Hydroponic Rhizophora sp Saplings Significantly Improve Effectiveness and Efficiency of Mangrove Planting

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Abstract. This research aims to evaluate the effectiveness and efficiency of planting mangroves Rhizophora sp using hydroponic saplings compared to conventional polybag saplings. The hydroponic method was tested to increase the efficiency of mangrove planting through effective effectiveness that is lighter and easier to carry in large quantities. This research involves planting mangrove seedlings on a field scale using both methods. The results showed that hydroponic saplings had better effectiveness and efficiency performance than polybag saplings. The advantages of hydroponic saplings in terms of portability and the ability to plant in large quantities can be an attractive alternative in conservation and rehabilitation efforts for mangrove ecosystems. The results of this research indicate that the use of hydroponic saplings in planting can increase effectiveness by 4,512-5,869%, where 1 person can carry 294-385 saplings compared to saplings in small size polybags where 1 person can only carry 7 saplings and can achieve efficiency by 2 %, where 1 Ha only requires 7-9 people compared to saplings in large polybags where 382-384 people have to carry them people, which means it can reduce the number of people 98 % that perform significantly improve from polybag saplings.

1. Introduction

The development of hydroponic cultivation of Rhizophora sp mangrove saplings is an effort to produce saplings that can facilitate the planting process compared to saplings cultivated using the polybag method. Rhizophora sp mangrove saplings are generally cultivated conventionally in small polybags measuring 5 cm x 15 cm and weighing 410-450 g, and small polybags measuring 12 cm x 23 cm weighing 1520-1540 g depending on the volume of soil and the size of the propagules planted in the polybags, this means that in the process of carrying mangrove saplings to the field, there is a weight limit that can be carried by 1 adult so as not to cause Low Back Pain (LBP).

The weight and limitations of carrying seedlings in polybags gave rise to the innovation of cultivating Rhizophora sp mangrove saplings hydroponically, where the cultivation process does not use soil media so that the propagules are cultivated in a container that can

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accommodate the propagules to be exposed to seawater with a maintenance period of 4 months for planting in the field. Hydroponic mangrove saplings that are 4 months old can be used for planting in the field, where one person can carry more saplings compared to mangrove saplings in polybags, making it easier to bring the saplings to the field for the planting process. This research aims to evaluate the effectiveness and efficiency of planting mangroves Rhizophora sp using hydroponic saplings compared to conventional polybag saplings.

2. Method

This research was carried out by comparing the hydroponic method and the polybag method that calculates:

A. Calculate the effectiveness by comparing the capacity of 1 person to carry hydroponic mangrove saplings by carrying the saplings in a polybag, referring to the standard weight tolerance that can be carried comfortably and does not cause Low Back Pain (LBP) by 1 person, namely under 10 Kg referring to [1]
B. Calculate the efficiency by comparing the number of people needed to carry hydroponic mangrove saplings with carrying saplings in polybags in meeting the planting capacity in an area of 1 Ha with a planting distance of 2 m, which requires 2.500 mangrove saplings.

In this research, 2 sizes of seedling propagules were used, the small size weighing 26-34 g and the large size 73-81 g, then used 2 sizes of polybags which are generally used in mangrove cultivation, namely small polybags measuring 5 cm x 15 cm where the weight after being Fill 400 g with soil and the large size measures 12 cm x 23 cm where the weight after filling with soil is 1.500 g.

3. Result and Discussion

The size of the propagules of *Rhizophora sp* mangrove seedlings varies for each species, which refers to the introduction of mangroves in Indonesia [2] There are 3 species with sizes in Table 1.

Table 1. Various sizes of mangrove seedling propagules *Rhizophora sp*

No	Spesies	Propagule Size
1	*Rhizophora apiculata*	18-38 cm and diameter 1-2 cm
2	*Rhizophora mucronata*	36-70 cm and diameter 2-3 cm
3	*Rhizophora stylosa*	20-35 cm (sometimes 50 cm) and diameter 1,5-2,0 cm

Rhizophora apiculata mangrove propagules can survive floating in the sea for up to 77-89 days and *Rhizophora mucronata* can survive in the sea for up to 150 days. [3] [4], then the mangrove propagules *Rhizophora stylosa* float in the sea for up to 210 days and start growing on the 14th day [4] [5], where this phenomenon shows that *Rhizophora sp* mangrove propagules are able to survive and continue to grow even though they are floating in sea water, where even though they are floating, mangrove propagules that are exposed to sunlight can carry out photosynthesis even though their growth is slow [6], then the *Rhizophora mangle* is known to survive floating in the sea for 302 days and on the 14th day it starts to grow [7] so it is the beginning of innovation to grow *Rhizophora sp* mangrove saplings using

the hoidroponic method where the saplings are only exposed to sea water and without using soil media such as the polybag method.

3.1. Effectiveness

3.1.1. Comparison of Hydroponic Mangroves with Small Polybags

Comparison of the capacity of 1 person to carry small and large mangrove saplings hydroponically with those in a small polybag measuring 5 cm x 15 cm weighing 400 g.

Table column description:

A. Weight of saplings (g)
B. Weight Tolerance < 10 Kg (g) = 9.999 g
C. Number of Hydroponic Saplings that can be brought = B/A
D. Weight of a small polybag containing soil (g) = 400 g
E. Weight of Saplings and Polybags (g) = A+D
F. Number of saplings in polybags that can be carried = B/E
G. Increased Effectiveness = C/F
H. Effectiveness Percentage (%) = G x 100%

Table 2. Comparison for small mangrove saplings

No	A (g)	B (g)	C	D (g)	E	F	G	H (%)
1	34	9.999	294	400	434	23	12,76	1.276
2	26	9.999	385	400	426	23	16,38	1.638

Based on the results of Table 2, the comparison of the capacity to carry small hydroponic mangrove saplings with carrying small-sized saplings in small-sized polybags for 1 person shows that the use of hydroponic mangrove saplings can increase effectiveness by 1.276-1.638 %, where 1 person can carry 294-285 saplings compared to saplings in small size polybags where 1 person can only carry 23 saplings.

Table 3. Comparison for large mangrove saplings

No	A (g)	B (g)	C	D (g)	E	F	G	H (%)
1	73	9.999	137	400	473	21	6,48	648
2	81	9.999	123	400	481	21	5,94	594

Based on the results of Table 3, the comparison of the capacity for carrying large hydroponic mangrove saplings with carrying large-sized saplings in small-sized polybags for 1 person shows that the use of hydroponic mangrove saplings can increase effectiveness by 594-648%, where 1 person can carry 123-137 saplings compared to saplings in small size polybags where 1 person can only carry 21 saplings.

3.1.2. Comparison of Hydroponic Mangroves with Large Polybags

Comparison of the capacity of 1 person to carry small and large mangrove saplings hydroponically with those in a large polybag measuring 12 cm x 23 cm weighing 1.500 g.

Table column description:

A. Weight of saplings (g)
B. Weight Tolerance < 10 Kg (g) = 9.999 g
C. Number of Hydroponic Saplings that can be brought = B/A
D. Weight of a large polybag containing soil (g) = 1.500 g
E. Weight of Saplings and Polybags (g) = A+D
F. Number of saplings in polybags that can be carried = B/E
G. Increased Effectiveness = C/F
H. Effectiveness Percentage (%) = G x 100%

Table 4. Comparison for small mangrove saplings

No	A (g)	B (g)	C	D (g)	E	F	G	H (%)
1	34	9.999	294	1.500	1.534	7	45,12	4.512
2	26	9.999	385	1.500	1.526	7	58,69	5.869

Based on the results of Table 42, the comparison of the capacity for carrying small hydroponic mangrove saplings with carrying small-sized saplings in large-sized polybags for 1 person shows that the use of hydroponic mangrove saplings can increase effectiveness by 4.512-5.869%, where 1 person can carry 294-385 saplings compared to saplings in small size polybags where 1 person can only carry 7 saplings.

Table 5. Comparison for large mangrove saplings

No	A (g)	B (g)	C	D (g)	E	F	G	H (%)
1	73	9.999	137	1.500	1.573	6	21,55	2.155
2	81	9.999	123	1.500	1.581	6	19,52	1.952

Based on the results of Table 5, the comparison of the capacity to carry large hydroponic mangrove saplings with carrying large-sized saplings in large-sized polybags on 1 person shows that the use of hydroponic mangrove saplings can increase effectiveness by 1.952-2.155%, where 1 person can carry 123-137 saplings compared to saplings in small size polybags where 1 person can only carry 6 saplings.

The results of a comparison of the capacity of 1 person to carry small and large-sized mangrove saplings hydroponically with those in small or large-sized polybags show that the use of small-sized hydroponic mangrove saplings is the most effective for carrying by 1 person, so it is easier to see the effectiveness as an instrumental value [8].

3.2. Efficiency

3.2.1. Comparison of Hydroponic Mangroves with Small Polybags

Comparison of the number of people needed to carry small and large mangrove saplings hydroponically with those in small polybags, to meet the planting capacity in an area of 1 Ha with a planting distance of 2 m which requires 2.500 mangrove saplings.

Table column description:

A. Number of Hydroponic Saplings that can be carried by 1 person

B. Number of saplings in 1 Ha = 2.500
C. Number of people needed to carry hydroponic saplings in 1 Ha = B/A
D. Number of saplings in polybags that can be carried by 1 person
E. Number of people needed to carry small polybag saplings in 1 Ha = B/D
F. Increased Efficiency = C/E
G. Efficiency Percentage (%) = F x 100%
H. Percentage of people reduced = 100% - G

Table 6. Comparison for small mangrove saplings

No	A	B	C	D	E	F	G (%)	H (%)
1	294	2.500	9	23	109	0,08	8	92
2	385	2.500	7	23	107	0,06	6	94

Based on the results of Table 6, the comparison of the number of people carrying small hydroponic mangrove saplings with carrying small-sized saplings in small polybags to fulfill planting capacity in an area of 1 Ha shows that the use of hydroponic mangrove saplings can achieve efficiency by 6-8 %, where 1 Ha only requires 7-9 people compared to saplings in small polybags which must be carried by 107-109 people, which means it can reduce the number of people 92-94 %.

Table 7. Comparison for large mangrove saplings

No	A	B	C	D	E	F	G (%)	H (%)
1	137	2.500	18	21	118	0,15	15	85
2	123	2.500	20	21	120	0,17	17	83

Based on the results of Table 7, the comparison of the number of people carrying large hydroponic mangrove saplings versus carrying large-sized saplings in small polybags to meet planting capacity in an area of 1 Ha shows that the use of hydroponic mangrove saplings can achieve efficiency by 15-17 %, where 1 Ha only requires 18-20 people compared to seedlings in small polybags which must be carried by 118-120 people, which means it can reduce the number of people 83-85 %.

3.2.2. Comparison of Hydroponic Mangroves with Large Polybags

Comparison of the number of people needed to carry small and large mangrove saplings hydroponically with those in large polybags, to meet the planting capacity in an area of 1 Ha with a planting distance of 2 m which requires 2.500 mangrove saplings.

Table column description:
A. Number of Hydroponic Saplings that can be carried by 1 person
B. Number of saplings in 1 Ha = 2.500
C. Number of people needed to carry hydroponic saplings in 1 Ha = B/A
D. Number of saplings in polybags that can be carried by 1 person
E. Number of people needed to carry large polybag saplings in 1 Ha = B/D
F. Increased Efficiency = E/C

G. Efficiency Percentage (%) = F x 100%
H. Percentage of people reduced = 100% - G

Table 8. Comparison for small mangrove saplings

No	A	B	C	D	E	F	G (%)	H (%)
1	294	2.500	9	7	384	0,02	2	98
2	385	2.500	7	7	382	0,02	2	98

Based on the results of Table 8, the comparison of the number of people carrying small hydroponic mangrove saplings versus carrying small-sized saplings in large polybags to fulfill planting capacity in an area of 1 Ha shows that the use of hydroponic mangrove saplings can achieve efficiency by 2 %, where 1 Ha only requires 7-9 people compared to saplings in large polybags where 382-384 people have to carry them people, which means it can reduce the number of people 98 %. .

Table 9. Comparison for large mangrove saplings

No	A	B	C	D	E	F	G (%)	H (%)
1	137	2.500	18	6	393	0,05	5	95
2	123	2.500	20	6	395	0,05	5	95

Based on the results of Table 9, the comparison of the number of people carrying large hydroponic mangrove saplings versus carrying large-sized saplings in large-sized polybags to fulfill planting capacity in an area of 1 Ha shows that the use of hydroponic mangrove saplings can achieve efficiency by 5 %, where 1 Ha only requires 18-20 people compared to seedlings in large polybags which must be carried by 393-395 people, which means it can reduce the number of people 95 %. .

The results of the comparison of the number of people carrying small and large-sized hydroponic mangrove saplings with those in small or large-sized polybags to fulfill the planting capacity in an area of 1 Ha shows that the use of small-sized hydroponic mangrove saplings is the most efficient to fulfill the planting capacity in an area 1 Ha, the efficiency value is attached to processes rather than to goals [8].

4. Conclusion

The results of this research indicate that the use of small-sized saplings hydroponic saplings in planting can increase effectiveness by 4,512-5,869 %, where 1 person can carry 294-385 saplings compared to saplings in small-size polybags where 1 person can only carry 7 saplings and can achieve efficiency by 2 %, where 1 Ha only requires 7-9 people compared to saplings in large polybags where 382-384 people have to carry them. These people mean it can reduce the number of people to 98 %, significantly improving from polybag saplings.

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