaline soils due to bicarbonate (HCO_3^-) accumulation.

1.3) Microbial activity and organic matter decomposition

- Microorganisms release organic acids, such as carbonic and humic acids, which lower soil pH.
- Nitrogen fixation by legumes can help stabilize soil pH.

1.4) Fertilizers and agricultural chemicals

- Ammonium sulfate ((NH₄)₂SO₄) acidifies soil.
- Animal manure and compost help maintain optimal pH levels.
- Lime (CaCO₃) increases pH in acidic soils.

1.5) Salt accumulation

- Areas with shallow groundwater and high evaporation tend to accumulate sodium ions (Na⁺), resulting in alkaline soils.

2) Methods for Measuring Soil pH

2.1) pH meter method

- Mix 20 g of soil with 40 mL of distilled water.
- Insert the pH electrode into the soil suspension.
- Record the stable pH value.

2.2) GLOBE Thailand standard method

- Collect soil samples from 10–15 cm depth.
- Use a calibrated soil pH test kit.
- Compare the resulting color with a pH scale.

2.1.4.2 Soil Fertility

Soil fertility refers to the soil's ability to supply essential nutrients for plant growth. Key factors influencing soil fertility include nutrient availability, nutrient retention capacity, and microbial activity that decomposes organic matter and releases nutrients. Primary nutrients required by plants are nitrogen (N), phosphorus (P), and potassium (K), collectively known as **N–P–K**, which are major components of agricultural fertilizers.

1) *Forms of Nitrogen in Soil*

- **Ammonium (NH₄⁺)** – found in soils undergoing organic matter decomposition.
- **Nitrate (NO₃⁻)** – the most readily available form for plant uptake.
- **Nitrite (NO₂⁻)** – an intermediate form in nitrogen transformation.
- **Organic nitrogen** – present in undecomposed plant and animal residues.

2) *Forms of Phosphorus in Soil*

- Water-soluble phosphorus – readily absorbed by plants.
- Phosphorus bound with aluminum or iron – less available to plants.
- Organic phosphorus – present in plant and animal residues.

3) *Forms of Potassium in Soil*

- Water-soluble potassium – readily available for plant uptake.
- Exchangeable potassium – adsorbed on soil particles and released through cation exchange.
- Mineral potassium – slowly released from clay minerals.

4) *Methods for Analyzing N, P, and K*

- Collect soil samples from 10–15 cm depth.
- Prepare soil solution by mixing 10 g of soil with 50 mL of distilled water.
- Use test kits and compare color changes with N–P–K standards.
- Record and analyze results.

2.2 Related Research

Somchai Jaidee (2017) studied the physical and chemical properties of agricultural soils in Chiang Mai Province, focusing on soil structure, soil color, moisture, and pH. The results indicated that most soils exhibited a granular structure suitable for water and air movement, with pH values ranging from 6.0 to 7.0, which are optimal for plant cultivation.

Sureeporn Saengthong (2019) investigated the use of organic fertilizers to improve soil quality for marigold cultivation. The study found that organic fertilizers significantly increased nitrogen and phosphorus levels, improved soil structure, and promoted plant growth.

Noppadon Wattana (2018) examined the effects of soil moisture on plant growth, emphasizing the relationship between soil moisture and growth rate. Optimal soil moisture (60–70% of water-holding capacity) resulted in the best plant growth, while excessive or insufficient moisture reduced nutrient uptake.

Apichat Jaikwang (2020) studied the levels of major nutrients (N, P, and K) in soils used for economic crop cultivation. The findings revealed low nitrogen and phosphorus levels but moderate potassium content, suggesting the need for nutrient supplementation.

Wilaiwan Suksawat (2021) analyzed the relationship between soil color and soil fertility using the Munsell Soil Color Chart. Dark-colored soils were found to have higher fertility due to higher organic matter content, whereas light-colored soils tended to be less fertile.

Chapter 3

Research Methodology

The study of soil in the Phaya Kham irrigation canal area aims to analyze the physical and chemical characteristics of soil that affect plant growth. This research focuses on soil sampling and the analysis of soil structure, soil color, soil cohesion, soil texture, soil temperature, soil moisture, soil pH, and soil NPK values. The results obtained are intended to be used to improve soil conditions to enhance suitability for plant cultivation.

This study follows the **GLOBE Protocols for Pedosphere (Soil)**, which are internationally recognized standards for soil studies.

3.1 Sample Group

Soil samples were collected from the Phaya Kham irrigation canal area, Nong Hoi Subdistrict, Mueang District, Chiang Mai Province.

3.2 Research Sites

3.2.1 Phaya Kham irrigation canal, Nong Hoi Subdistrict, Mueang District, Chiang Mai Province

3.2.2 Science laboratory, Building 7, Varee Chiang Mai School

3.3 Soil Sampling

Soil samples were collected using a shovel to excavate soil from selected sampling points at a depth of approximately 10–20 centimeters. Sampling was conducted in rows or distributed across the study area to ensure representative samples. Care was taken to avoid external contamination, such as stones, plant debris, or other irrelevant materials. The collected soil samples were placed in plastic bags or sealable containers to preserve their properties until laboratory analysis.

3.3.1 Materials and Equipment

1. Shovel
2. Zip-lock plastic bags
3. Gloves

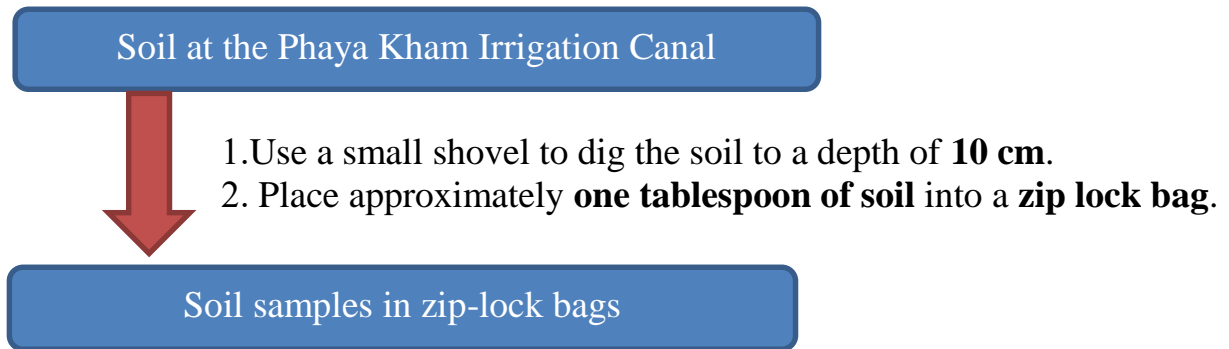


Figure 3.1 Shows the steps for measuring soil structure

3.4 Soil Structure Analysis

Soil structure refers to the arrangement of soil particles, which affects water drainage and soil aeration. The methods used to analyze soil structure are as follows:

3.4.1 Materials and Equipment

1. Soil sampling equipment
2. Soil structure reference diagrams

3.4.2 Procedure for Measuring Soil Structure

1. Collect soil samples using appropriate methods for soil characterization and record preliminary information, such as environmental conditions.
2. Place the undisturbed soil sample on the hand and observe it carefully, focusing on the soil structure. Soil structures occur in various forms, as shown in the soil structure reference diagrams.
3. Measure the size and shape of the soil aggregates and record the data on the soil structure data sheet.
4. Data collection frequency: once at each study site.

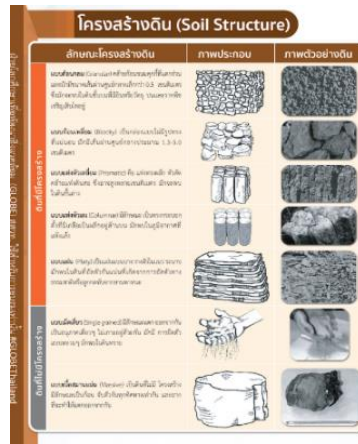


Figure 3.2 Soil Structure Diagrams
 Source: <https://globefamily.ipst.ac.th/globe-protocols>
 Accessed on January 8, 2026

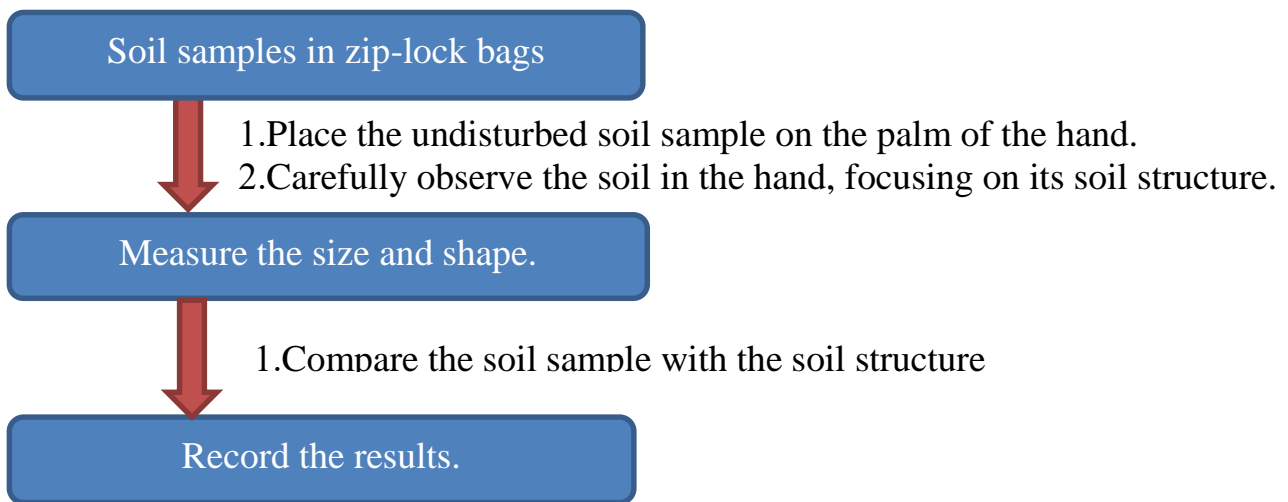


Figure 3.3 shows the steps of soil sample collection.

3.5 Soil Color Analysis

Soil color indicates the chemical substances coating soil particles, the amount of organic matter, and soil moisture content. Soil color comparison is based on the **Munsell system**. The procedures for soil color analysis are as follows:

3.5.1 Materials and Equipment

1. Munsell Soil Color Chart
2. Soil samples
3. Spray bottle with water

3.5.2 Procedure for Measuring Soil Color

1. Take soil particles from each soil layer, observe them, and record in the data sheet whether the soil is dry, moist, or wet. If the soil is dry, moisten it slightly by spraying water from the prepared bottle.
2. Stand so that sunlight shines over the shoulder onto the Munsell Soil Color Chart and the soil sample being examined.
3. Break the soil particle into two parts.
4. Record the soil color values in the data recording sheet.

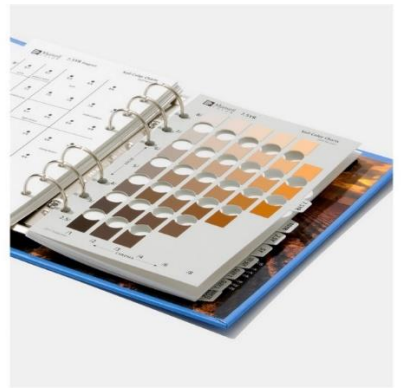


Figure 3.4 Munsell Soil Color Chart

Source: <https://www.tcg-plus.com/product/soil-color-book/>
Accessed on January 8, 2026

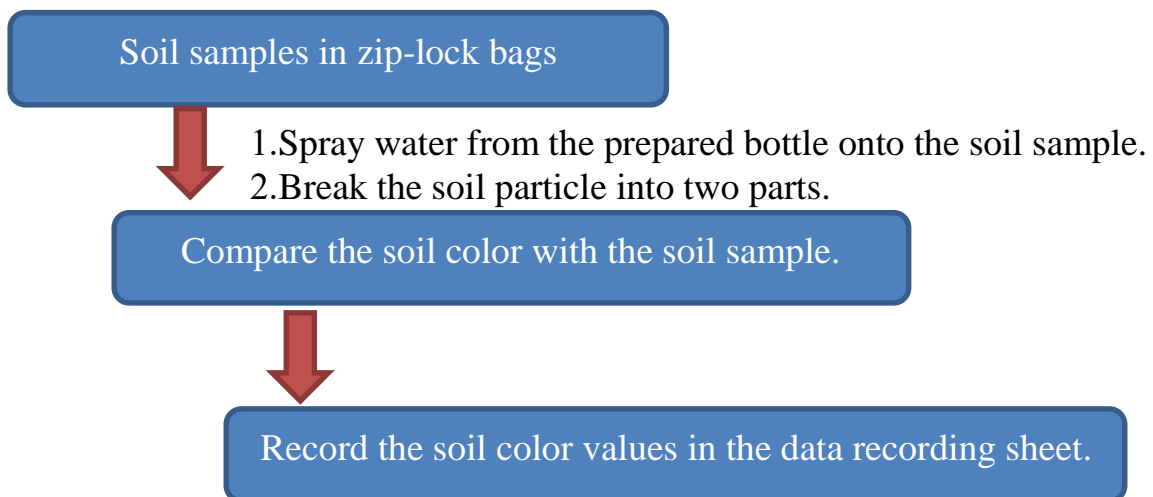


Figure 3.5 illustrates the steps for analyzing soil color.

3.6 Analysis of Soil Cohesion

Soil cohesion refers to the behavior of soil in response to external forces. It is related to soil texture, soil structure, and the level of soil moisture at the time of observation. Therefore, the soil's response to applied force varies according to moisture content. The assessment of soil cohesion is conducted at different moisture levels using the following methods.

3.6.1 Materials and Equipment

1. Equipment for collecting soil samples
2. Soil cohesion comparison chart

3.6.2 Procedure for Measuring Soil Cohesion

1. Take soil particles from the topsoil layer. If the soil is dry, moisten it by spraying water, then remove soil particles and observe their cohesion.
2. Hold a soil particle between the thumb and index finger and gently press it until it breaks apart.
3. Record the observed type of soil cohesion in the data recording sheet.



Figure 3.6 Soil Cohesion Comparison Diagrams

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

Accessed on January 8, 2026

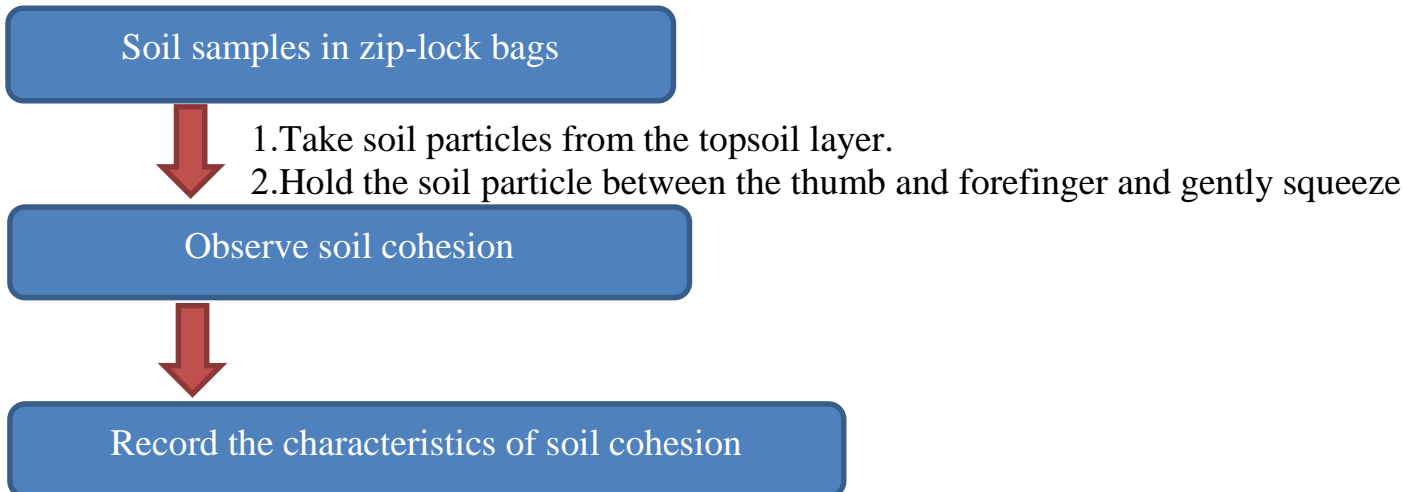


Figure 3.7 shows the steps for analyzing soil cohesion.

3.7 Soil Temperature Measurement

Soil temperature is directly related to atmospheric temperature, with soil acting as an insulating layer between subsurface materials and the atmosphere. Soil temperature is generally lower than air temperature, and the deeper the soil layer, the smaller the temperature variation. Soil temperature affects plant growth, including the timing of bud emergence or leaf fall, as well as the rate of organic matter decomposition. The measurement procedures are as follows:

3.7.1 Materials and Equipment

- Probe-type soil thermometer

3.7.2 Soil Temperature Measurement Procedure

1. Insert the thermometer into the soil to a depth of approximately 10–15 centimeters.
2. Wait for the temperature reading to stabilize for 1–2 minutes.
3. Record the soil temperature in the data recording sheet.



Figure 3.8 Needle soil thermometer

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

Accessed on February 8, 2025

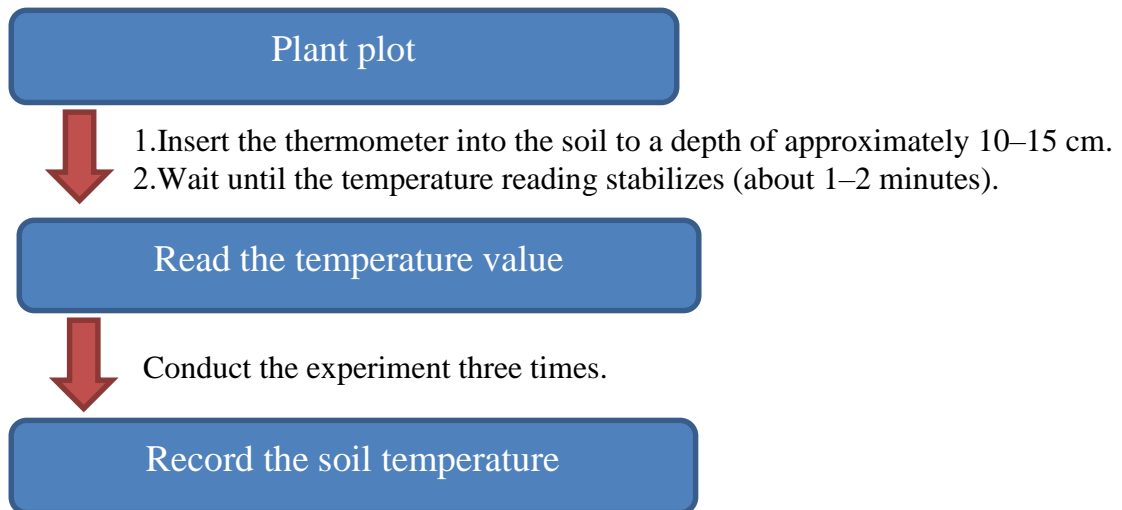


Figure 3.9 Showing the steps for measuring soil temperature

3.8 Measurement of Soil Moisture

Soil moisture affects the availability of water in the soil that plants can use. The uptake of nutrients by plants must occur in ionic form, with soil water acting as the medium. Soil moisture serves as a reservoir of water in the soil; soil functions like a sponge, helping to prevent flooding by retaining water. Soil moisture also influences the processes of erosion of soil, rocks, and minerals.

Soil moisture is related to relative humidity in the atmosphere, as water in the soil evaporates into the atmosphere, increasing relative humidity. The measurement procedures are as follows:

3.8.1 Materials and Equipment

- Needle-type soil moisture meter

3.8.2 Procedure for Measuring Soil Moisture

1. Select the location where soil moisture will be measured.
2. Insert the probe of the soil moisture meter into the soil to a depth of approximately 5–10 cm.
3. Wait until the value displayed on the meter stabilizes (approximately 10–30 seconds).
4. Record the measured soil moisture value.



Figure 3.10 Needle-type soil moisture and pH meter

Source: <https://www.tools.in.th/temperature-monitoring-device/needle-thermometer/>
 Accessed on February 8, 2025

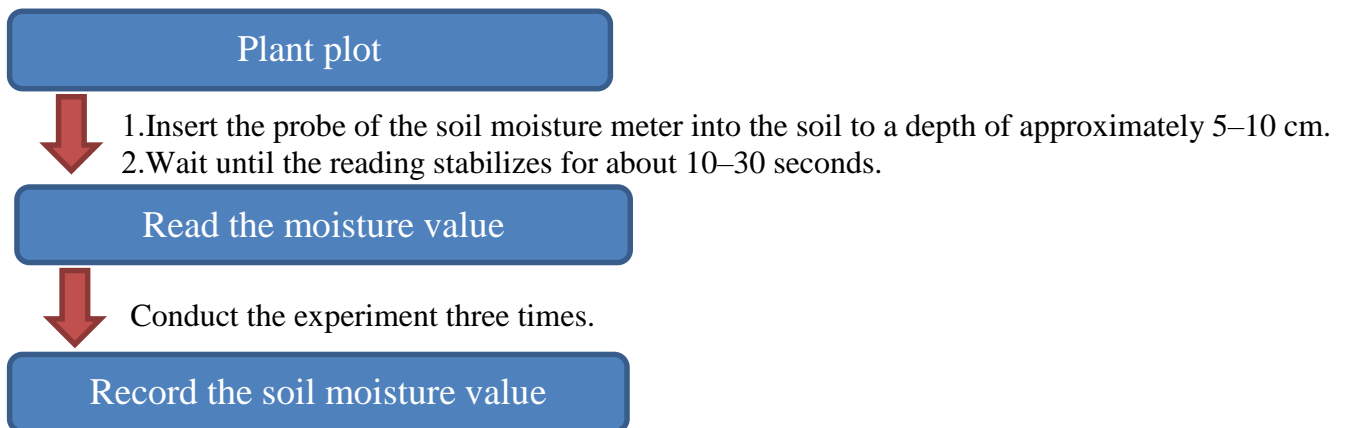


Figure 3.11 Steps for measuring soil temperature

3.9 Measurement of Soil Acidity–Alkalinity (pH)

Measuring soil acidity–alkalinity (pH) is an important step in soil studies and agricultural land management because soil pH directly affects plant growth, nutrient uptake, and the activity of soil microorganisms. The methods of analysis are as follows:

3.9.1 Materials and Equipment

- Needle-type soil pH meter

3.9.2 Procedure for Measuring Soil pH

1. Select the location where the soil pH will be measured.
2. Insert the probe of the soil pH meter into the soil to a depth of approximately 5–10 centimeters.
3. Wait about 1–2 minutes for the meter to display the actual soil pH value.
4. Read the pH value from the scale shown on the meter.
5. Record the obtained pH value.



Figure 3.12 Soil pH meter

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

Accessed on 8 January 2026

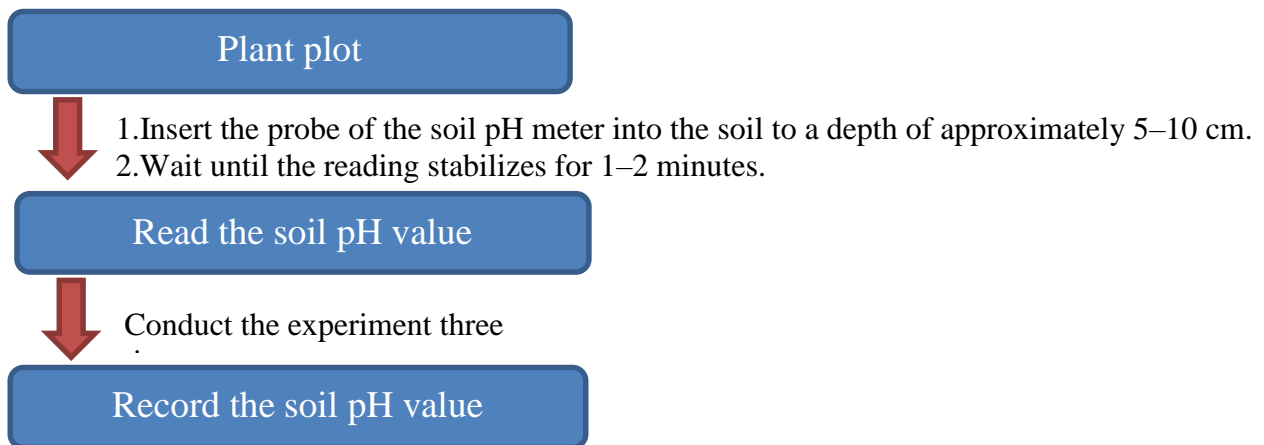


Figure 3.13 Showing the steps for measuring soil temperature

3.10 Measurement of Soil Fertility

Soil fertility can be determined by the amount of essential nutrients present in the soil, such as nitrogen (N), phosphorus (P), and potassium (K), which are the most important primary nutrients required by plants. The analytical procedures are as follows:

3.10.1 *Materials and Equipment*

1. Dried and sieved soil samples
2. Distilled water
3. Teaspoon
4. Test tube or cup holder
5. Soil property data recording sheet
6. Soil fertility test kit with reagents for determining soil N, P, and K

3.10.2 *Methods for Measuring Soil Fertility*

3.10.2.1 Preparation of Soil Solution

1. Weigh 20 grams of dried and sieved soil and place it into a beaker.
2. Add 20 milliliters of distilled water to obtain a soil-to-water ratio of 1:1.
3. Stir the mixture with a glass rod for 30 seconds, then let it stand for 3 minutes. Repeat this process 5 times.

4. After stirring 5 times, allow the mixture to stand until the soil settles. A clear solution will be visible at the top of the beaker.

3.10.2.2 Measurement of Soil Fertility Using a Soil Test Kit

(Nitrate (NO_3^-) – Nitrogen in Soil)

1. Use a pipette to transfer 2.5 milliliters of the soil solution into a test tube.
2. Add one packet of HI 3895-N reagent to the solution.
3. Cap the test tube and shake for approximately 30 seconds to dissolve the reagent.
4. Compare the resulting pink color with the nitrate color chart.

3.10.2.3 Measurement of Soil Fertility Using a Soil Test Kit

(Phosphorus (P_2O_5) in Soil)

1. Use a pipette to transfer 2.5 milliliters of the soil solution into a test tube.
2. Add one packet of HI 3895-P reagent to the solution.
3. Cap the test tube and shake for approximately 30 seconds to dissolve the reagent.
4. Compare the resulting blue color with the phosphorus color chart.

3.10.2.4 Measurement of Soil Fertility Using a Soil Test Kit

(Potassium (K_2O) in Soil)

1. Use a pipette to transfer 0.5 milliliters of the soil solution into a test tube.
2. Add distilled water to obtain a total volume of 2.5 milliliters.
3. Add one packet of HI 3895-K reagent to the solution.
4. Cap the test tube and shake for approximately 30 seconds to dissolve the reagent.
5. Compare the resulting turbidity with the potassium comparison chart.



Figure 3.14 Soil fertility test kit with reagents for determining soil N, P, and K values

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

Accessed on 8 January 2026

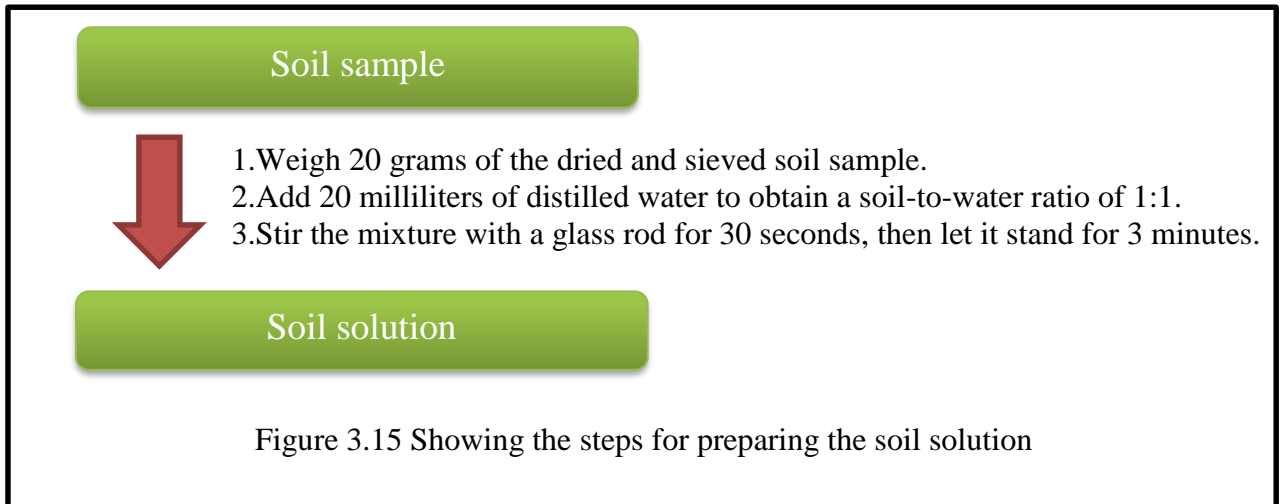


Figure 3.15 Showing the steps for preparing the soil solution

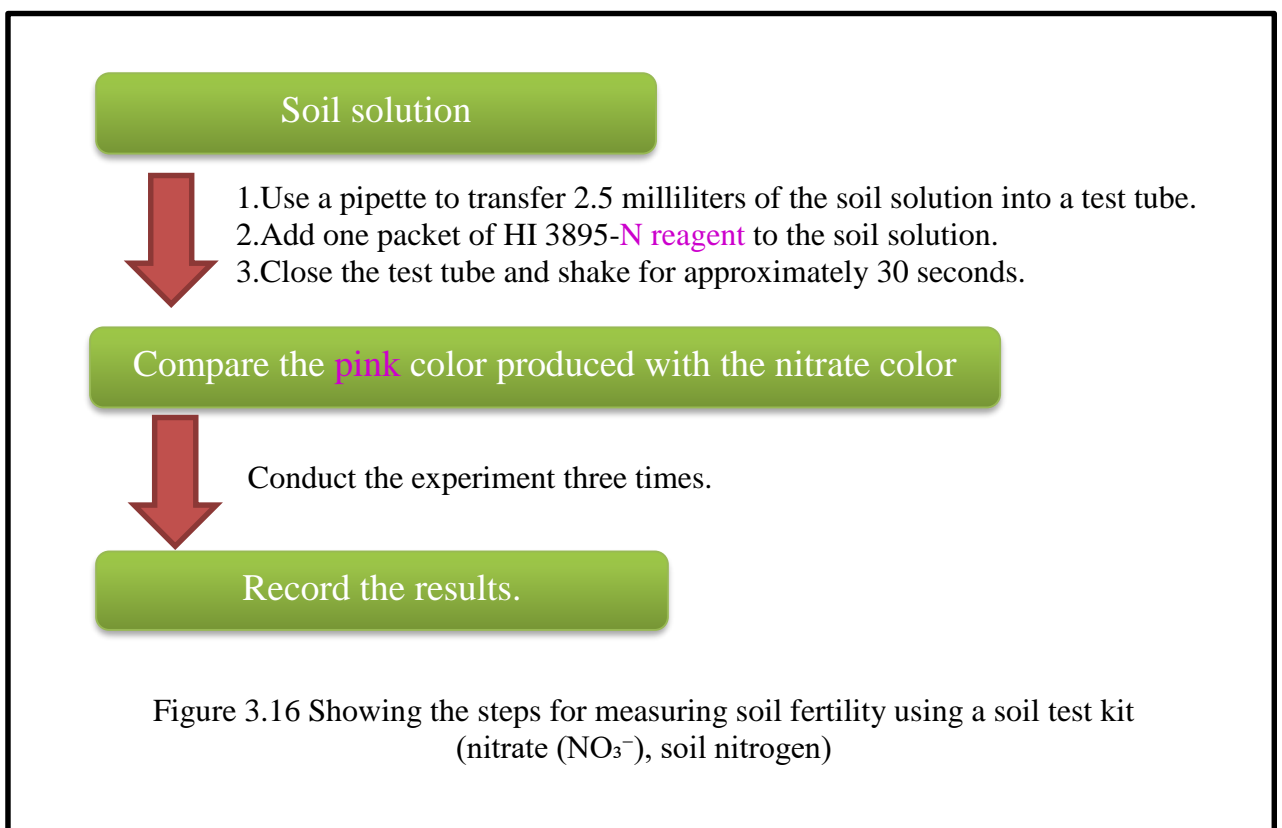
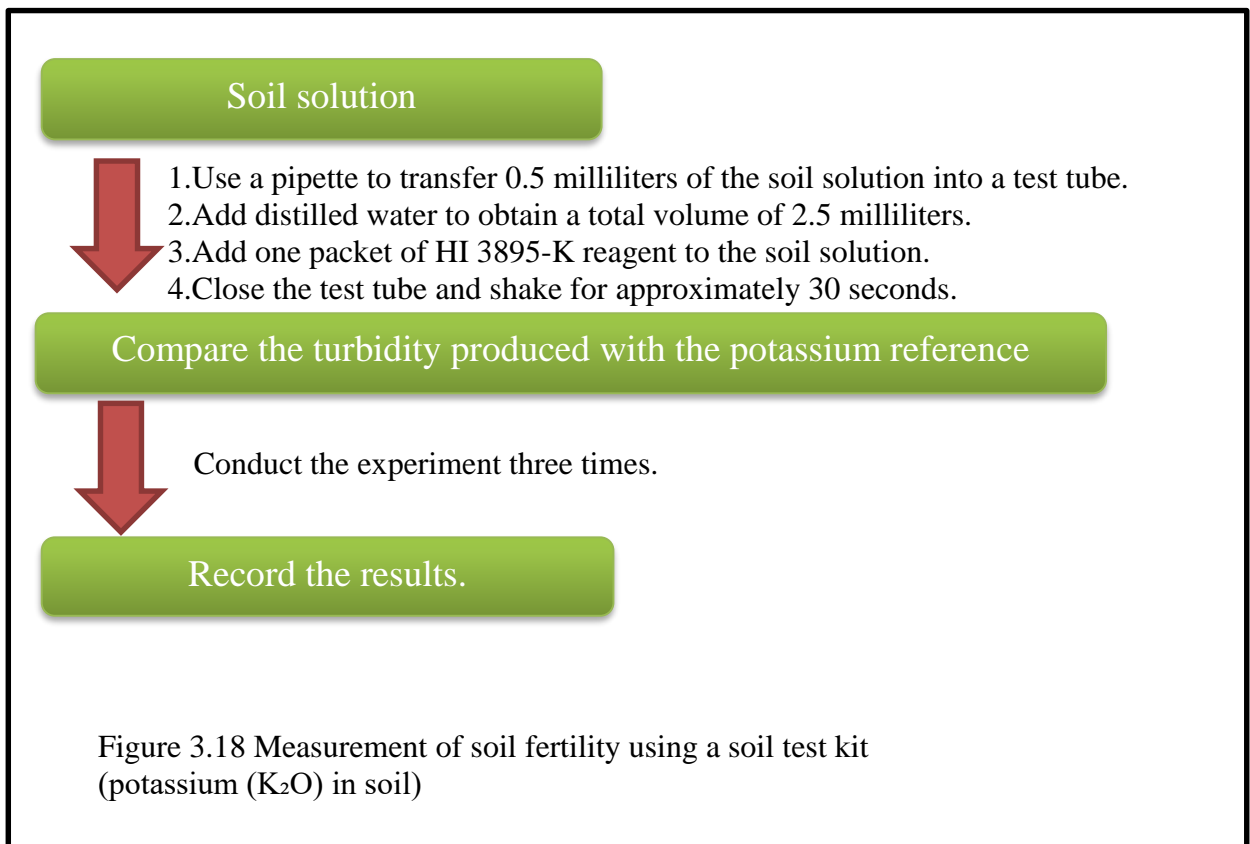
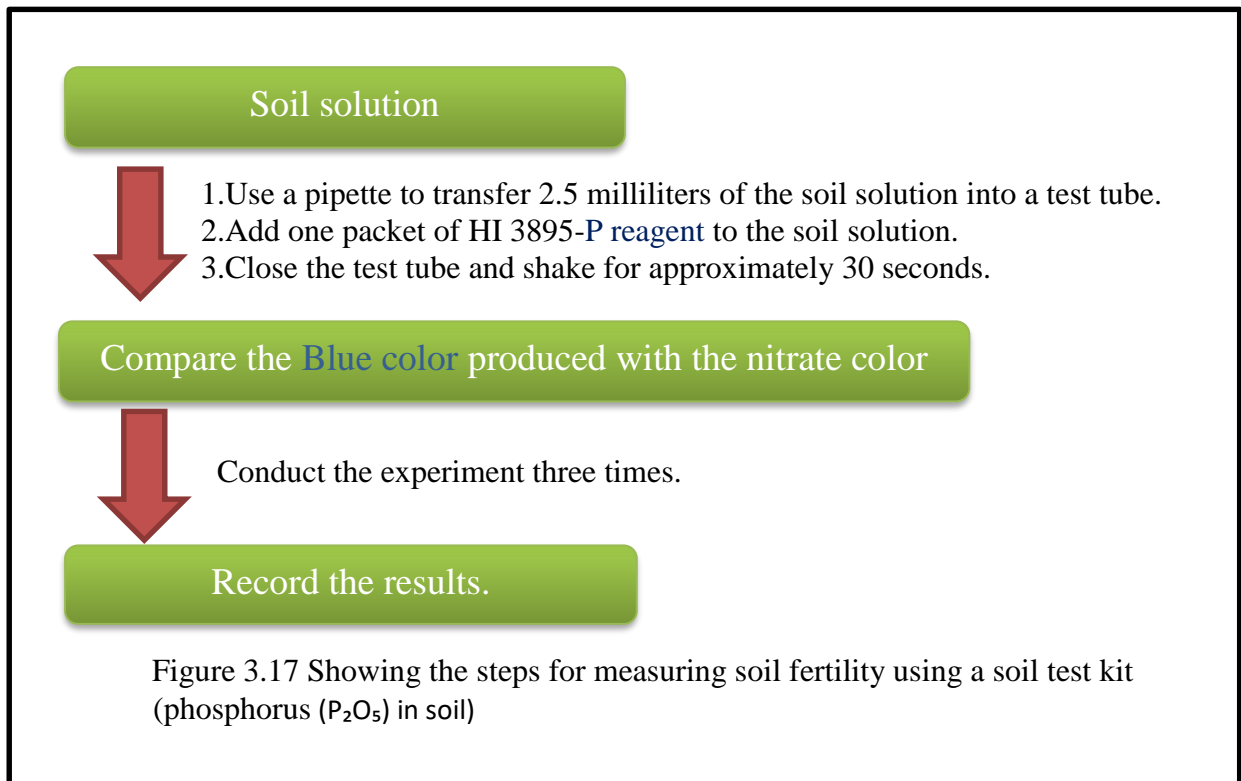


Figure 3.16 Showing the steps for measuring soil fertility using a soil test kit (nitrate (NO_3^-), soil nitrogen)



Chapter 4 Results and Discussion

This study aimed to analyze the physical and chemical properties of soil along the Phaya Kham irrigation canal at Varee Chiang Mai School, with a focus on evaluating soil suitability for plant cultivation and using the obtained data to improve soil conditions for optimal plant growth. The study revealed several noteworthy findings, which are summarized and discussed as follows.

4.1 Results of Physical Soil Property Analysis

4.1.1 Soil Structure

The analysis of soil structure showed that the soil along the Phaya Kham irrigation canal exhibited variations among the different samples, as presented in Table 4.1, which summarizes the soil structure measurements.

Table 4.1 Physical characteristics of soil structure measurements in soil samples 1, 2, and 3.

Soil sample	Soil Structure
1	Blocky
2	Granular
3	Granular

Note: Samples were collected at 4:00 p.m. on November 15, 2025.

From the analysis of physical properties, it was found that Soil Sample 1 had a **blocky soil structure**, which is commonly found in soils with poor drainage and may negatively affect plant growth because air and water cannot circulate freely. Soil Samples 2 and 3 exhibited a **granular soil structure**, which is suitable for water and air drainage in the soil. This type of structure allows plant roots to grow well and enhances the efficient absorption of water and nutrients.

Granular soil structure is considered ideal for plant cultivation because it promotes good water and air movement within the soil, whereas blocky soil structure may hinder plant growth if soil improvement measures are not applied. Therefore, the addition of organic matter, such as compost or animal manure, can help improve soil structure and make it more suitable for plant growth.

4.1.2 Soil Color

From the analysis of soil color, it was found that the soil along the Phaya Kham mine varied among sampling points within the same plot.

Differences were observed among the soil samples, as shown in Table

4.2. Soil color

Table 4.2 Physical characteristics showing soil color measurements of soil samples 1, 2, and 3.

Soil sample	Soil color level
1	7.5 YR 2.5/2
2	7.5 YR 3/2
3	7.5 YR 3/2

Note: Samples were collected at 4:00 p.m. on November 16, 2025.

Using the Munsell Soil Color Chart, it was found that the soil color along the Phaya Kham mine was predominantly 7.5 YR 2.5/2 and 7.5 YR 3/2. These colors indicate a high organic matter content in the soil. Dark-colored soils are often associated with higher soil fertility, as organic matter is a major source of essential nutrients for plant growth. Dark soil color therefore suggests fertile soil conditions due to the presence of organic matter, which plays a key role in increasing nutrient availability. However, soil color alone cannot fully indicate soil fertility; other factors such as soil pH and nutrient content must also be considered.

4.1.3 Soil Consistency

The analysis of soil consistency showed that the soils exhibited different degrees of consistency among the samples, as presented in Table 4.3.

Table 4.3 Physical characteristics showing measurements of soil consistency in soil samples 1, 2, and 3.

Soil sample	Soil consistency
1	Compact
2	Friable
3	Friable

Note: Samples were collected at 4:00 PM on November 16, 2025.

From the analysis of physical properties, it was found that Soil Sample 1 exhibited a **compact** consistency, which may affect water drainage and air circulation in the soil. Soil Samples 2 and 3 showed a **friable** consistency, which is suitable for plant cultivation because the soil allows good drainage while maintaining an appropriate level of moisture. Friable soil consistency is ideal for plant growth as it promotes effective water and air movement, whereas compact soil may hinder plant development. Therefore, the addition of organic matter can help improve soil consistency and make it more suitable for plant growth.

4.1.4 Soil Temperature

The analysis of soil temperature showed that the soil temperature varied among the different samples, as presented in Table 4.4.

Table 4.4 Physical characteristics showing soil temperature measurements of Soil Samples 1, 2, and 3.

Soil sample	Soil temperature (°C)
1	25.0
2	25.5
3	25.6
Average	25.4

Note: Samples were collected at 4:00 p.m. on November 16, 2025.

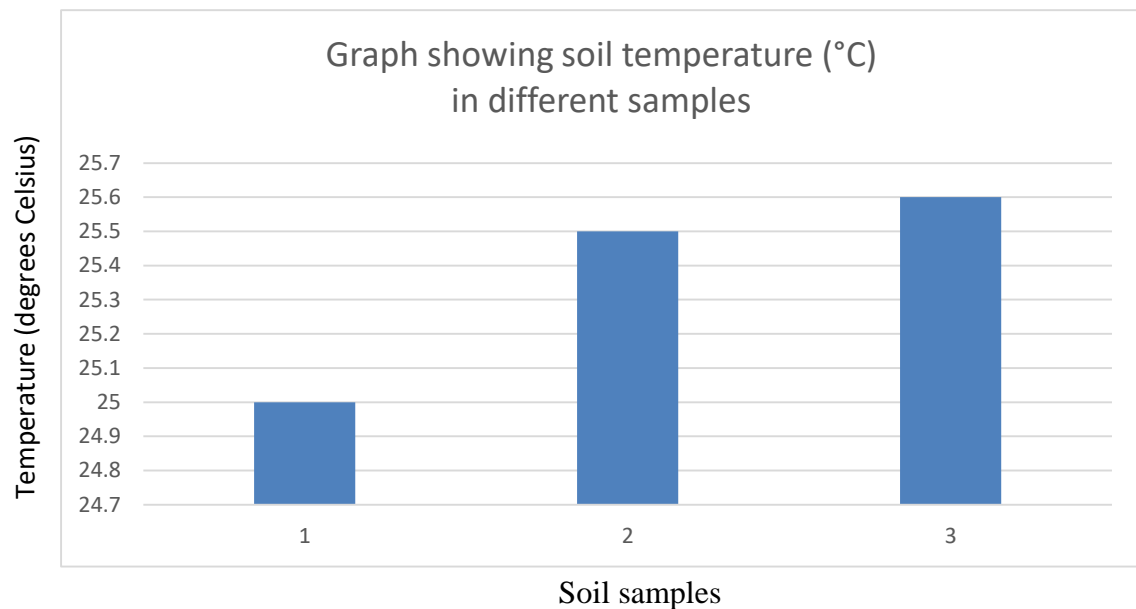


Figure 4.1 Graph showing soil temperature (degrees Celsius) in different samples.

The measured soil temperature ranged between 27–28 degrees Celsius, as shown in the soil temperature measurement table. This temperature range is suitable for plant growth. Excessively high soil temperatures may affect the decomposition of organic matter and the activity of soil microorganisms, while excessively low temperatures may slow plant growth. An appropriate soil temperature promotes plant growth and microbial activity in the soil. However, soil temperature should be monitored regularly to prevent changes that may affect plant growth.

4.1.5 Soil Moisture

The soil moisture ranged between 27–28 grams per cubic meter, as shown in Table 4.5, which presents the soil moisture measurements of soil samples 1, 2, and 3.

Table 4.5 Physical characteristics of soil moisture measurements in soil samples 1, 2, and 3.

Soil sample	Soil moisture (grams per cubic meter)
1	600
2	550
3	650
Average	600

Note: Samples were collected at 4:00 p.m. on November 16, 2025.

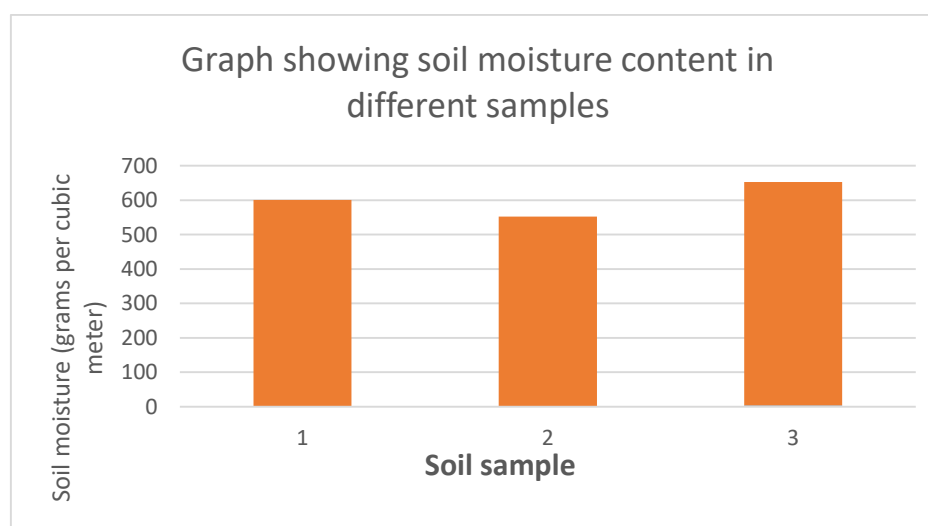


Figure 4.2 Graph showing soil moisture content in different samples

The soil moisture content ranged from **550–650 grams per cubic meter**, as shown in the soil moisture measurement table. This level is suitable for plant cultivation. Adequate soil moisture allows plants to absorb water and nutrients efficiently. Appropriate soil moisture is an important factor that promotes plant growth. However, it was found that some areas had lower soil moisture, which may negatively affect plant growth if proper water management is not implemented.

4.2 Results of the analysis of chemical properties of soil

4.2.1 Soil Acidity–Alkalinity (pH)

From the measurement of soil pH, it was found that the pH values ranged from 6.5 to 6.9, as shown in Table 4.6, which presents the results of soil acidity–alkalinity (pH) measurements for soil samples 1, 2, and 3.

Soil sample	pH value
1	6.9
2	6.8
3	6.5
Average	6.73




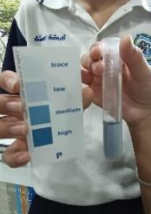
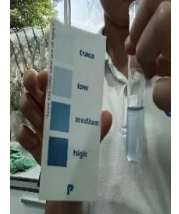
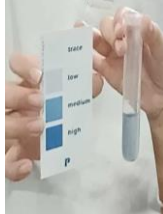



Note: Samples were collected at 4:00 PM on November 16, 2025.

From the measurement of soil pH, it was found that the pH values ranged from 6.5 to 6.9, as shown in the table of soil acidity–alkalinity measurements. This range is suitable for plant cultivation. A pH at this level allows plants to absorb nutrients efficiently and also promotes the activity of soil microorganisms that aid in the decomposition of organic matter. An appropriate pH level supports effective nutrient uptake by plants. However, soil pH should be monitored regularly to prevent changes that may affect plant growth.

4.2.2 Soil Fertility

The analysis of soil fertility showed that the levels of nitrogen (N), phosphorus (P), and potassium (K) varied among the different soil samples, as presented in Table 4.7.

Table 4.7 Nitrogen (N), Phosphorus (P), and Potassium (K) values.

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

Note: Samples were collected at 4:00 PM on November 16, 2025.

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

Soil nutrients	Soil sample	Level
Nitrogen (N)	1	Trace
	2	Trace
	3	Trace
Phosphorus (P)	1	Medium
	2	Medium
	3	Medium
Potassium (K)	1	Medium
	2	Medium
	3	Medium

From the analysis of the primary soil nutrients namely nitrogen (N), phosphorus (P), and potassium (K) it was found that nitrogen (N) was at a very low level, as shown in the table of recorded N levels. Nitrogen is an essential nutrient for leaf and stem growth. Phosphorus (P) was at a moderate level, as indicated in the table of recorded P levels, and is an important nutrient for root and flower development. Potassium (K) was also at a moderate level, as shown in the table of recorded K levels, and plays a key role in strengthening plants and enhancing disease resistance. Although the soil contained potassium at a moderate level, nitrogen and phosphorus were at low levels, which may affect plant growth. Therefore, the application of fertilizers containing nitrogen and phosphorus can help improve soil fertility and promote plant growth.

Chapter 5

Conclusions and Recommendations

This study aimed to analyze the physical and chemical properties of soil, with a focus on evaluating its suitability for plant cultivation in the area surrounding the Phaya Kham mine, and to use the obtained data to improve soil conditions to support plant growth. The study yielded several noteworthy findings, which can be summarized and discussed as follows.

5.1 Summary of Research Findings

Based on this study, the research findings can be summarized as follows.

5.1.1 Physical Properties of the Soil

1. Soil structure:

The soil along the Phaya Kham mine exhibited varying structures among the samples. Sample 1 showed a blocky structure, which may affect water drainage and air movement within the soil. In contrast, Samples 2 and 3 exhibited a granular structure, which is suitable for water and air drainage and supports healthy root growth.

2. Soil color:

The soil color in the Phaya Kham mine area was predominantly 7.5 YR 2.5/2 and 7.5 YR 3/2, indicating a high organic matter content. Dark-colored soils are often associated with higher soil fertility, as organic matter is an important source of essential nutrients for plant growth.

3. Soil consistency:

Sample 1 exhibited compact soil consistency, which may negatively affect water and air drainage. In contrast, Samples 2 and 3 had a friable soil consistency, which is suitable for plant cultivation because it allows good water drainage while maintaining appropriate moisture levels.

4. Soil temperature:

The measured soil temperature ranged from 25.0 to 25.6 degrees Celsius, which is suitable for plant growth. Excessively high soil temperatures may affect the decomposition of organic matter and microbial activity in the soil, while excessively low temperatures may slow plant growth.

5. Soil moisture:

Soil moisture levels ranged from 550 to 650 grams per cubic meter, which is appropriate for plant cultivation. Adequate soil moisture enables plants to absorb water and nutrients efficiently.

5.1.2 Chemical Properties of the Soil

1. **Soil acidity–alkalinity (pH):**

The soil pH ranged from 6.5 to 6.9, which is suitable for plant cultivation. A pH level within this range allows plants to absorb nutrients efficiently and also promotes the activity of soil microorganisms that aid in the decomposition of organic matter.

2. **Soil fertility:**

Analysis of the primary soil nutrients—nitrogen (N), phosphorus (P), and potassium (K)—revealed that nitrogen (N) was at a very low level, phosphorus (P) was at a low level, and potassium (K) was at a moderate level. Although potassium was present at a moderate level, the low levels of nitrogen and phosphorus may negatively affect plant growth.

5.2 Recommendations

1. **Soil structure improvement:**

Organic matter should be added to the soil to improve soil structure and enhance soil fertility.

2. **Water management:**

Appropriate irrigation systems, such as drip irrigation, should be installed to maintain soil moisture at suitable levels.

3. **Nutrient supplementation:**

Fertilizers containing nitrogen and phosphorus should be applied to improve soil fertility.

4. **Regular pH monitoring:**

Soil pH should be monitored regularly to prevent changes that may affect plant growth.

References

Kanyaporn Sangkaew. (2023). *Effects of soil amendments on the physicochemical properties of soil and corn yield grown in sandy soils in Northeastern Thailand*. Land Development Department. Retrieved from https://orgweb.idd.go.th/sources/img/part_km/FILES_2671_667547fc923fe (Accessed: January 12, 2026).

Khajonyot Sirinin. (2019). *Development of a mixed soil formula for cultivating Green Oak lettuce for urban residents*. Thammasat University. Retrieved from <https://ethesisarchive.library.tu.ac.th/thesis/2019> (Accessed: January 12, 2026).

Nichakorn Pathumrangsarn. (2022). *Analysis of soil factors affecting production and sweetness levels of pineapple in Ratchaburi Province*. Ban Mueang Chom Bueng Rajabhat University. Retrieved from <https://rdi.mcru.ac.th/file/m-pineapple/report> (Accessed: January 12, 2026).

Ms. Kanyaporn Sangkaew. (2023). *Effects of soil amendments on the physicochemical properties of soil and corn yield grown in sandy soils in Northeastern Thailand*. Land Development Department. Retrieved from https://orgweb.idd.go.th/sources/img/part_km/FILES_2671_667547fc923fe (Accessed: January 12, 2026).

Ms. Nichakorn Pathumrangsarn. (2022). *Analysis of soil factors affecting production and sweetness levels of pineapple in Ratchaburi Province*. Ban Mueang Chom Bueng Rajabhat University. Retrieved from <https://rdi.mcru.ac.th/file/m-pineapple/report/03> (Accessed: January 12, 2026).

Ms. Opas Wongthangprasert. (2021). *A study of the physical and chemical properties of soil: A case study of rice cultivation areas in Chachoengsao and Chonburi provinces*. Burapha University. Retrieved from <https://buuir.buu.ac.th/bitstream/1234567890/10336/1/53910198> (Accessed: January 12, 2026).

Appendix

Appendix A Experimental Results Tables

The results of the physical and chemical property analyses of the soil are presented in Tables A.1–A.2.

A.1 Results of the Analysis of Physical Properties of Soil

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

Soil sample	Soil structure
1	Blocky structure
2	Granular structure
3	Granular structure

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

Soil sample	Soil color level
1	7.5 YR 2.5/2
2	7.5 YR 3/2
3	7.5 YR 3/2

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

Soil sample	Soil consistency
1	Compact
2	Friable
3	Friable

Table A.4 Physical characteristics showing soil temperature measurements of Soil Samples 1, 2, and 3.

Soil sample	Soil temperature (°C)
1	25.0
2	25.5
3	25.6
Average	25.4

Table A.5 Physical characteristics of soil moisture measurements in soil samples 1, 2, and 3.

Soil sample	Soil moisture (grams per cubic meter)
1	600
2	550
3	650
Average	600

Table A.6 which presents the results of soil acidity–alkalinity (pH) measurements for soil samples 1, 2, and 3.

Soil sample	pH value
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) in soil samples 1, 2, and 3.

Soil nutrients	Soil sample	Level
Nitrogen (N)	1	Trace
	2	Trace
	3	Trace
Phosphorus (P)	1	Medium
	2	Medium
	3	Medium
Potassium (K)	1	Medium
	2	Medium
	3	Medium

Appendix B Illustrations of the Research Process

B.1 Study of the Physical Properties of Soil



B.1.1 Soil sampling



B.1.2 Soil sample 1



B.1.3 Soil sample 2



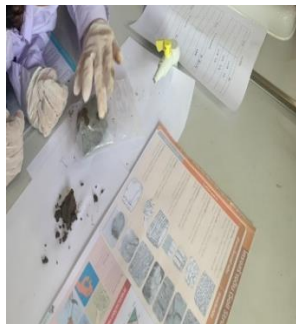
B.1.4 Soil sample 3



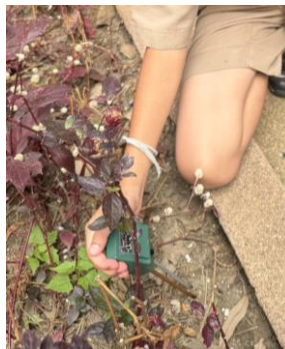
B.1.5 Analysis of soil structure



B.1.6 Analysis of soil color



B.1.7 Analysis of soil consistency



B.1.8 Analysis of soil temperature



B.1.9 Analysis of soil moisture

B.2 Study of the Chemical Properties of Soil



B.2.1 Analysis of soil pH



B.2.2 Drying the soil samples



B.2.3 Grinding the soil samples



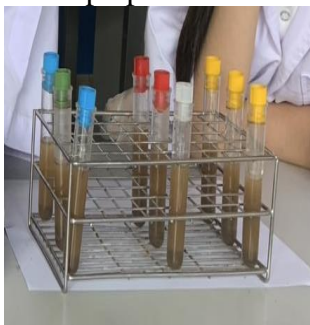
B.2.4 Placing the soil samples into test tubes for soil solution preparation



B.2.5 Adding water to the solution preparation tubes



B.2.6 Shaking to mix thoroughly



B.2.7 Allowing the soil to stand for sedimentation



B.2.8 Pipetting the soil solution into test tubes



B.2.9 Adding test reagents to determine N, P, and K levels

B.2 Study of the Chemical Properties of Soil



B.2.10 Color comparison for determining nitrogen (N) content



B.2.12 Color comparison for determining phosphorus (P) content



B.2.13 Color comparison for determining potassium (K) content

B.3 Experimental equipment



B.3.1 Shovel



B.3.2 Ziplock bags



B.3.3 Soil moisture meter



B.3.4 pH meter



B.3.5 Soil thermometer



B.3.6 Munsell Soil Color Chart



B.3.7 Test tubes



B.3.8 Beaker



B.3.9 Soil solution preparation tubes



B.3.10 Pipette



B.3.11 Three-way pipette filler



B.3.12 Scoop



B.3.13 Test tube rack



B.3.14 NPK soil test kit