Studying the effect of using sludge from wastewater treatment ponds from rubber factories on the growth of kale.

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Abstract:

Study on the use of sediment from rubber factory wastewater treatment ponds for growing kale(Chinese kale) .The objectives were to study the quality of sediment from a rubber factory wastewater treatment pond affecting the growth of kale and to compare the growth of kale grown in different planting media. The experimental design was divided into 6 experimental sets with 3 replications per experiment.Experimental set 1) Soil Experimental set 2) Sludge from a rubber factory wastewater treatment pond Experimental set 3) Sludge from a rubber factory wastewater treatment pond mixed with Azola in a ratio of 50:1.Experimental set 4) Sludge from a rubber factory wastewater treatment pond mixed with Azola in a ratio of 50:1.5 Experimental set 5) Sludge from a rubber factory wastewater treatment pond mixed with Azola in a ratio of 50:2 Experimental set 6) Sludge from a rubber factory wastewater treatment pond mixed with Azola in a ratio of 50:2.5Analyze soil quality including pH, soil texture, soil color, moisture, porosity, and soil nutrients. Organic matter content and growth rate of kale The study found that the color of the planting material was mostly grey. Except for the planting material in the ratio 50:1 which is dark gray. All experimental sets were sandy loam.The highest moisture content was 90% in the third experimental set. The highest porosity was 20.13% in the fourth experimental set. Soil nutrient levels increased sequentially in the fourth, fifth and sixth experimental sets. The highest organic matter content was in the fourth experimental set. The growth of kale in rubber factory sludge improved significantly.wastewater treatment ponds compared to planting soil. However, when analyzing the yield of Chinese kale grown in planting materials mixed with Azolla, the growth rate was lower in the fifth and sixth experimental sets. The sixth experimental set gave the best planting results. This shows that sludge from rubber factory wastewater treatment ponds can be applied as a planting material to promote growth and increase the yield of vegetables.

Keywords: Sludge from rubber factory wastewater treatment ponds, Azolla, Planting material ,Kale

Research Question:

1.Can sludge from rubber factory wastewater treatment ponds be applied beneficially?

2.Does mixing sludge from rubber factory wastewater treatment ponds with Azolla improve the quality of planting material and promote the growth of Chinese kale?

Hypothesis:

1.Sludge from wastewater treatment ponds from rubber factories can be used as planting material.

2. Mixing sludge from wastewater treatment ponds from rubber factories with Azolla will improve the quality of the planting material and promote the growth of kale in the appropriate ratio.

Objectives:

1.To study the quality of planting materials that affect the growth of kale.

2. To compare the growth of Chinese kale grown with different planting materials.

Introduction and Review of Literature:

Farmers in Trang Province Most of Thailand is engaged in growing rubber trees and selling the rubber they harvest. The rubber is then sent to several rubber factories in Trang Province. According to the Ministry of Labor, Trang has 92 rubber factories.These plants treat wastewater before releasing it into the environment as required by law. To reduce contamination from chemicals, organic matter and other pollutants. before releasing into natural water sources The wastewater treatment process creates a large amount of sediment.Especially in large industries that can produce several tons of sludge per day. This sludge is usually removed. This leads to space management problems due to accumulation. aware of this problemThe research team decided to apply the sludge to growing vegetables in the garden. The sludge is combined with natural materials such as Azolla, which can improve soil fertility by fixing nitrogen from the atmosphere into the soil. Improve soil structure for better drainage and aeration.Kale is a popular vegetable because of its good taste and high nutritional value, including calcium, beta-carotene, vitamin A, vitamin C, vitamin K, and antioxidants that help relieve constipation.100 grams of fresh kale provides approximately 2.7 grams of protein, making it a high-protein green leafy vegetable compared to other green leafy vegetables.(https://health.kapook.com/view196961.html).Currently, the consumption of chemical-free vegetables is becoming more popular, and planting materials used must be fertile and nutrient-rich, with good porosity and water retention. Azolla, with high nitrogen content (approximately 4-5%), can replace chemical fertilizers and enhance soil fertility. Azolla's high nitrogen content results from cyanobacteria living in its leaf cavities, fixing atmospheric nitrogen. Azolla can be used as green manure and is suitable for organic farming. It multiplies rapidly, so it can be harvested, dried in the sun for about two days (resulting in a slight decrease in nutrient content by about 0.5%), and stored in sacks for future use. Typically, 20 grams of dried Azolla is used per kilogram of planting material. Experimental results show that dried Azolla is as effective as fresh Azolla. Six kilograms of dried Azolla can replace 10-12 kilograms of urea fertilizer. Nutrient analysis of this Azolla species shows high levels of nitrogen (5%), phosphorus (0.8%), and potassium (5%).

The research team aims to use sludge from wastewater treatment ponds from rubber factories as planting material.Compare with sludge mixed with Azolla in various ratios. To study the quality of planting materials suitable for growing kale.

Research Methods and Materials *(Including GLOBE Data!)*:

Materials:

1. Sludge from rubber factory wastewater treatment ponds
2. Planting soil
3. Azolla
4. Kale seeds

Equipment:

5. Soil fertility test kit to measure NPK
6. pH meter
7. Soil moisture meter
8. Hot air oven
9. High-temperature furnace (Muffle furnace)

Methods

1)Study site

This research was conducted at two locations:

1. Wastewater treatment pond of the Quang Khun Rubber (Trang) Co., Ltd. processing plant, located in Na Mueang Phet Sub-district, Sikao District, Trang Province (coordinates 7°33'28"N 99°25'31"E).
2. Princess Chulabhorn Science High School, Trang, located in Bang Rak Sub-district, Mueang District, Trang Province (coordinates 7.5595°N 99.6114°E).

Soil Properties Data Collection

The soil properties collected include:

- Physical properties: soil color, texture, moisture content, and porosity percentage.
- Chemical properties: pH, nutrient levels, and organic matter content.

The analysis was conducted according to GLOBE methods as follows:

2.1 Soil Color: Compared using the Munsell Soil Color Book (2012).
2.2 Soil Texture: Analyzed according to GLOBE methods:

- Sun-dry soil for 8 hours.
- Sieve soil through a mesh.
- Moisten soil and compare texture using the field guide.

2.3 Porosity (%)

Place the planting material in trays with a diameter of 4 cm and a height of 4 cm, with drainage holes of 0.5 cm in diameter. Cut the planting material to the same size and cover the drainage holes with transparent tape. Weigh the sample, then pour a known volume of water into the material until it is saturated. Weigh the sample again and calculate the porosity using the formula:

Porosity=(Weight after adding water−Weight before adding water)×100Volume of the tray\text{Porosity} = \frac{(\text{Weight after adding water} - \text{Weight before adding water}) \times 100}{\text{Volume of the tray}}

2.4 Measuring Soil pH

Prepare a soil solution as done for the nitrogen test. Add one sachet of HI 3895-ph reagent to the soil solution, close the test tube, and shake for about 30 seconds to dissolve the chemicals. Compare the resulting blue color to the pH color chart.

2.5 Measuring Soil Moisture Content

Weigh the soil sample before drying, then dry it in a hot air oven at 60°C for 24 hours to remove moisture. Weigh the soil sample after drying and calculate the moisture content using the formula:

Moisture Content=(Weight before drying−Weight after drying)×100Weight after drying\text{Moisture Content} = \frac{(\text{Weight before drying} - \text{Weight after drying}) \times 100}{\text{Weight after drying}}

2.6 Analyzing Organic Matter Content in Soil

Weigh 50 grams of the soil sample, then incinerate it in a high-temperature furnace at 450°C for 5 hours. Weigh the soil sample after incineration and calculate the organic matter content using the formula:

Organic Matter Content=(Weight before incineration−Weight after incineration)×100Weight before incineration\text{Organic Matter Content} = \frac{(\text{Weight before incineration} - \text{Weight after incineration}) \times 100}{\text{Weight before incineration}}

2.7 Nutrient Analysis in Soil

Nitrogen Test Weigh 20 grams of dried and sieved soil, then pour it into a plastic cup. Add 80 ml of distilled water to achieve a soil-to-water ratio of 2:8. Stir the soil with a glass rod for 30 seconds, then let it stand for 3 minutes. Repeat this process 5 times. After the final stirring, let the soil settle until clear water is visible on top. Pipette 2.5 ml of the soil solution into a test tube, add one sachet of HI 3895-N reagent, close the test tube, and shake for 30 seconds to dissolve the chemicals. Compare the resulting pink color to the nitrate color chart.

Phosphorus Test Prepare the soil solution as done for the nitrogen test, then add one sachet of HI 3895-P reagent to the soil solution. Close the test tube, shake for 30 seconds to dissolve the chemicals, and compare the resulting blue color to the phosphorus color chart.

Potassium Test Prepare the soil solution as done for the nitrogen test, pipette 0.5 ml of the soil solution into a test tube, and add distilled water to a total volume of 2.5 ml. Add one sachet of HI 3895-K reagent to the soil solution, close the test tube, and shake for 30 seconds to dissolve the chemicals. Compare the resulting turbidity to the potassium color chart.

3. Analyzing Kale Growth in Planting Material

Record the growth of kale plants every 7 days for 7 weeks post-transplant, measuring:

1. Height: Measured during growth using a ruler from the base to the tip and from the root to the tip at the end of the growing period.
2. Leaf count and width.
3. Yield: Total fresh weight of kale, measured using a digital scale accurate to two decimal places.

4. Statistical Analysis

- Mean
- Standard Deviation (SD)
- ANOVA: Two-Factor Without Replication

Results

3. Data Analysis

Research Results

The scientific project on the study of the effects of applying sediment from rubber processing plant wastewater treatment ponds on the growth of kale was divided into two parts as follows:

Part 1: Study of the properties of planting materials, including general soil, sediment from rubber processing plant wastewater treatment ponds, and sediment mixed with duckweed at ratios of 50:1, 50:1.3, 50:2, and 50:2.5.

The study found that the color of the test set 1, which differed from other sets, had no effect on the experiment. The soil texture in each experiment was loamy sand, suitable for growing kale. The average moisture content was 70%, and the average porosity in each test set was 15%.

Experimental set	Physical properties of soil			
	Soil color	Soil texture	Moisture content	soil porosity
Experiment Set 1	black	sandy loam	70.00±0.58	16.90±1.11
Experiment Set 2	dark gray	sandy loam	70.00±1.73	13.56±0.99
Experiment Set 3	dark gray	sandy loam	90.00±1.20	17.44±1.60
Experiment Set 4	dark gray	sandy loam	80.00±1.00	20.13±1.60
Experiment Set 5	dark gray	sandy loam	80.00±0.58	17.83±1.90
Experiment Set 6	dark gray	sandy loam	70.00±1.00	19.06±1.40

Table 1: Shows the physical properties of the soil.

The study found that the average pH of all six test sets was 7, which is suitable for growing kale.

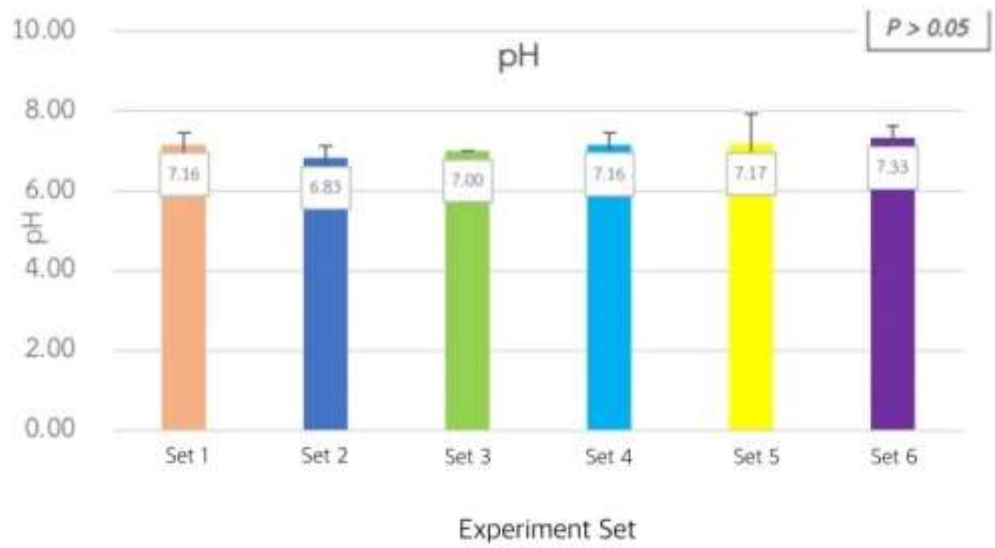

Figure 2: Bar graph showing the study of soil pH.

The study found that in Test Set 1, the levels of nitrogen (N), phosphorus (P), and potassium (K) were all medium.In Test Set 2, the level of nitrogen (N) was low, while phosphorus (P) and potassium (K) were medium.In Test Set 3, nitrogen (N) and potassium (K) levels were medium, but the level of phosphorus (P) was high.In Test Set 4, the levels of nitrogen (N) were high, while phosphorus (P) and potassium (K) were medium.In Test Set 5, the levels of nitrogen (N) were high, while phosphorus (P) and potassium (K) were medium.In

Test Set 6, the levels of nitrogen (N) were high, while phosphorus (P) and potassium (K) were medium.

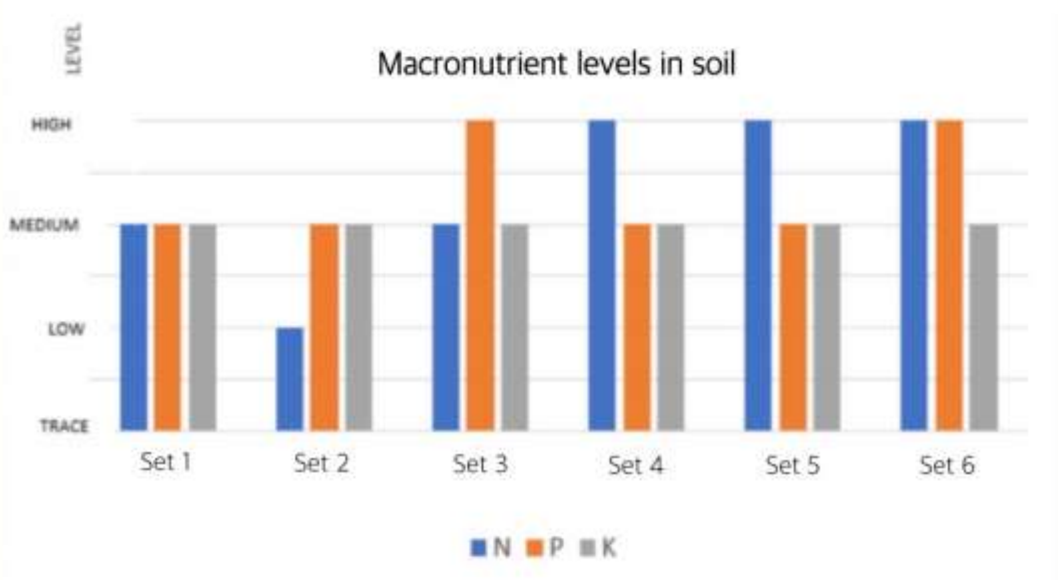

Figure 3: Bar graph showing nutrient levels in planting materials.

The study found that in Test Set 1, the levels of nitrogen (N), phosphorus (P), and potassium (K) were all medium.In Test Set 2, the level of nitrogen (N) was low, while phosphorus (P) and potassium (K) were medium.In Test Set 3, nitrogen (N) and potassium (K) levels were medium, but the level of phosphorus (P) was high.In Test Set 4, the levels of nitrogen (N) were high, while phosphorus (P) and potassium (K) were medium.In Test Set 5, the levels of nitrogen (N) were high, while phosphorus (P) and potassium (K) were medium.In Test Set 6, the levels of nitrogen (N) were high, while phosphorus (P) and potassium (K) were medium.

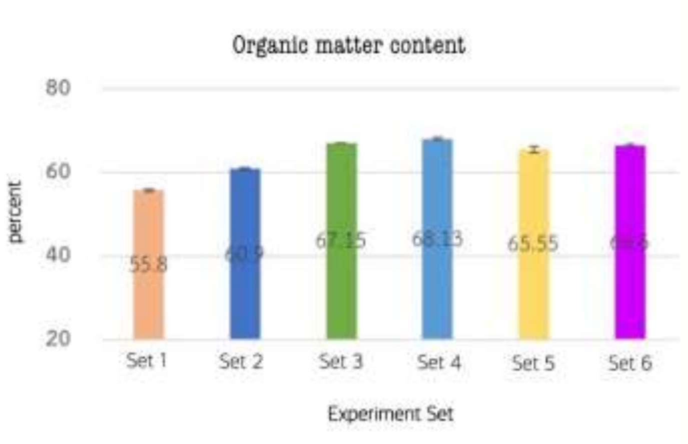

Figure 4 illustrates a bar graph showing the levels of organic matter in the planting material

Results of the Experiment

When comparing the properties of the planting materials in the six test sets, it was found that the addition of duckweed did not affect soil color and texture, but it did increase moisture content and soil porosity percentages.

Part 2: Results of Kale Growth in Planting Materials

The study found that kale in Test Set 6 showed the best growth, followed by Test Set 5. The least effective growth was observed in Test Set 1, which used general planting soil.

Experiment set	Height of kale							
	before	Week 1	Week 2	Week 3	Week 4	Week5	Week6	Week7
Set 1	2.7±0.16	6.37±0.05	8±0.04	10.99±0.46	13.64±0.07	16.78±0.07	18.96±0.05	21.85±0.07
Set 2	3.14±0.69	5.83±0.45	11.03±0.02	13.82±0.06	17.22±0.07	19.88±0.07	21.45±0.04	24.2±0
Set 3	4.24±0.5	7.17±0.02	9.83±0.06	12.67±0.07	15.77±0.02	18.27±0.06	20.89±0.07	23.88±0.09
Set 4	3.27±0.21	5±0.16	10.23±0.04	11.89±0.08	13.13±0.02	16.61±0.05	19.8±0.04	24.33±0.02
Set 5	3.87±0	6±0.08	11.03±0.04	14.13±0.02	17.71±0.04	21.67±0.07	23.95±0.04	27.33±0.02
Set 6	3.1±0.22	6.33±0.04	12.13±0.03	16.22±0.05	20.73±0.02	25.66±0.03	28.9±0.02	32.64±0.07

Table 2 shows the height of kale plants measured weekly over a period of 7 weeks.

The study found that kale in Test Set 6 showed the best height growth, followed by Test Set 5. The least effective growth in height was observed in Test Set 1, which used general planting soil.

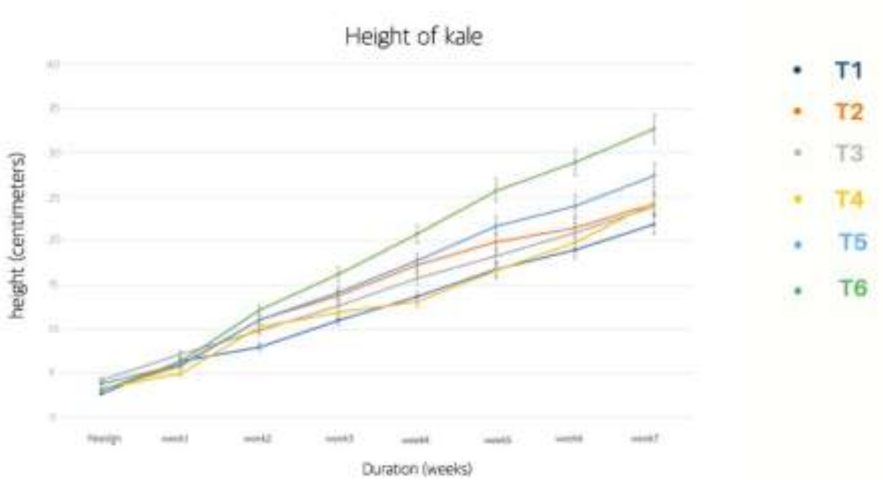

Figure 5: Graph showing the height of kale plants measured weekly.

The study found that kale in Test Set 6 showed the best leaf growth, followed by Test Set 5. The least effective leaf growth was observed in Test Set 1, which used general planting soil.

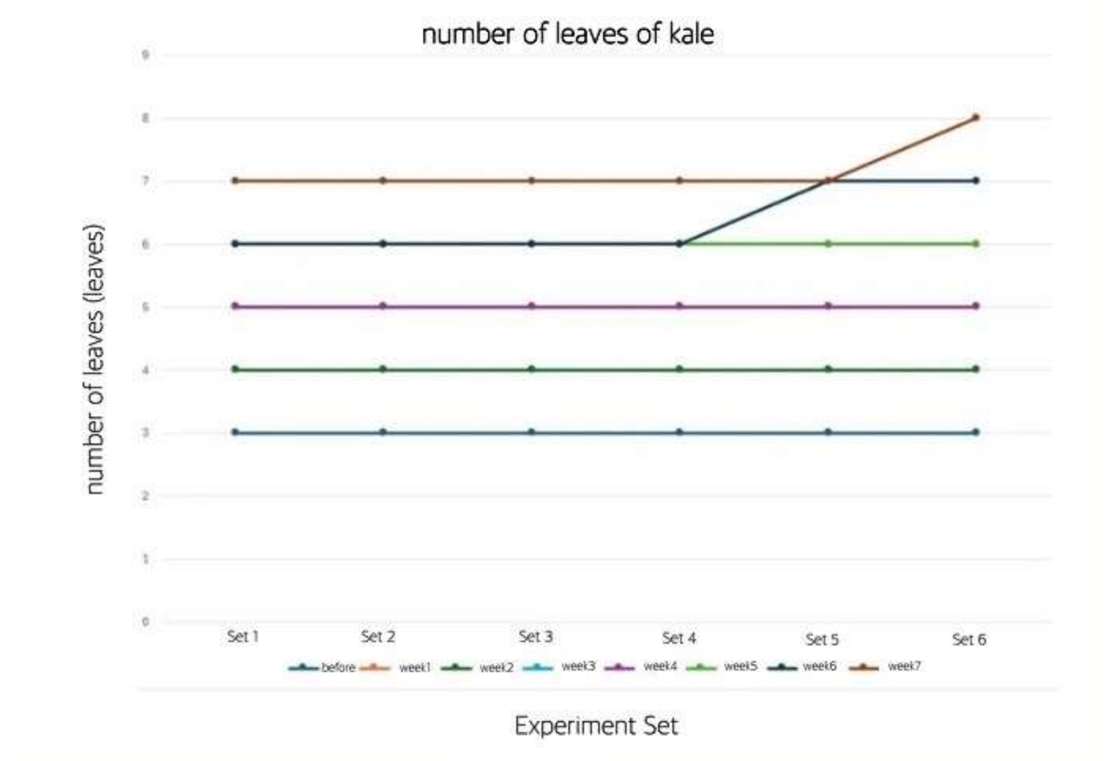

Figure 6: Graph showing the number of kale leaves measured weekly.

The study found that kale in Test Set 6 showed the best leaf growth, followed by Test Set 5 .The least effective leaf growth was observed in Test Set 1, which used general planting soil.

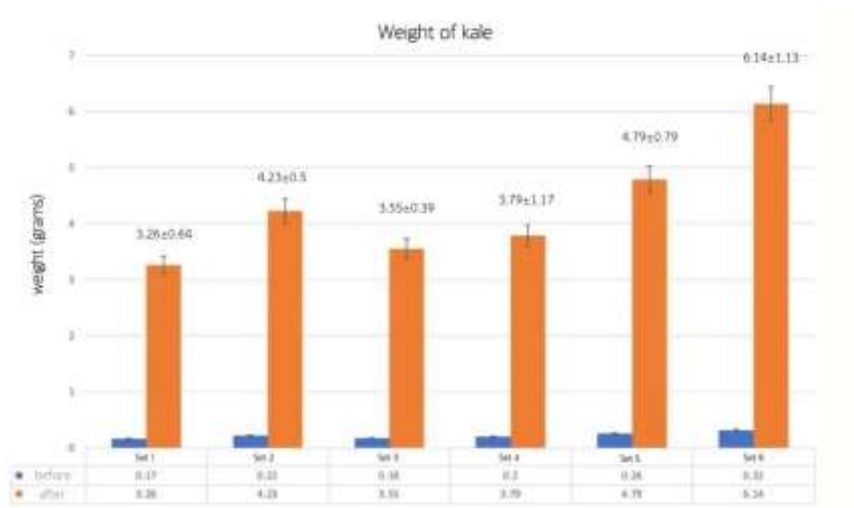

Figure 7: Bar graph showing the weight of kale before and after the experiment

The study of kale growth over the 7-week period showed that in Test Set 6, which used rubber processing plant wastewater sediment mixed with duckweed at a ratio of 50:2.5, the kale had the best growth in terms of height, number of leaves, and weight. This was followed by Test Set 5, which used a ratio of 50:2. The least effective growth was observed in Test Set 1, which used general planting soil.

Discussion and Conclusions

The study on the effects of applying sediment from rubber processing plant wastewater treatment ponds on the growth of kale found that this sediment can be developed into effective planting material. When mixed with duckweed at ratios of 50:1, 50:1.5, 50:2, and 50:2.5, the planting material had high moisture content, high porosity, neutral pH, appropriate nutrients, increasing nitrogen levels, and moderate organic matter content, making it suitable for growing kale. The best results were observed in Test Set 6, followed by Test Set 5. The least effective growth was observed in Test Set 1, which used general planting soil.

Recommendations

1. Test other plant species to evaluate growth performance in the planting material.
2. Use chemical analysis tools with high precision to report fertilizer quality as numerical data. This allows accurate and precise adjustments to improve the planting material according to specific objectives.
3. Improve the physical and chemical properties of the planting material using sediment from other industrial sources through additional methods.

Acknowledgments

In conducting the science project on the study of the effects of applying sediment from rubber processing plant wastewater treatment ponds on the growth of kale, we would like to express our gratitude to Dr. Kanittha Amnukmoni, Director of Princess Chulabhorn Science High School, Trang, for providing the facilities and equipment for the research. We also extend our heartfelt thanks to our advisor, Mrs. Salamiah Kittibunyatiwakorn, and all the project course instructors for their valuable advice and guidance in this research.

We would like to thank the teachers in the project promotion group, the Science and Technology Learning Group, and all involved parties for their assistance in various aspects, including the convenience of using research equipment and tools. Special thanks to our research team members for their dedication and perseverance in completing this research successfully, and to our families and friends for their continuous support and encouragement.

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Any benefits arising from this research are due to the generosity of these individuals and organizations. Therefore, we would like to express our deepest gratitude and appreciation on this occasion.

Benefits obtained

1.It is possible to improve the sludge from wastewater treatment ponds of rubber factories for beneficial use

2.Develop and improve the formulation of planting material in the sludge from wastewater treatment ponds of rubber factories to achieve the most suitable ratio for the growth of kale

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GLOBE's databases

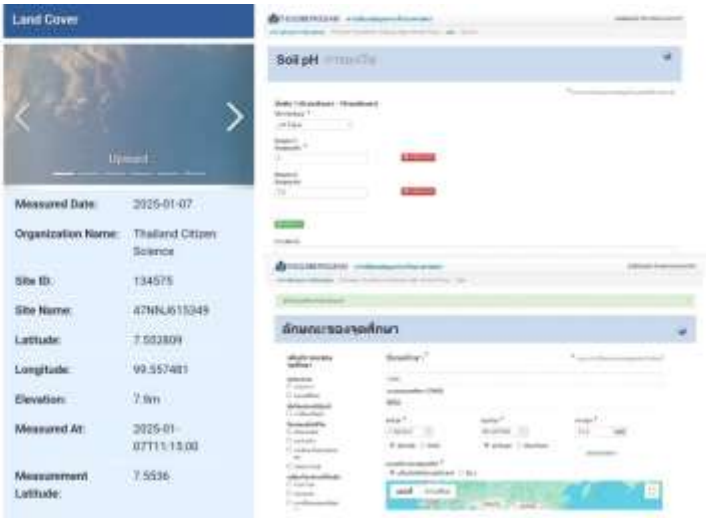

Figure 8 : Shows the submission of experimental measurement data into GLOBE Data Entry

(Optional) Badge

I MAKE AN IMPACT

This research aims to address issues caused by sediment accumulation in wastewater treatment ponds at rubber processing factories, particularly in space management. The excessive sediment from wastewater treatment is not utilized and is instead stored in designated areas, leading to limited available space for other uses. To maximize the benefits of these sediments, we propose using them for growing kale (Brassica oleracea var. alboglabra), a widely consumed vegetable rich in vitamins, minerals, and antioxidants, which also helps regulate weight and blood sugar levels. Additionally, we incorporate Azolla (Azolla spp.), which contains 4-5% nitrogen, to enhance soil organic matter and nutrient content, improving soil structure and aeration.

I AM A DATA SCENIST IT

This research requires the collection of various types of data, including the physical and chemical properties of the soil and the growth parameters of Chinese kale, recorded weekly over seven weeks—specifically plant height and leaf count. Additionally, we measure the plant's weight before and after the experiment to assess growth performance. To organize the collected data efficiently, we create tables and visual representations such as graphs and charts, making it easier to compare results. Furthermore, we compare the outcomes of six different experimental groups, analyzing soil properties and plant growth in each set of conditions. The goal is to determine which experimental setup is most suitable for optimal Chinese kale growth and to rank the remaining treatments accordingly.

I AM A COLLABORATOR

This research would not have been successfully completed without effective team collaboration. Clear planning and proper task allocation ensured a systematic approach to the study. Through teamwork, we conducted experiments, resolved challenges, and continuously improved the research process until we achieved success. Additionally, working together in data collection, analysis, and interpretation—as well as creating structured tables and graphs—played a crucial role in ensuring the research reached its full potential. Collaboration was essential in making this project a success.