A Study of Soil Properties Affecting the Growth and Yield of Sudan Roselle in Organic Post-Rice Fields in Phak Mai Subdistrict, Sisaket Province.

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Research Title A Study of Soil Properties Affecting the Growth and Yield of Sudan Roselle in Organic Post-Rice Fields in Phak Mai Subdistrict, Sisaket Province.

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Abstract

This research aimed to investigate the relationship between soil properties in post-rice organic farming fields and the growth and yield of Sudan roselle (Hibiscus sabdariffa L.) in Phak Mai Subdistrict, Sisaket Province. The study was conducted in three post-rice organic farming areas—Khok Samrong, Kut Kwang, and Nong Lung villages—with similar organic fertilizer management practices. Soil samples were collected at depths of 5, 10, and 30 cm before planting and after harvest to analyze soil physical and chemical properties and soil fertility following the GLOBE Protocols, including soil texture, soil structure, soil moisture, soil temperature, soil pH, and primary nutrients (N, P, and K). Data on plant growth and yield components were also recorded and analyzed using descriptive statistics. The results indicated that variations in soil physical and chemical properties and soil fertility among the study areas significantly influenced the growth and yield of Sudan roselle, with areas having higher soil moisture and greater availability of primary nutrients producing taller plants and higher yield. These findings provide baseline scientific information for soil management and post-rice land-use planning to support sustainable organic farming in Phak Mai Subdistrict.

Keywords: Sudan roselle, soil properties, soil fertility, post-rice fields, organic farming

Introduction of Literature

Soil is a vital natural resource that plays a crucial role in ecosystem sustainability and agricultural production, as it serves as a medium for plant root anchorage, a reservoir for water and nutrients, and a key component linking soil, water, atmosphere, and living organisms. Both physical and chemical soil properties—such as soil texture, moisture content, soil pH, and soil fertility—are therefore directly related to plant growth and crop yield (Preecha Changkwanyuen, 2015). Organic farming is a production system that emphasizes the conservation of natural resources, reduction of synthetic chemical inputs, and promotion of natural processes in the soil, particularly through increasing organic matter and enhancing soil biological activity. These processes contribute to improved soil structure and fertility, making soils more suitable for crop cultivation (Ampol Senanarong, 2017). After rice harvesting, soils in organic paddy fields undergo various changes as a result of soil and water management throughout the growing season, which may affect their potential for cultivating other crops during the post-rice period. Sudan roselle is a crop that can adapt well to diverse agricultural environments, has a short growth cycle, and can provide additional income for farmers. However, its growth and yield are still strongly dependent on soil properties, especially those related to nutrient uptake and soil water-holding capacity (Surapol Nititham, 2019). Therefore, studying the relationship between soil properties and plant growth and yield is an important approach for systematically explaining soil–plant interactions and is consistent with the Earth system science concept.

Phak Mai Subdistrict, Sisaket Province, is an agricultural area where rice farming is the primary livelihood, and organic farming practices have been continuously promoted within the community. Utilizing post-rice fields for cultivating alternative crops, such as roselle, is one approach to increasing farmers' income and improving the efficiency of soil resource use. However, farmers in the area still lack scientific information that clearly demonstrates the relationship between soil properties in post-rice organic farming fields and the growth and yield of crops cultivated during the post-rice period. Although organic fertilizers are applied in a similar manner across the area, physical soil characteristics—such as soil texture, moisture content, and drainage—may vary among locations. These differences can influence soil properties and crop productivity. Without systematic investigation, soil management practices and crop selection may not align with the actual potential of the land (Preecha Changkwanyuen, 2015).

Therefore, this research aimed to investigate the relationship between soil properties in post-rice organic farming fields and the growth and yield of Sudan roselle in the agricultural area of Phak Mai Subdistrict, Sisaket Province. The study employed soil measurement and data collection methods based on the GLOBE Project protocols, which provide standardized approaches for environmental science research. The findings of this study are expected to enhance understanding of local soil–plant systems and serve as baseline information for improving soil management, planning post-rice land use, and supporting the sustainable development of agriculture within the community.

Research Questions

Based on this understanding, this study was designed to investigate the relationship between soil properties in post-rice organic farming fields and the growth and yield of Sudan roselle (Hibiscus sabdariffa L.) in the study area, with the aim of understanding how variations in soil physical and chemical properties influence plant growth and productivity.

Therefore, this study aims to address the following research questions:

1. How are soil properties in post-rice organic farming fields related to the growth and yield of Sudan roselle (Hibiscus sabdariffa L.)?
2. How do soil properties in post-rice organic farming fields differ between the pre-planting period and the post-harvest period?

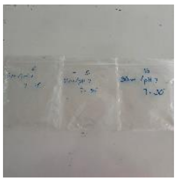
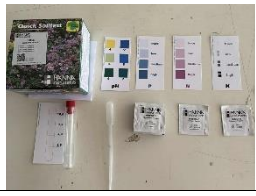
Research Hypothesis

1. Soil properties in post-rice organic farming fields are significantly related to the growth and yield of Sudan roselle (Hibiscus sabdariffa L.).
2. Soil properties in post-rice organic farming fields differ significantly between the pre-planting and post-harvest periods.

Research Methods and Materials

The research entitled "A Study of Soil Properties Affecting the Growth and Yield of Sudan Roselle in Organic Post-Rice Fields in Phak Mai Subdistrict, Sisaket Province" was conducted using survey-based data collection methods. Field observations and photographic documentation were employed to record soil conditions, plant growth, and yield characteristics, and the results were presented using visual evidence. The study required the use of specific equipment, materials, and research methods, as described below.

1. Experimental Equipment and Tools

Materials and Equipment		
Shovel / Spade 	Ziplock Bags and Labels 	Thermometer 
Digital Weighing Scale 	pH meter 	HI 3895 Soil Test Kit for N, P, and K 
Drying Oven 	Pipettes and Test Tubes 	Measuring Tape 
Test Tube Rack	Beaker	Google Sheet
Google earth	Google slide	Distilled Water
Dropper / Dropper Pipette	Canva	Data Recording Sheets
Digital Camera	Mobile Phone	Scissors

【Figure 1. Experimental equipment and tools】

2. Research Methods

1.Definition of the Study Area

Three study sites were selected within Phak Mai Subdistrict, including organic post-rice farming fields at Khok Samrong Village, Kut Kwang Village, and Nong Lung Village, Phak Mai Subdistrict, Huai Thap Than District, Sisaket Province.

2.Soil Sampling

Soil samples were collected from three study sites. At each site, soil sampling was conducted at three depth levels: 5 cm, 10 cm, and 30 cm. A zigzag sampling method was used to determine sampling locations, with 15 sampling points established at each soil depth. Soil was excavated according to the specified depths, and samples from each depth were thoroughly mixed to form composite samples. The composite soil samples were then tightly sealed in ziplock bags and analyzed for soil properties following the GLOBE Project protocols.

3.Soil Property Measurement

3.1 Study the physical properties of soil, including soil structure, soil elasticity, soil moisture, soil temperature, soil texture, and soil color, by conducting measurements before planting and after planting crops. The operational procedures are as follows.

1) Soil structure was assessed by observing the natural aggregation of soil particles. A soil clod was placed on the palm of the hand and gently pressed to examine how the soil broke apart or formed cracks. The shape of the soil structure was then classified, such as spherical or platy forms.

2) Soil elasticity was measured by evaluating the resistance of the soil to compression. A soil clod approximately 1.5–2 cm in size was pressed between the thumb and index finger to classify the soil as friable or hard.

3) Soil moisture content was determined by weighing the soil samples before and after oven-drying. The moisture content was then calculated as a percentage relative to the dry weight of the soil.

4) Soil temperature was measured using a metal probe thermometer inserted into the soil at depths of 5 cm, 10 cm, and 20 cm. The thermometer was left in place for at least 2 minutes until the temperature stabilized, after which the readings were recorded.

5) Soil texture was determined by moistening the soil to an appropriate level until it could be molded into a ball. The soil was then rolled into a flat ribbon between the thumb and index finger. If the soil could be rolled into a ribbon longer than 5 cm, it was classified as clay soil. If the soil could not be rolled into a ribbon or formed only a short piece, it was classified as sandy soil or sandy loam.

3.2 Study the chemical properties and fertility of soil, including soil pH and the concentrations of major nutrients in the soil, namely nitrogen (N), phosphorus (P), and potassium (K). Measurements were conducted before planting and after planting crops. The procedures are as follows.

1) Soil pH was determined by mixing soil with distilled water at a 1:1 ratio and shaking the mixture for 30 seconds. The suspension was then allowed to stand for 30 minutes. The pH of the clear supernatant was measured using a pH meter or pH indicator paper.

2) The nitrogen (N) content was determined using a settled soil solution. A 2.5 mL aliquot of the soil solution was transferred into a test tube using a pipette. One packet of HI 3895-N reagent was added, after which the test tube was capped and shaken for 30 seconds. The resulting pink color was then compared with a nitrate color chart to estimate the nitrogen content in the soil.

3) The phosphorus (P) content was determined using a settled soil solution.

A 2.5 mL aliquot of the soil solution was pipetted into a test tube. One packet of HI 3895-P reagent was added, and the tube was capped and shaken for 30 seconds. The resulting blue color was then compared with a phosphorus color chart to estimate the phosphorus content in the soil.

4) The potassium (K) content was determined using a settled soil solution. A 2.5 mL aliquot of the soil solution was transferred into a test tube using a pipette. One packet of HI 3895-K reagent was added, after which the tube was capped and shaken for 30 seconds. The resulting turbidity was compared with a potassium reference chart to estimate the potassium content in the soil.

3.3 Study of growth and yield of Sudan roselle. Data on plant growth and yield characteristics were collected, including plant height, number of leaves, stem diameter, number of pods per plant, average flower diameter (cm), average calyx length (cm), and average calyx thickness (mm).

3.4 Yield data of Sudan roselle grown in post-rice organic farming plots in three villages in Phak Mai Subdistrict, Sisaket Province were collected. Data collection was conducted in January 2026.

4. Enter the data into the Data Entry system at https://www.globe.gov.

Research Results

Based on soil sample collection and analysis of soil properties in the post-rice organic farming plots at the three study sites, soil samples were collected at depths of 5, 10, and 30 cm both before planting and after harvest during the post-rice harvest period from November 1, 2025, to February 6, 2026. The results were then analyzed and compared, as follows:

Table 1 shows the physical properties of soil in each studyarea before planting and after planting.

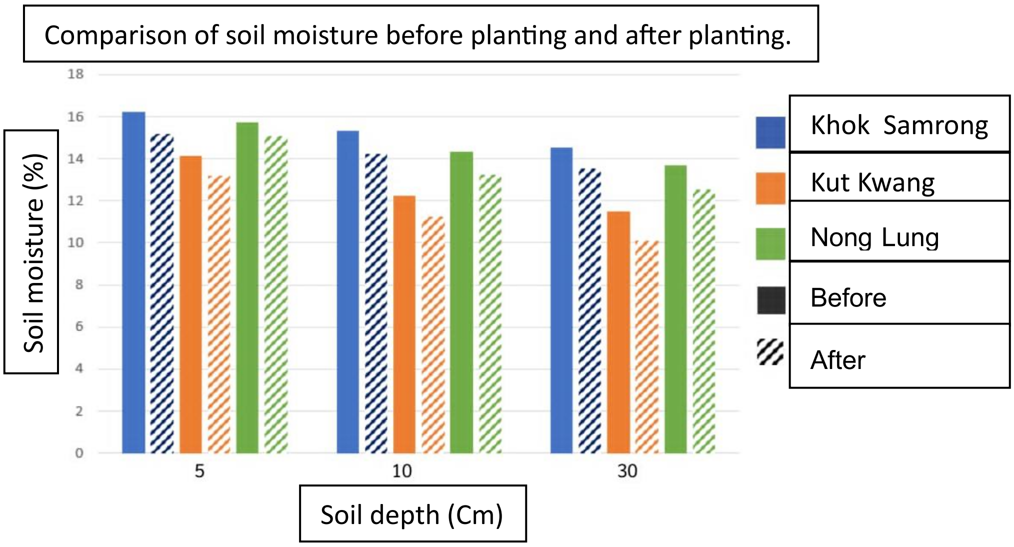
Study area (villages)	Depth (cm)	Soil texture		Soil structure		Soil expansion	
		Before	After	Before	After	Before	After
Khok Samrong	5	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
	10	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
	30	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
Kut Kwang	5	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
	10	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
	30	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
Nong Lung	5	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
	10	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable
	30	Sandy clay loam	Sandy clay loam	Granular	Granular	Loose and friable	Loose and friable

From Table 1, it was found that the physical properties of soils in all three study areas—Ban Khok Samrong, Ban Kut Kwang, and Ban Nong Lung—were characterized as sandy clay loam. The soils exhibited high fertility or high organic matter content. Soil structure and soil extensibility at different depth levels (5, 10, and 30 cm) indicated that the soils were well-aerated and had good drainage, which facilitated efficient nutrient uptake by roselle roots and consequently increased roselle yield.

Table 2 Comparison of soil temperature and soil moisture before planting and after planting.

Study area (villages)	Depth (cm)	Soil temperature			Soil moisture %		
		Before	After	Difference	Before	After	Difference
Khok Samrong	5	29	29	0	16.22	15.20	1.02
	10	30	30	0	15.35	14.22	1.13
	30	30	30	0	14.55	13.55	1.00
	Average	30	30	0	15.37	14.32	1.05
Kut Kwang	5	29	29	0	14.12	13.20	0.92
	10	29	29	0	12.25	11.24	1.04
	30	29	29	0	11.48	10.12	1.36
	Average	29	29	0	12.61	11.52	1.10
Nong Lung	5	29	29	0	15.72	15.10	0.62
	10	29	29	0	14.32	13.22	1.10
	30	30	30	0	13.67	12.52	1.15
	Average	30	30	0	14.57	13.61	0.96

From Table 2, it was found that in all three study areas—Ban Khok Samrong, Ban Kut Kwang, and Ban Nong Lung—soil temperature and soil moisture varied according to time periods and daily weather conditions. The suitable temperature range was 18–35 °C. The plant prefers full sunlight throughout the day, is tolerant of drought conditions, but requires consistently moist soil during the early stages of growth.

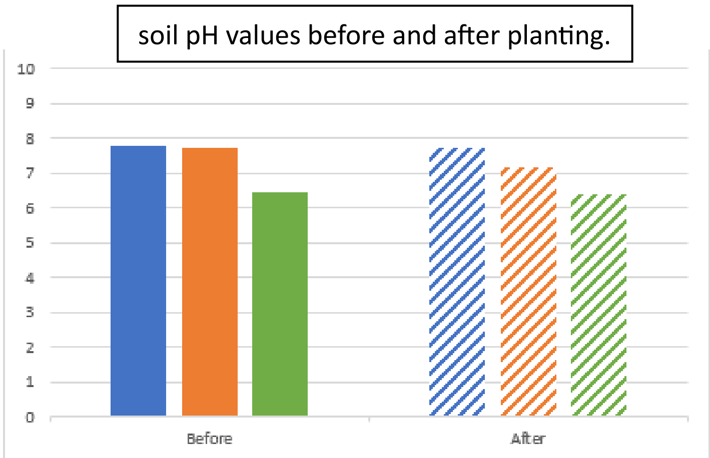


【Figure 2 Comparison of soil moisture before planting and after planting. 】

Table 3 shows the chemical properties and soil fertility before planting and after planting.

Study area (villages	Depth (cm)	pH value		Nitrogen		Phosphorus		Potassium	
		Before	After	Before	After	Before	After	Before	After
Khok Samrong	5	7.88	7.80	Moderate	Low	Moderate	Low	Moderate	Low
	10	7.80	7.77	Moderate	Low	Moderate	Low	Moderate	Low
	30	7.66	7.65	Moderate	Low	Moderate	Low	Moderate	Low
	Average	7.78	7.74						
Kut Kwang	5	7.08	7.05	Moderate	Low	Moderate	Low	Moderate	Low
	10	7.97	7.67	Moderate	Low	Moderate	Low	Moderate	Low
	30	7.20	7.1	Moderate	Low	Moderate	Low	Moderate	Low
	Average	7.74	7.20						
Nong Lung	5	6.47	6.40	Moderate	Low	Moderate	Low	Moderate	Low
	10	6.57	6.50	Moderate	Low	Moderate	Low	Moderate	Low
	30	6.44	6.34	Moderate	Low	Moderate	Low	Moderate	Low
	Average	6.46	6.40						

From Table 3, which presents the chemical properties and soil fertility, the soil pH in most of the study areas was within the range suitable for cultivating Sudan roselle, namely slightly acidic to neutral conditions. The pH values ranged from 6.0 to 7.5, which provide optimal soil conditions for the growth of Sudan roselle. In addition, the levels of primary nutrients (N, P, and K) were higher before planting than after harvesting, as the roselle plants absorbed these nutrients for growth and yield production.



【Figure 3 Graph showing soil pH values before and after planting.】

Table 4 Table showing N, P, and K nutrients before planting, after planting, and their trends.

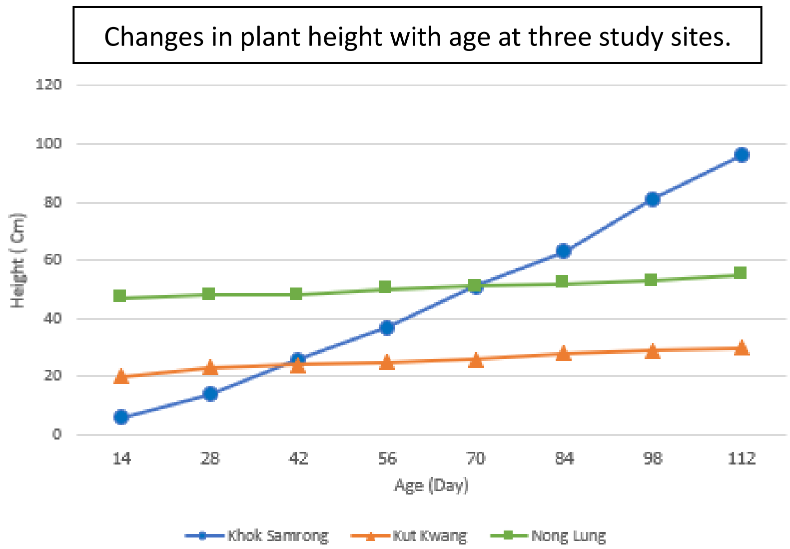
Khok Samrong			
Nutrients	Before	After	Trend
N	Moderate	Low	Decrease
P	Moderate	Low	Decrease
K	Moderate	Low	Decrease
Kut Kwang			
Nutrients	Before	After	Trend
N	Moderate	Low	Decrease
P	Moderate	Low	Decrease
K	Moderate	Low	Decrease
Nong Lung			
Nutrients	Before	After	Trend
N	Moderate	Low	Decrease
P	Moderate	Low	Decrease
K	Moderate	Low	Decrease

From table 4 ,it was found that the levels of major nutrients, including nitrogen (N), phosphorus (P), and potassium (K), in all three study areas—Ban Khok Samrong, Ban Kut Kwang, and Ban Nong Lung—were at a moderate level before planting and decreased to a low level after planting in all areas. The overall trend of all nutrients showed a decrease after crop cultivation.

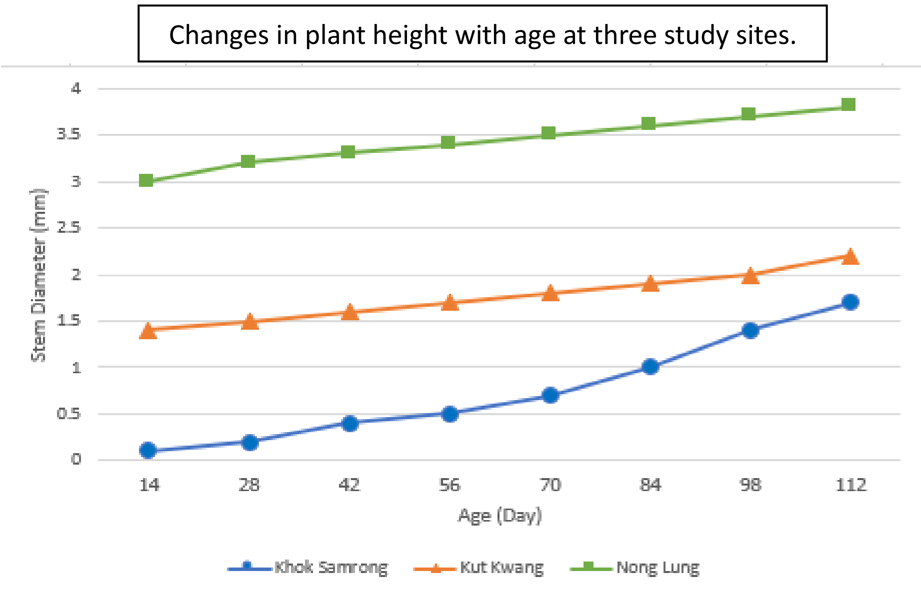
Table 5 shows the growth data of Sudan roselle from planting to harvest, with data collected every 14 days.

Study area (villages)	Growth	Plant age (days)								Average
		14	28	42	56	70	84	98	112	
Khok Samrong	Plant height (cm)	6	14	26	37	51	63	81	96	0.74
	Stem diameter (mm)	0.1	0.2	0.4	0.5	0.7	1	1.4	1.7	0.01
	Number of leaves (leaves)	3	9	24	33	36	39	40	42	0.4
Kut Kwang	Plant height (cm)	20	23	24	25	26	28	29	30	0.45
	Stem diameter (mm)	1.4	1.5	1.6	1.7	1.8	1.9	2	2.2	0.02
	Number of leaves (leaves)	14	16	17	19	20	22	23	24	0.30
Nong Lung	Plant height (cm)	47	48	48	50	51	52	53	55	0.83
	Stem diameter (mm)	3	3.2	3.3	3.4	3.5	3.6	3.7	3.8	0.04
	Number of leaves (leaves)	52	55	59	61	62	64	66	67	0.96

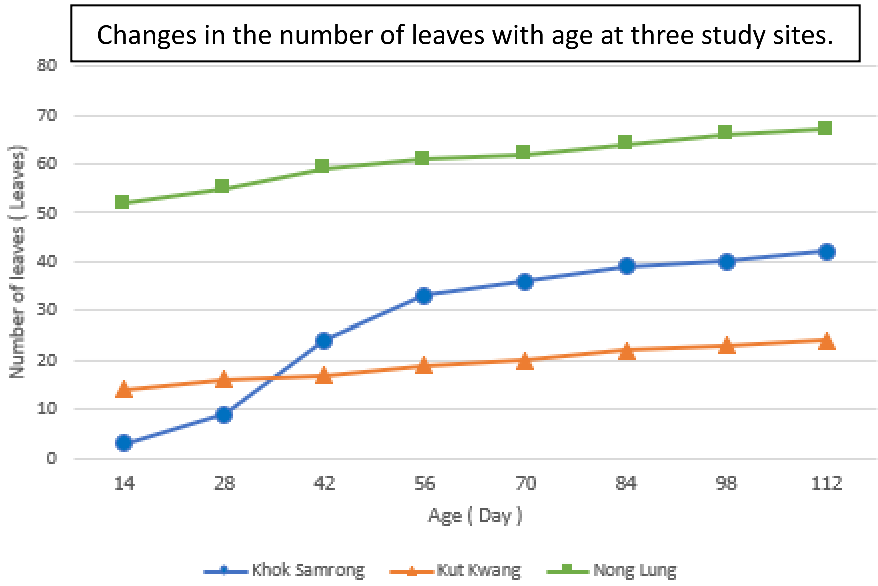
From Table 5, which presents the growth of Sudan roselle from planting to harvest with data collected every 14 days, it was found that plants grown in plots with suitable soil moisture and higher nitrogen availability at Ban Nong Lung showed greater growth trends in terms of plant height, number of leaves, and stem diameter compared with the other plots.



【Figure 4 Changes in plant height with age at three study sites.】



【Figure 5 Changes in stem diameter with age at three study sites.】



【Figure 6 Changes in the number of leaves with age at three study sites.】

Discussion

The results of this study indicate that soil nutrient availability had a strong influence on the growth and yield of Sudan roselle. Areas with higher nitrogen content showed better vegetative growth, particularly in terms of plant height, number of leaves, and stem diameter. This finding is consistent with the principle that nitrogen plays a key role in promoting stem and leaf development, which directly affects overall plant vigor.

In addition to nitrogen, phosphorus and potassium were important factors influencing yield components. Higher levels of these nutrients were associated with an increased number of pods per plant and greater calyx thickness. Phosphorus supports flowering and pod formation, while potassium contributes to yield quality and plant strength, resulting in improved productivity of Sudan roselle.

Soil depth also played a significant role in plant growth and development. Nutrients and soil moisture in the upper soil layers at depths of 5–10 cm were particularly important during the early growth stage, as they supported root establishment and initial plant development. During the later growth and yield formation stages, the deeper soil layer at approximately 30 cm, which had a higher moisture-holding capacity, helped maintain plant health and reduce stress during periods of limited rainfall.

Furthermore, the use of standardized GLOBE measurement methods enhanced the reliability and consistency of the data. Techniques such as soil color classification using the Munsell Soil Color Chart and standardized chemical test kits allowed for accurate assessment of soil properties. As a result, the interpretation of the relationships between soil characteristics and the growth and yield of Sudan roselle can be considered scientifically credible.

Conclusion

1.The soils in all three study areas—Ban Khok Samrong, Ban Kut Kwang, and Ban Nong Lung—were characterized by sandy loam texture. Soil structure and soil consistency at depths of 5, 10, and 30 cm were relatively stable, while soil temperature and soil moisture varied according to time and daily weather conditions.

2.In terms of chemical properties and soil fertility, soil pH in most areas was within a range suitable for crop cultivation. The levels of primary nutrients, including nitrogen (N), phosphorus (P), and potassium (K), were higher before planting than after harvesting, as these nutrients were absorbed by Sudan roselle for growth and yield production.

3.Sudan roselle grown in plots with suitable soil moisture and higher nitrogen availability, particularly in Ban Khok Samrong, showed better growth performance in terms of plant height, number of leaves, and stem diameter compared with plants grown in other plots.

4.Regarding yield, the number of pods per plant and calyx thickness showed a clear relationship with the levels of phosphorus and potassium in the soil..

Citations

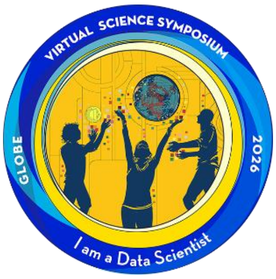
Pricha, C. (2015). Fundamentals of soil science. Kasetsart University Press. https://www.car.chula.ac.th/display7.php?bib=b1710256

Surapol, N. (2019). Soil and fertilizer management for post-rice cropping. Thai Journal of Organic Agriculture, 5(2), 45–58. https://www.tci-thaijo.org

Amphon, S. (2017). Guidelines for sustainable agricultural development at the community level. Ministry of Agriculture and Cooperatives. https://www.moac.go.th

The GLOBE Program. (2025). GLOBE soil (pedosphere) protocols. GLOBE Program Office. https://www.globe.gov/get-trained/globe-etraining/pedosphere-soil

I AM A DATA SCIENTIST

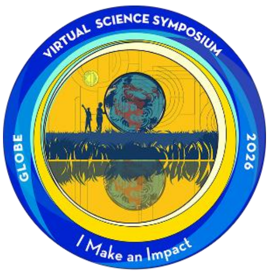


Our research focuses on analyzing soil quality data that influence the growth and yield of Sudan roselle by examining soil physical and chemical properties. The study includes measurements of soil moisture, soil temperature, soil pH, and major nutrients—nitrogen (N), phosphorus (P), and potassium (K)—collected before planting and after harvesting across three study sites. The collected data were systematically analyzed and compared, with the results presented in tables and graphs to clearly illustrate differences and trends in soil properties and plant responses. This approach enables effective interpretation of the data, supports the research questions, and allows for scientifically sound conclusions; therefore, we believe that this study meets all the required criteria for the "I AM A DATA SCIENTIST" badge.

I AM A COLLABORATOR

This research was successfully completed through the collaboration of a four-member team, with each member contributing specific responsibilities that complemented one another. Ms. Thananya Treekaew served as the team leader, providing overall direction and coordinating activities to ensure smooth project progress. Ms. Suchawadee Yodsai played a key role in data analysis and offered valuable suggestions throughout the study. Ms. Arpasiri Jungin was responsible for data collection and organization to ensure accuracy and completeness, while Mr. Kunlarote Kaewchan handled the compilation and final review of the manuscript to ensure clarity and quality. Throughout the project, the team worked efficiently with effective communication, strong teamwork, and shared responsibility; therefore, we believe that our team fully meets the criteria for the "I AM A COLLABORATOR" badge.

I MAKE AN IMPACT



Our research contributes to sustainable agriculture and environmental management by focusing on how soil quality influences the growth and yield of Sudan roselle cultivated in post-rice fields. We analyzed key soil physical and chemical properties, including soil moisture, soil temperature, soil pH, and major nutrients—nitrogen (N), phosphorus (P), and potassium (K)—and examined their relationships with plant growth and yield. The findings demonstrate that appropriate soil and nutrient management can improve crop productivity while maintaining soil fertility, providing practical guidance for farmers and local communities in managing agricultural land sustainably. Moreover, sharing the research results raises awareness among communities and stakeholders about the importance of soil conservation and efficient resource use. This project not only supports local agricultural development but also encourages environmentally responsible practices toward a more sustainable future; therefore, we believe it meets the criteria for the "I MAKE AN IMPACT" badge.