Development of Seagrass Enhalus acoroides Planting Techniques Using Natural Materials for Anchoring to Enhance Survival and Growth Rates.

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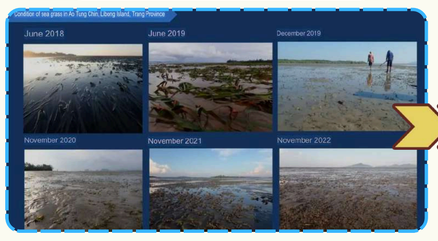
Abstract

Tape Seagrass (*Enhalus acoroides*) is a vital ecosystem with the potential to significantly lower the amount of carbon dioxide, and one of primary greenhouse gases responsible for global warming, because it has greater carbon sequestration ability. Seagrass ecosystems have been severely damaged all over the world, and restoration is urgently needed. This present research intended to innovate and experiment on processes based on natural materials with the goal of optimizing the survival of E.acoroides. There were four methods used during testing: (1) Bamboo Quadrat, (2) Sugarcane pot, (3) Sugarcane pot and Bamboo quadrat, and (4) Traditional Wooden Stake Anchoring and control group. The average survival percentage was highest of Sugarcane pot and Bamboo quadrat with 74.07%, and lowest in the control group with 7.41%. An ANOVA test at a 0.05 significance level revealed that there was a significant relationship between planting technique and seagrass survival percentage. There were no statistically significant differences at the .05 level for the growth measurements of leaf length, leaf width, and number of leaves among the surviving samples. Soil quality, both before and after planting in terms of pH and organic content, did not reveal any significant difference. Whereas, after planting, nitrogen (N), phosphorus (P), and potassium (K) content was greater.

Rationale of the Study

A seagrass decline crisis has occurred.



Reference : https://www.triplepundit.com/story/2021/carlsberg-wwf-seagrass/720341

The development of planting techniques has emerged.

Reference : https://shorturl.asia/ySmdJ

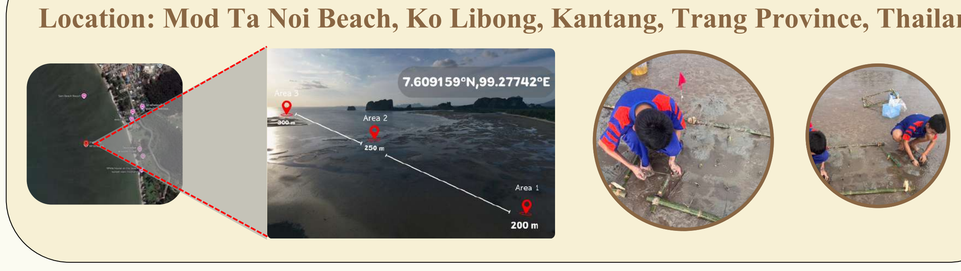
Objectives

1. To develop seagrass planting techniques using natural materials to enhance survival and growth rates.
2. To assess soil quality before and after planting with different techniques.

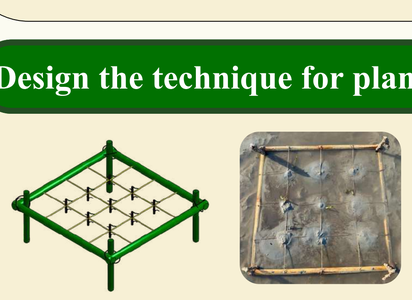
Methodology

Study Site

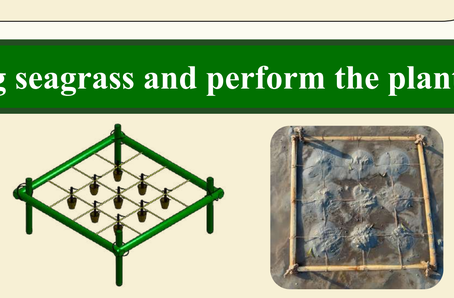
Location: Mod Ta Noi Beach, Ko Libong, Kantang, Trang Province, Thailand



Design the technique for planting seagrass and perform the planting.



Technique 1 : Bamboo Quadrat



Technique 3 : Sugarcane pot and Bamboo quadrant

Technique 2 : Sugarcane pot

Technique 4 : Traditional Wooden Stake Anchoring

Control Group

Analyze data on survival rate, growth rate, and soil quality.

survival rate

$$\text{Survival rate} = \frac{\text{Number of surviving plants}}{\text{Number of trees planted}} \times 100$$

alyze using One-way ANOVA at a significance level of .05.

growth rate

- Arithmetic mean
- Standard deviation

alyze using One-way ANOVA at a significance level of .05.

soil quality

Soil pH

Soil Nutrient N P K

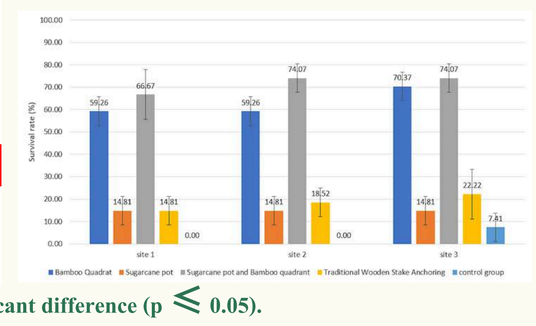
Characteristic soil and adhesion

Organic matter in the soil

Experimental results

1 Development of seagrass planting techniques to increase survival rate.

Techniques	Average surviving plants (plant)			Total (plant)
	site 1	site 2	site 3	
Bamboo Quadrat	5.33±0.58^{a}	5.33±0.58^{a}	6.33±0.58^{a}	16.99±0.58^{a}
Sugarcane pot	1.33±0.58^{b}	1.33±0.58^{b}	1.33±0.58^{b}	3.99±0.00^{b}
Sugarcane pot and Bamboo quadrant	6.00±1.00^{c}	6.67±0.58^{c}	6.67±0.58^{c}	19.34±0.39^{c}
Traditional Wooden Stake Anchoring	1.33±0.58^{d}	1.67±0.58^{d}	2.00±1.00^{d}	5.00±0.36^{d}
Control group	0.00±0.00^{e}	0.00±0.00^{e}	0.67±0.58^{e}	0.67±0.39^{e}
Total (plant)	13.99±2.68	15.00±2.85	17.00±2.87	**45.99±1.53**



Note: The letters displayed differently in the columns indicate a statistically significant difference ($p \leqslant 0.05$).

Cost-effectiveness study of seagrass planting techniques.

Technique	Bamboo Quadrat	Sugarcane pot	Sugarcane pot and Bamboo quadrant	Traditional Wooden Stake Anchoring	Control group
Capital cost (Bath)	72	45	90	45	27
Time required (hour)	1.25	0.37	1.67	0.67	0.12
Survival Rate (%)	62.96	14.81	71.60	18.51	2.47
Cost-Effectivene	44.04	13.17	34.11	11.36	1.88

Cost-effectiveness calculation

$$\frac{\text{Survival rate}^{2}_{x}}{\text{Time spent} \quad \text{Cost}} = \text{Cost-effectiveness}$$

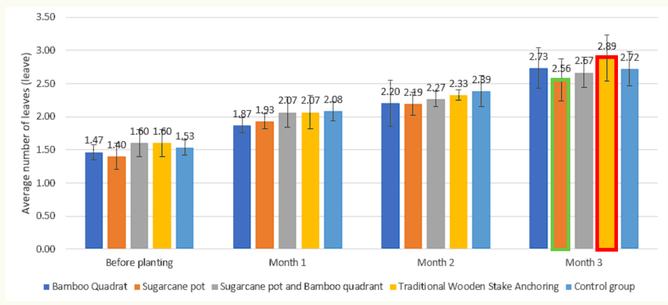
The Bamboo Quadrat technique has the highest cost-effectiveness at 44.04, making it the most cost-effective technique for planting.

2 Development of seagrass planting techniques to increase growth rate.

Techniques	Average leaf length (cm.)			
	Before planting	Month 1	Month 2	Month 3
Bamboo Quadrat	11.94±0.52^{a}	12.59±0.53^{a}	14.63±0.65^{a}	15.79±0.62^{a}
Sugarcane pot	12.38±0.60^{a}	13.27±0.74^{a}	14.58±0.56^{a}	16.04±0.48^{a}
Sugarcane pot and Bamboo quadrant	11.98±0.83^{a}	12.77±0.50^{a}	14.49±0.63^{a}	16.49±0.54^{a}
Traditional Wooden Stake Anchoring	11.36±0.24^{a}	12.31±0.62^{a}	14.46±0.65^{a}	15.91±0.43^{a}
Control group	11.12±0.52^{a}	12.59±0.46^{a}	14.27±0.27^{a}	15.34±0.36^{a}

Techniques	Average leaf width (cm)			
	Before planting	Month 1	Month 2	Month 3
Bamboo Quadrat	0.61±0.05^{a}	0.62±0.07^{a}	0.66±0.10^{a}	0.68±0.11^{a}
Sugarcane pot	0.61±0.03^{a}	0.63±0.04^{a}	0.65±0.08^{a}	0.67±0.09^{a}
Sugarcane pot and Bamboo quadrant	0.62±0.08^{a}	0.64±0.08^{a}	0.66±0.09^{a}	0.67±0.09^{a}
Traditional Wooden Stake Anchoring	0.62±0.04^{a}	0.63±0.02^{a}	0.64±0.06^{a}	0.65±0.06^{a}
Control group	0.62±0.04^{a}	0.62±0.04^{a}	0.63±0.04^{a}	0.64±0.06^{a}

Note: The letters displayed differently in the columns indicate a statistically significant difference ($p \leqslant 0.05$).



The average leaf length of seagrass planted using Sugarcane pot and Bamboo quadrant technique had the longest average leaf length, as the pots help provide nutrients to the seagrass. This is consistent with the research of Prasert Thongnoonoi. However, when analyzing the growth rate of seagrass planted using different techniques, there was no statistically significant difference at the 0.05 level.

3 Study of soil quality before and after planting seagrass using different techniques.

Sites	Techniques	Soil Texture	pH		Orgaanic Matter		N		P		K	
			before	after	before	after	before	after	before	after	before	after
1	Bamboo Quadrat	Sand	8.6±0.1^{a}	8.5±0.1^{a}	1.48±0.05^{a}	1.01±0.04^{a}	trace	trace	low	low	trace	low
	Sugarcane pot	Sand	8.6±0.1^{a}	8.4±0.1^{a}	1.59±0.02^{a}	1.26±0.03^{a}	trace	low	trace	low	low	low
	Sugarcane pot and Bamboo quadrant	Sand	8.4±0.0	8.6±0.1^{a}	1.52±0.10^{a}	1.15±0.16^{a}	trace	low	trace	low	low	low
	Traditional Wooden Stake Anchoring	Sand	8.4±0.1^{a}	8.6±0.1^{a}	1.35±0.08^{a}	0.91±0.16^{a}	trace	trace	low	low	low	low
	Control group	Sand	8.4±0.1^{a}	8.5±0.1^{a}	1.69±0.04^{a}	1.39±0.04^{a}	trace	trace	trace	trace	trace	trace
2	Bamboo Quadrat	Loamy Sand	8.6±0.1^{a}	8.6±0.1^{a}	3.17±0.09^{a}	2.60±0.13^{a}	trace	trace	trace	trace	low	medium
	Sugarcane pot	Loamy Sand	8.5±0.1^{a}	8.6±0.1^{a}	3.40±0.08^{a}	3.09±0.10^{a}	trace	low	low	low	trace	low
	Sugarcane pot and Bamboo quadrant	Loamy Sand	8.5±0.0	8.6±0.1^{a}	3.04±0.06^{a}	2.5±0.26^{a}	trace	low	trace	low	low	low
	Traditional Wooden Stake Anchoring	Loamy Sand	8.6±0.1^{a}	8.5±0.1^{a}	3.43±0.13^{a}	3.05±0.27^{a}	low	medium	trace	low	trace	trace
	Control group	Loamy Sand	8.5±0.1^{a}	8.6±0.1^{a}	3.07±0.17^{a}	2.98±0.06^{a}	trace	low	low	low	low	low
3	Bamboo Quadrat	Loamy Sand	8.6±0.1^{a}	8.5±0.2^{a}	4.08±0.20^{a}	3.55±0.33^{a}	low	low	trace	low	trace	low
	Sugarcane pot	Loamy Sand	8.5±0.1^{a}	8.4±0.2^{a}	4.09±0.12^{a}	3.65±0.20^{a}	low	medium	low	low	low	medium
	Sugarcane pot and Bamboo quadrant	Loamy Sand	8.5±0.1^{a}	8.4±0.1^{a}	4.39±0.11^{a}	3.92±0.19^{a}	low	low	low	medium	low	low
	Traditional Wooden Stake Anchoring	Loamy Sand	8.5±0.1^{a}	8.6±0.1^{a}	4.60±0.15^{a}	4.44±0.08^{a}	trace	low	trace	low	trace	trace
	Control group	Loamy Sand	8.5±0.1^{a}	8.6±0.1^{a}	4.63±0.16	4.48±0.11^{a}	low	low	low	low	low	low

The experiment found that the soil quality before and after planting, including pH and organic matter, did not differ significantly at the 0.05 level. However, the mineral content in the soil, which includes N, P, and K, increased after planting because the seagrass contributed to the increase of N and P.

Summary and discussion of results

The Sugarcane pot and Bamboo quadrant technique had the highest seagrass survival rate, as the bamboo quadrat helped anchor the seagrass to the soil surface, and the Sugarcane pot technique improved root attachment. The control group had the lowest survival rate because there were no materials to anchor the seagrass to the soil surface, causing it to easily detach. When analyzed using Anova at a significance level of .05, it was found that the survival rate of seagrass was related to the planting technique.

The growth rate of seagrass that survived the planting using the developed techniques, including leaf length, leaf width, and number of leaves, showed no statistically significant difference at the .05 significance level.

The soil quality before and after planting, including pH and organic matter content, showed no significant difference at the .05 significance level. However, the mineral content in the soil, including N, P, and K, increased after planting because the seagrass helped increase N and P.

Suggestions

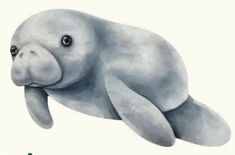
We will enhance the development of seagrass planting techniques that involve dome-shaped coverings to protect the seagrass from marine animals grazing during the restoration period.

Benefits

It is an option for using appropriate seagrass planting techniques.

Promote awareness of marine environmental issues.

Determine the soil quality after planting seagrass using different techniques.



Acknowledgements

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Reference

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