Abstract

Research name : A study to compare the physical and chemical characteristics of the soil before planting and after plowing Covering the Sunn hemp plantation in the rubber plantation area, Village No. 8, Ban Na Subdistrict, Palian District,Trang Province

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This project aims to study soil properties by comparing the physical and chemical characteristics of soil before planting sunn hemp and after incorporating it into the soil. The study was conducted in a rubber plantation in Village 8, Ban Na Subdistrict, Palian District, Trang Province. The findings revealed that the soil quality before planting sunn hemp had an average nitrogen content of 0.27 mg/L, an average phosphorus content of 0.20 mg/L, and an average potassium content of 1.07 mg/L. The average pH was 5.87, the average salinity was 55.40 ppm, and the organic matter content was ≥3.5, which is considered a high level.After sunn hemp reached the flowering stage and was incorporated into the soil over 1–2 months, the soil quality improved compared to soil without sunn hemp cultivation. The nitrogen content ranged from 1.40 to 3.13 mg/L, phosphorus ranged from 1.73 to 3.93 mg/L, and potassium ranged from 5.80 to 12.60 mg/L. The pH level increased to a range of 6.93 to 7.03, salinity ranged from 147.80 to 166.93 ppm, and the organic matter content remained ≥3.5. Further analysis of the soil 1–2 months after incorporation showed even higher soil quality. The nitrogen content ranged from 4.20 to 5.93 mg/L, phosphorus from 4.67 to 6.53 mg/L, and potassium from 15.47 to 18.07 mg/L. The pH level further increased to 7.23–7.28, while salinity ranged from 101.27 to 191.27 ppm. The organic matter content remained consistently ≥3.5, indicating a high level.

Before planting sunn hemp, the soil was classified as sandy clay loam with a granular structure. After incorporating sunn hemp for 1–2 months, the soil structure transformed into loam, sandy clay loam, silty loam, sandy loam, and loamy sand.

Based on these findings, it can be concluded that incorporating sunn hemp into the soil enhances all measured soil parameters and improves soil structure. This suggests that sunn hemp incorporation is an effective approach for soil improvement to support future agricultural activities.

Keywords: Sunn hemp, physical properties, chemical properties, decomposition, soil testing, average value

Introduction

Rubber is an economically significant crop for the country's economy. It serves as a raw material in the production of various goods, supporting industries ranging from manufacturing to general consumer products. Rubber is a crop that thrives under specific environmental conditions, with soil structure being one of the key limitations to its successful cultivation, particularly in Thailand (Office of Agricultural Economics, 2006). Inappropriate soil structure can lead to various challenges in rubber cultivation, including soil degradation, nutrient imbalance, and low organic matter content. Consequently, it is crucial to identify optimal soil improvement methods that enhance soil fertility and promote sustainable rubber growth (Arshad et al., 1979).One approach involves planting green manure crops such as mung beans, soybeans, cowpeas, sesbania, and chili peppers. These fast-growing legumes not only contribute to soil fertility but also serve as a source of organic matter. Among these, sunn hemp (Crotalaria juncea) is a particularly effective green manure crop, capable of reaching a height of 180–300 cm. Sunn hemp enhances soil fertility by fixing atmospheric nitrogen through its root nodules, which store nitrogen in nodular bacteria. This nitrogen is gradually released into the soil five to six weeks after incorporation, helping to balance soil nutrients.The primary benefit of sunn hemp is that it grows quickly, can be easily incorporated into the soil, and effectively increases soil nitrogen levels. This process helps maintain soil balance, preserve soil structure, and improve fertility.

This study aims to investigate the physical and chemical properties of soil before and after the incorporation of sunn hemp. It will analyze soil characteristics, including organic matter content, soil pH, cation exchange capacity, macronutrient levels (N, P, K), organic matter content, and soil structural properties in a rubber plantation in Village 8, Ban Na Subdistrict, Palian District, Trang Province.

Research Objectives

1.To examine the properties and compare the physical and chemical characteristics of the soil before and after plowing and the application of Sunn hemp during its flowering stage and after the flowers have completely fallen in a rubber plantation located in Village No. 8, Ban Na Subdistrict, Palian District, Trang Province.

2.To examine and compare the properties of the soil following the plowing and covering of Sunn hemp during its flowering stage and after the flowers had fully fallen, which occurred at distinct intervals.

Research Questions

1.What are the differences, if any, in the physical and chemical properties of soil before sunn hemp cultivation and after cultivation while the plants still have leaves and after the leaves have completely fallen in the rubber plantation area, Village No. 8, Ban Na Subdistrict, Palian District, Trang Province?

2. Different time periods for plowing and covering the Sunn hemp during its flowering stage and after the flowers have completely fallen off influence Are there distinctions in the physical and chemical properties of soil? If so, how?

Research Hypotheses

1.The cultivation of Sunn hemp in a rubber plantation located in Village No. 8, Ban Na Subdistrict, Palian District, Trang Province, led to an examination of the physical and chemical properties of the soil prior to the planting of Sunn hemp, as well as the soil conditions following plowing and the coverage of Sunn hemp during its flowering stage and after the flowers had fully dropped.

2.Different periods for plowing and covering Sunn hemp, both during its flowering stage and after the flowers have fallen, yield varying effects on the soil's physical and chemical properties.

Materials, Equipment, and Research Methodology

1.Thermometer
2.Moisture meter
3.NPK meter
4.Organic matter meter
5.pH test paper
6.Soil color comparison chart
7.Soil structure comparison sheet
8.Field soil texture examination manual
9.Soil auger
10.Soil compaction test kit
11.Dropper
12.Glass funnel
13.Soil structure sample sheet
14.Beaker
15.Chemical spatula
16.Stirring rod
17.Distilled water
18.Filter paper
19.Sample container
20.Notebook
21.pH meter
22.Salinity meter
23.Soil sieve
24.Standard soil tray

Principles of GLOBE Soil Examination

- The examination follows the Pedosphere (Soil) Assessment Methodology
- The examination considers Biosphere Environmental Factors

Study Site Selection

The study was conducted in the vicinity of Suan Yang Phra Village, Village No. 8, Ban Na Subdistrict, Palian District, Trang Province.

- Soil samples were collected systematically from three different site categories: areas where rubber plantations had been recently cleared, areas with a longer elapsed time since clearance, and areas where rubber trees had been completely removed.
- Each sampling site covered 30 × 30 square meters, with a total of 7 sampling points, each covering 10 square meters.

Research Methodology

1.Preparation Stage

1.)Define the research topic: The study focuses on the physical and chemical characteristics of soil after rubber plantation clearance in a 30 × 30 square meter area with in Rubber plantation Village, Village No. 8, Ban Na Subdistrict, Palian District, Trang Province

2.)Conduct a literature review and explore relevant academic sources to gather fundamental knowledge on soil characteristics, soil properties, and the effects of land-use changes.

3.)Review and select research methods based on GLOBE soil assessment protocols to ensure standardized data collection.

4.)Develop a soil sampling strategy for the selected study area by defining latitude, longitude, and specific sampling locations to ensure accuracy.

2. Procedure

1) Convene a meeting to collaboratively plan the research activities within the research group.

2) Investigate the research domain.

3) Gather soil samples to assess soil temperature, moisture, and mineral composition. (N P K) Assesses soil pH, salinity, organic matter content, structure, texture, color, and adhesion.

3.1) Specify the sampling point using an area of 30×30 square meters in the rubber plantation area village No. 8, Ban Na Subdistrict, Palian District, Trang Province .

3.2) Measure the temperature inside the soil using a thermometer and collect data 5 times.

Measurement methodology

3.2.1) Drill holes in the soil using a shovel to a depth of approximately 5 and 10 centimeters from the soil surface.

3.2.2) Insert the thermometer into for 2 minutes before reading the temperature.

3.3) Measure soil moisture content using a moisture meter and collect data 5 times.

Measurement methodology

3.3.1) Drill holes in the soil using a shovel at depths of approximately 5 and 10 centimeters from the soil surface.

3.3.2) Insert the moisture meter into the drilled hole and for 2 minutes before reading the moisture content.

3.4) Measurement of Soil Nutrients (NPK) Using an NPK Test Kit (Data Collected 5 Times)

Measurement Procedure

3.4.1) Weigh 20 grams of air-dried, crumbled soil and place it into a beaker.

3.4.2) Add 20 or 100 milliliters of distilled water to achieve a 1:1 soil-to-water ratio.

3.4.3) Stir the soil with a glass rod for 30 seconds, then let it sit for 3 minutes. Repeat this step 5 times.

3.4.4) After stirring 5 times, allow the soil to settle in the beaker. You will observe a clear layer of water at the top.

3.4.5) Insert a standardized NPK meter into the clear water layer, avoiding contact with the sediment at the bottom. Wait until the reading stabilizes, then record the NPK values.

3.5) Measurement of Soil Acidity and Alkalinity (pH) Using pH paper and a pH meter (Data Collected 5 Times)

Measurement Procedure Using pH Paper

3.5.1) Weigh 20 grams of air-dried, crumbled soil and place it into a beaker.

3.5.2) Stir the soil with a glass rod for 30 seconds, then let it sit for 3 minutes. Repeat this step 5 times.

3.5.3) After stirring 5 times, allow the soil to settle in the beaker. You will observe a clear layer of water at the top.

3.5.4) Fold filter paper into a cone and place it in a funnel, with a flask or Erlenmeyer beneath to catch the filtrate.

3.5.5) Pour the clear supernatant through the filter until it drains completely.

3.5.6) Dip a pH test strip into the filtered water. Wait until the reading stabilizes, then record the pH value.

Measurement Procedure Using a pH Meter

3.5.7) Weigh 20 grams of air-dried, crumbled soil and place it into a beaker.

3.5.9) Add 20 milliliters of distilled water to achieve a 1:1 ratio of soil to water.

3.5.10) Stir the soil with a glass rod for 30 seconds, then let it sit for 3 minutes. Repeat this procedure 5 times.

3.5.11) After stirring 5 times, allow the soil to settle. A clear layer of water will appear at the top.

3.5.12) Insert a calibrated pH meter into the clear layer of water, ensuring it does not touch the sediment at the bottom. Wait until the reading stabilizes, then record the soil pH value.

3.6)Using a soil structure reference chart (Data collected 5 times)

Measurement of Soil Structure

3.6.1) Collect soil samples designated for studying soil structure and record preliminary observations.

3.6.2) Place an undisturbed soil sample in your hand. Observe it carefully, noting its structure. Soil structure can vary in form, as illustrated in the soil structure reference chart.

3.6.3) Measure the size and shape of the soil aggregates and record the data in the soil structure measurement log.

3.6.4) Frequency of data collection: once at each study point.

3.7) Soil Color Measurement Using a soil color reference chart (Data collected 5 times)

Measurement Procedure

3.7.1) Examine a soil clod and record in the data sheet whether the soil is moist, dry, or wet. If the soil is dry, lightly moisten it using a spray bottle.

3.7.2) Split the soil clod into two parts.

3.7.3) Position yourself so that sunlight passes over your shoulder onto both the color chart and the soil sample you are examining.

3.7.4) Record the observed soil color in the data sheet.

3.8) Measurement of Soil Cohesion Using a soil cohesion reference sheet (Data collected 5 times)

Measurement Procedure

3.8.1) Observe a soil clod. If the soil is dry, lightly spray it with water, then separate the clod to examine its cohesion.

3.8.2) Place the soil clod between your thumb and index finger, gently squeezing it into sections.

3.8.3) Record the observed cohesion characteristics in the data sheet, selecting one of the standard cohesion categories.

3.9) Soil Texture Measurement Using a Field Soil Texture Assessment Manual (Data collected 5 times)

Measurement Procedure

3.9.1) Take a clod of soil, approximately 3 cm in diameter, and knead it with a small amount of water until the soil begins to adhere to your fingers.

3.9.2) Classify the soil texture according to the field tactile assessment method, as outlined in the Field Soil Texture Assessment Manual.

3.9.3) Record the classification results in the data log.

3.10) Measurement of Soil Organic Matter Using an Organic Matter Test Kit (Data collected 5 times)

Measurement Procedure

3.10.1) Randomly select 3 soil samples from the total of 15 samples collected. Place them in a stainless steel tray to be oven-dried.

3.10.2) Preheat the soil oven to 90°C and insert the stainless steel tray containing the soil samples.

3.10.3) After drying, grind the soil thoroughly using a mortar and pestle, then sieve it into a beaker.

3.10.4) Transfer 1 scoop of the sieved soil into a reaction flask.

3.10.5) Add 1 vial of the test reagent and shake for 5 minutes.

3.10.6) Add 1 bottle of water (30 mL) and allow the soil to settle for 10–20 minutes.

3.10.7) Compare the resulting solution color with the organic matter reference scale to determine the % OM.

3.11) Soil Salinity Measurement Using a salinity meter (Data collected 5 times)

Measurement Procedure

3.11.1) Weigh 20 grams of air-dried, crumbled soil and place it into a beaker.

3.11.2) Add 20 milliliters of distilled water to achieve a 1:1 soil-to-water ratio.

3.11.3) Stir the soil with a glass rod for 30 seconds, then let it sit for 3 minutes. Repeat this step 5 times.

3.11.4) After stirring 5 times, allow the soil to settle. You will observe a clear layer of water at the top.

3.11.5) Insert a calibrated salinity meter into the clear water layer, avoiding contact with the sediment at the bottom. Wait until the reading stabilizes, then record the salinity value.

3.12) Submitting Data to GLOBE Data Entry

Upon completing all measurements, the collected data are entered into the GLOBE Data Entry system for centralized storage and global comparison.

Data Analysis and Conclusion

1.Data Analysis

•The data obtained from each measurement are analyzed to identify trends and relationships among the measured parameters (e.g., temperature, pH, moisture, salinity, NPK levels, organic matter).

•Statistical tools such as mean and standard deviation (S.D.) are used to evaluate the variability of each parameter across different sampling points and conditions.

2.Graphical Representation

•Graphs are created to compare average values of the measured parameters, highlighting differences under various conditions or time intervals.

3.Conclusion

•The results of this study are summarized to provide insights into how different factors (e.g., land-use changes, timing of sampling) influence the physical and chemical properties of the soil.

•Recommendations may be proposed for further research or soil management practices, based on the observed outcomes.

Research Results

Geographic Coordinates

A study was conducted in the area surrounding Suan Yampra, Village No. **8**, Ban Na Subdistrict, Palian District, Trang Province. The geographic coordinates are shown in Table **1.**

Table 1: Geographic Coordinates

Zone	Geographic Coordinates	
	Latitude (N)	**Longitude (E)**
Rubber plantation, Village No. 8, Ban Na Subdistrict, Palian District, Trang Province	7.282270	99.707856

Soil Experiment Results : Physical Properties of Soil

Table 2: Soil Structure Before Planting Sunn Hemp and After Plowing Under

Soil before planting															
point at/ Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Soil Consistence	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
soil texture	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam
soil color	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4	2.5YR 6/4
soil structure	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular
Soil plowing and covering one month after flowering															
point at/ Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Soil Consistence	Firm	Firm	Firm	Firm	Firm	Friable	Friable	Firm	Firm	Friable	Firm	Firm	Firm	Firm	Friable
soil texture	Loam	Loam	Loam	Silty Clay Loam	Loam	Sandy Loam	Sandy Loam	Loamy Sand	Loamy Sand	Loamy Sand	Sandy Loam	Sandy Loam	Loam	Sand	Sand
soil color	7.5YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/1	10YR 4/1	7.5YR 4/1	7.5YR 4/1	10YR 4/2	10YR 3/2	7.5YR 3/1	7.5YR 4/1	7.5YR 4/1	7.5YR 4/1	10YR 4/1
soil structure	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular

Soil plowing and covering two months after flowering															
point at/ Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Soil Consistence	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable
soil texture	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Loam	Loam	Loam
soil color	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2	10YR 4/2
soil structure	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular

From Table 2: Soil Structure Before Planting Sunn Hemp and After Plowing Under

Soil Before Planting

The soil structure before planting at points 1-15 shows that the soil is dense due to the compression of soil particles. This results in a high resistance force, making the soil difficult to break. The soil color, based on the Munsell soil color chart, is 2.5 YR 6/4, indicating a reddish-brown color. The soil texture is sticky, plastic-like when wet, and has a granular structure.

Soil After One Month of Plowing (Flowering Stage)

The soil structure after one month of plowing at points 1-15 exhibits looseness and increased porosity. This is due to the breakdown of soil particles from mechanical disturbances, which causes minor separation between aggregates. The soil color, according to the Munsell color chart, is 7.5 YR 3/1, 7.5 YR 4/1, 7.5 YR 4/2, 10 YR 4/1, and 10 YR 4/2, indicating a darker brownish color. The soil remains plastic-like when wet and crumbly when dry. The soil structure is still granular.

Soil After Two Months of Plowing (Flowering Stage)

The soil structure after two months of plowing at points 1-15 still exhibits looseness due to minor disturbances. The soil color, based on the Munsell soil color chart, is 10 YR 4/2, indicating a yellowish-brown color. The soil texture remains crumbly when dry, and the structure is still granular.

Table 3: Soil Structure

Soil plowing and covering one month after the flowers fall															
point at/ Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Soil Consistence	Friable	Friable	Firm	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Firm	Friable
soil texture	Loam	Silt Loam	Silt Loam	Loamy Sand	Loamy Sand	Loam	Silt	Silt	Silt	Loam	Loam	Loam	Loamy Sand	Loamy Sand	Loam
soil color	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 4/1	10YR 3/1	7.5YR 3/1	10YR 3/1	10YR 3/1	7.5YR 2.5/2	7.5YR 4/1	7.5YR 3/1	7.5YR 2.5/1	10YR 4/1	10YR 3/1	10YR 3/1
soil structure	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular
Soil plowing and covering two months after the flowers fall															
point at/ Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Soil Consistence	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable	Friable
soil texture	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam
soil color	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1	7.5YR 3/1
soil structure	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular	Granular

From Table 3: Soil Structure

Soil after plowing for 1 months (flowers fall off)

The soil structure after a one-month interruption in sunn hemp cultivation (dormant period), from points 1–15, showed a less compacted and more porous nature. This was due to the fragmentation of soil aggregates under less pressure, making it easier for the soil to break apart. The soil color, as analyzed using the Munsell soil color chart, was recorded at 7.5 YR 2.5/1, 7.5 YR 2.5/2, 7.5 YR 3/1, 7.5 YR 4/1, and 10 YR 3/1. The soil exhibited a dark brown hue, with a moist, fine-grained, powdery texture, and a cloddy structure.

Soil after plowing for 2 months (flowers fall off)

The soil structure after a two-month interruption in sunn hemp cultivation (dormant period), from points 1–15, exhibited a highly porous nature due to the fragmentation of soil aggregates under minimal pressure. The soil color, as analyzed using the Munsell soil color chart, was recorded at 7.5 YR 3/1, indicating a dark brown hue. The soil was observed to be moist, fine-grained, and powdery, with a cloddy structure.

Soil Experiment Results: Chemical Properties of Soil

Table 4: Changes in Soil Values at Each Measurement Interval

Sampling stage	measured value							
	average humidity (%)	average temperature (˚c)	average N value (mg/l)	average P value (mg/l)	Average K value (mg/l)	average pH	average salinity (ppm)	organic matter level (%)
1.Soil before planting	3.73 ±0.98	35.70 ±1.10	0.27 ±0.44	0.20 ±0.40	1.07 ±1.24	5.87 ±0.34	55.40 ±19.44	>=3.50
2.Soil when it has flowers	6.03 ±0.29	29.41 ±0.90	0.47 ±0.62	0.47 ±0.62	2.47 ±1.86	7.53 ±0.19	46.27 ±17.49	>=3.50
3.Soil when flowers fall	6.97 ±0.99	27.99 ±0.73	0.60 ±0.61	2.40 ±2.33	4.53 ±2.39	7.27 ±0.93	55.40 ±19.44	>=3.50

4.Soil plowing and covering 1 month after flowering	8.84 ±1.21	28.29 ±1.35	1.40 ±0.69	1.73 ±1.06	5.80 ±2.99	6.93 ±0.17	166.93 ±55.14	>=3.50
5.Soil plowing and covering 1 month after the flowers fall	7.09 ±1.42	28.83 ±0.75	4.20 ±3.56	4.67 ±4.03	15.47 ±12.18	7.28 ±0.28	191.27 ±109.02	>=3.50
6.Soil plowing and covering 2 months after flowering	3.31 ±2.43	29.00 ±0.90	3.13 ±1.63	3.93 ±2.05	12.60 ±5.67	7.03 ±0.37	147.80 ±54.46	>=3.50
7.Soil plowing and covering 2 months after the flowers fall	2.34 ±1.60	29.27 ±0.99	5.93 ±4.22	6.53 ±4.53	18.07 ±14.01	7.25 ±0.25	101.27 ±45.42	>=3.50

From Table 4 : which presents the average soil values at different measurement intervals, the findings indicate variations in soil moisture, temperature, nutrient content (NPK), pH, salinity, and organic matter across different periods of measurement.

The average soil moisture varied across different measurement intervals. The highest recorded average soil moisture was found in soil plowed under after one month (flowering stage), with a moisture content of approximately 8.84%. In contrast, the lowest recorded moisture level was found in soil plowed under after two months (post-flowering stage), with an average moisture content of 2.34%. The highest standard deviation (S.D.) of soil moisture was observed in soil plowed under after two months (flowering stage), with an S.D. of ±2.43, indicating significant variability. Conversely, the lowest S.D. was found in soil at the bud formation stage, with a value of ±0.29, indicating minimal variability.

The average soil temperature also showed variations. The highest temperature was recorded before planting, with an average of 35.7°C, while the lowest was observed in the post-flowering stage, averaging 27.99°C. The S.D. of soil temperature was highest in soil plowed under after one month (flowering stage) at ±1.35, indicating substantial variability, whereas the lowest S.D. was found in soil during the post-flowering stage at ±0.73, indicating more consistent temperature readings.

Regarding the average nutrient content (NPK), the highest recorded levels were in soil plowed under after two months (post-flowering stage), whereas the lowest levels were found in soil before planting. The highest S.D. of nitrogen (N) was in soil plowed under after two months (post-flowering stage) at ±4.22, indicating high variability, while the lowest S.D. was in pre-planting soil at ±0.44. Similarly, the highest S.D. of phosphorus (P) was recorded in soil plowed under after two months (post-flowering stage) at ±4.53, compared to the lowest S.D. of ±0.40 in pre-planting soil. For potassium (K), the highest S.D. was ±14.01, observed in soil plowed under after two months (post-flowering stage), whereas the lowest was ±1.24 in pre-planting soil, suggesting substantial variations in nutrient content.

The average soil pH varied across different stages. The highest recorded pH was in soil at the bud formation stage, with an average of 7.53, while the lowest was in pre-planting soil at 5.87. The highest S.D. of pH was found in soil plowed under after one month (flowering stage) at ±0.17, whereas the lowest was recorded in soil at the post-flowering stage, with an S.D. of ±0.93.

Soil salinity also exhibited variations. The highest recorded salinity level was in soil plowed under after one month (post-flowering stage), with an average of 191.27 ppm, while the lowest was in soil at the bud formation stage, with an average of 46.27 ppm. The highest S.D. of soil salinity was ±109.02 in soil plowed under after one month (post-flowering stage), reflecting considerable variability, while the lowest S.D. was ±17.49 in soil at the bud formation stage.

Lastly, the organic matter content in soil remained consistent across all measurement periods, averaging ≥3.5%, with an S.D. of 0, indicating no observed variability in organic matter content.

Summary and Discussion of Research Findings

The study examined the physical and chemical properties of soil following the incorporation of sunn hemp in a rubber plantation located in Village 8, Ban Na Subdistrict, Palian District, Trang Province. Soil samples were collected five times from 15 locations, categorized as pre-planting soil, post-flowering soil, post-pod-setting soil, and post-incorporation soil. The incorporation process was conducted in two phases:

1. Methods of Sunn Hemp Incorporation: Two types of incorporation methods were analyzed, revealing that the soil reached a state of equilibrium with a slightly alkaline pH ranging from 6.93 to 7.25 and an organic matter content of ≥3.5%. The nitrogen content in the soil was measured within the range of 1.40–5.93 mg/kg, while available phosphorus and potassium were found between 1.73–6.53 mg/kg and 5.80–18.07 mg/kg, respectively. This aligns with findings by Allison (1954, cited in Sangthong, 2011), which suggest that when sunn hemp is incorporated into the soil, the decomposition process leads to a significant increase in organic matter and nutrient availability. Additionally, the decomposition and nutrient release process continues at a slower rate over time. Research by Euskirchen et al. (2013) further supports this, indicating that plant residues improve soil phosphorus retention. When sunn hemp is incorporated, the released nutrients enhance the root system's efficiency in absorbing nutrients, demonstrating that extended decomposition periods positively affect soil fertility.

2.Soil Quality in Relation to Physical and Chemical Properties: A comparative analysis between soil before planting and post-incorporation (both after flowering and after pod setting) revealed improvements in soil quality across both conditions. However, the most significant enhancement occurred after pod setting, as the concentrations of nitrogen (N), phosphorus (P), and potassium (K) increased significantly. Moreover, as the incorporation period extended from one month to two months, nutrient levels further improved.

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Research Team

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1. I AM A DATA SCIENTIST.

This project applies a scientific approach consisting of five key steps: observation, problem identification, hypothesis formulation, experimentation, data collection, and data analysis. The collected data were processed using Microsoft Excel to calculate averages and standard deviations (S.D.). Data analysis was performed based on recorded values to ensure accuracy and reliability, allowing for meaningful comparisons and conclusions. The results were then interpreted to confirm or refute the original hypotheses. Finally, the findings were compiled and presented in a structured format, ensuring clarity and systematic documentation for future study references.

2. I AM A COLLABORATOR

One of the most crucial aspects of this project is teamwork. The project's success heavily relied on collaboration, as no single individual could complete it alone. Each team member contributed their knowledge, ideas, and effort, fostering mutual support throughout all project stages from brainstorming and planning to conducting experiments, processing data, and drawing conclusions.This project required continuous teamwork, where each member had clearly defined roles and responsibilities. Collaboration ensured accuracy, efficiency, and timely completion of tasks. Moreover, it enhanced teamwork skills, which are essential for future research and professional endeavors. This experience also highlighted the importance of cooperation among peers, guidance from teachers, and support from the school. As a result, the project was successfully executed with valuable lessons learned along the way.

3. I MAKE AN IMPACT

This project aimed to improve soil quality within a rubber plantation in Village 8, Ban Na Subdistrict, Palian District, Trang Province. The study was linked to the research project "A Comparative Study of Soil Physical and Chemical Properties Before and After Incorporating Sunn Hemp in a Rubber Plantation in Village 8, Ban Na Subdistrict, Palian District, Trang Province." The research findings provided significant scientific insights, demonstrating that incorporating sunn hemp into the soil for 1–2 months enhanced soil quality and altered soil structure. This serves as a potential approach for future soil improvement to support agricultural productivity.

References

Raw data

Table of Soil Data Before Planting Sunn hemp

Point	Moisture Value	Temperature Value	N Value	P Value	K Value	pH Value	EC Value	Organic Matter
1	3	35.6	1	1	3	5	42	>=3.5
2	2	35.7	1	0	2	6	22	>=3.5
3	2	35.8	0	0	0	6	99	>=3.5
4	4	34.7	1	1	4	6	69	
5	4	39	0	0	1	6	37	
6	3	35.6	0	0	1	6	46	
7	3	35.6	0	0	0	6	81	
8	4.5	36.6	0	0	0	6	47	
9	4.5	35.4	0	0	0	6	66	
10	5	35	1	0	0	6	28	
11	5	36	0	1	2	5	57	
12	5	36.2	0	0	2	6	65	
13	4	35.8	0	0	1	6	47	
14	4	34	0	0	0	6	61	
15	3	34.5	0	0	0	6	64	

Table of Soil Data in the Early Flowering Stage of Sunn hemp

Point	Moisture Value	Temperature Value	N Value	P Value	K Value	pH Value	EC Value	Organic Matter
1	6	30.1	0	0	2	7.2	53	>=3.5
2	6.4	27.3	0	0	1	7.63	27	>=3.5
3	6	30.2	1	1	2	7.38	50	>=3.5
4	6.2	27.8	2	2	8	7.65	82	
5	5.9	29.9	0	0	2	7.22	32	
6	6	28.8	0	0	2	7.4	37	
7	5.9	30.2	1	1	2	7.45	57	
8	5.8	29.5	1	1	5	7.52	61	
9	5.7	28.8	0	0	1	7.84	30	
10	6.4	29.6	0	0	1	7.35	27	
11	6	30.1	1	1	4	7.47	54	
12	5.9	28.8	0	0	1	7.56	23	
13	5.4	30.5	0	0	2	7.68	50	
14	6.6	29.6	0	0	1	7.79	35	
15	6.2	29.9	1	1	3	7.77	76	

Table of Soil Data in the Late Flowering Stage of Sunn hemp

Point	Moisture Value	Temperature Value	N Value	P Value	K Value	pH Value	EC Value	Organic Matter
1	6.4	30.1	0	2	2	6	42	>=3.5
2	6.4	28.7	0	1	1	8	22	>=3.5
3	6	27.7	2	10	10	7	99	**>=3.5**
4	8.5	28	1	2	5	8	69	
5	6.4	27.5	0	0	3	8	37	
6	8	27	1	2	3	6	46	
7	6.4	28.2	1	4	7	8	81	
8	6	27.4	1	1	3	8	47	
9	8.5	27.7	1	2	8	8	66	
10	5.9	27.2	0	0	2	6	28	
11	8.5	28.7	0	2	4	6	57	
12	6.1	27.7	1	3	6	9	65	
13	6.5	28	0	2	4	7	47	
14	6.8	28.2	0	1	4	7	61	
15	8.1	27.7	1	4	6	7	64	

Table of Soil Data After One Month of Plowing (Flowering Stage)

Point	Moisture Value	Temperature Value	N Value	P Value	K Value	pH Value	EC Value	Organic Matter
1	5.9	29	1	2	6	6.93	184	>=3.5
2	8.5	30	1	1	4	7.14	109	>=3.5
3	8	29	1	1	4	6.76	139	>=3.5
4	8.9	30	0	0	2	7	99	
5	9	29	1	1	3	6.87	124	
6	8.5	30	2	2	6	6.57	120	
7	9.5	27	1	1	3	6.83	140	
8	10	27.5	1	1	3	6.98	164	
9	9.9	28.9	1	1	3	7	137	
10	10	27.5	2	3	8	6.93	294	
11	10	25	2	3	9	7.04	214	
12	10	28	1	1	6	6.97	122	
13	6.5	29	3	4	13	6.62	196	
14	8.9	27	2	3	9	7.13	258	
15	9	27.5	2	2	8	7.12	204	

Table of Soil Data After plowing for 1 months (flowers fall off)

Point	Moisture Value	Temperature Value	N Value	P Value	K Value	pH Value	EC Value	Organic Matter
1	6	29	10	10	35	6.42	439	>=3.5
2	6.9	27	3	3	11	6.92	181	>=3.5
3	8.5	29.5	6	7	19	7.26	260	>=3.5
4	6	28	14	16	50	7.2	411	
5	7.5	29	4	4	14	7.39	140	
6	4.5	29	3	3	9	7.33	154	
7	5	29.5	3	3	12	7.35	121	
8	6.5	29	1	1	5	7.47	99	
9	7.5	29.5	2	3	9	7.24	139	
10	5.9	30	2	3	9	7.45	94	
11	9.2	28	2	2	8	7.29	113	
12	9.2	29	1	1	5	7.55	91	
13	8.9	29	1	1	6	7.52	113	
14	6.9	28	4	4	14	7.45	217	
15	7.5	29	7	9	26	7.42	297	

Table of Soil Data After Two Months of Plowing (Flowering Stage)

Point	Moisture Value	Temperature Value	N Value	P Value	K Value	pH Value	EC Value	Organic Matter
1	1	29.5	2	2	7	7.2	86	>=3.5
2	2.5	29.5	2	2	8	7.36	94	>=3.5
3	2	30	1	1	4	7.62	82	>=3.5
4	1.2	28.2	2	3	9	6.9	133	
5	3	28.5	3	3	11	6.7	121	
6	8	30	3	3	10	6.98	166	
7	8	27.7	2	3	10	7.05	113	
8	7.5	27.5	2	3	10	6.85	176	
9	1	30	2	3	12	7.02	132	
10	1.5	29	4	6	17	7.53	188	
11	1.5	29	7	8	25	7	247	
12	2.5	27.7	6	8	22	7.58	275	
13	3	29	5	6	20	6.79	169	
14	2.5	28.9	3	4	13	6.39	116	
15	4.5	30.5	3	4	11	6.41	119	

Table of Soil Data After plowing for 2 months (flowers fall off)

Point	Moisture Value	Temperature Value	N Value	P Value	K Value	pH Value	EC Value	Organic Matter
1	1.2	29	15	15	39	7.5	64	>=3.5
2	2	31	4	5	15	6.92	222	>=3.5
3	7	30	7	8	22	6.85	109	>=3.5
4	3	29.5	16	18	58	7.23	96	
5	3	27.8	6	6	18	6.85	96	
6	4	28.9	3	4	13	7.11	176	
7	1.5	28	6	6	8	7.45	81	
8	4	31	2	3	6	7.03	140	
9	1.2	30	3	4	10	7.51	50	
10	1	29.5	3	4	11	7.53	51	
11	1.2	28.7	4	4	12	7.43	79	
12	2	27.7	3	2	7	7.52	69	
13	1	29	2	2	4	7.44	76	
14	1	30.5	6	6	18	7.32	103	
15	2	30	9	11	30	7	107	

Figure Section

Figure 1: Measuring soil temperature and moisture

Figure 2: Collecting soil samples

Figure 3: Washing soil samples

Figure 4: Measuring 20 ml of soil extract in a beaker

Figure 5: Stirring the sample for 30 seconds a specific number of times

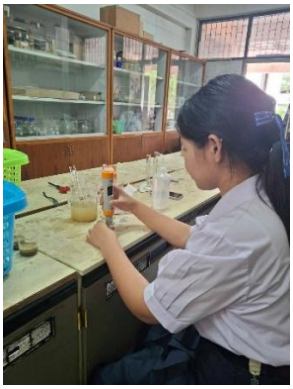

Figure 6: Measuring pH using a pH meter

Figure 7: Measuring P and K values using a P K meter

Figure 8: Measuring salinity levels

Figure 9: Drying the soil samples

Figure 10: Measuring the amount of organic matter in the soil

Figure 11: Analyzing soil structure based on its aggregation

Figure 12: Image of sunn hemp plants in bloom