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Original Article

The growth of seedlings of rhizophoraceae in the nursery utilizing fresh water

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Abstract

The recovery of the mangrove areas that have been degraded needs mangrove seedlings in large quantity. A mangrove nursery is generally located on the land close to the planting site and brackish water. The mangrove nursery by means of fresh water is an innovation in the provision of seeds. The objective of this experiment was to determine the growth of seedlings of *Rhizophoraceae* in fresh water based on the parameters of the number of leaves and the height of the shoots. The method of breeding utilizes fresh water and to keep the water remains available the water circulation is regulated. The results of the observations show that the number of leaves of *Bruguiera gymnorrhiza* has the number of pairs of leaves compared with *Rhizophora apiculata* dn *R. mucronata*. The average height of the shoots up to the age of 5 months after planting, the highest seedlings are *R. mucronata* seedlings. In general, mangrove nursery with fresh water can be utilized as a means for providing seedlings for rehabilitation of mangrove.

Key words: fresh water, mangrove, propagules, *Rhizophoraceae*, seedlings.

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Introduction

Mangroves provide many benefits to the surrounding areas. A mangrove ecosystem becomes a comfortable place for a variety of wildlife, such as fish, shrimps and crabs. Mangrove also functions as a protector of shoreline from the ocean waves and strong winds. According to Ghost (2011), a mangrove is a forest ecosystem that is highly susceptible to the influence of the environment. Dissanayake *et al*. (2014) states that scientific studies on the dependence on the propagules of mangrove nursery is still lacking, whereas this is very important information for mangrove restoration program. According to Fry and Cormier (2011), the mangrove area has been degraded by human activities such as land clearing and it is has been estimated that more than 50 % of the mangrove forests have been damaged or lost. Kusmana (2010) stated that the causes of mangrove degradation was due to the excessive exploitation, the water pollution and the conversion of mangroves into other uses.

The mangrove nursery for the purpose of rehabilitation or restoration of degraded mangrove areas is generally done in location close to the planting site. It is technically performed on special land. The substrate used is soil/mud surrounding the area with the brackish water for its irrigation. In one case, failure occurred when the dry season was long and the water had high salinity level that caused the seedlings in nurseries to die.

The experiment was conducted as an innovation or an alternative of mangrove nursery which has been customary. Seeding was done outside the habitat. The substrate used was the land around the settlements and the irrigation used fresh water. Scientific data on the breeding of *Rhizophoraceae* using freshwater are not many. The advantage that can be gained is easier in supervision and maintenance as it is close to where the growers live; It does not require the brackish water and the mud from their natural habitat.

The problem of this study is: "How is the growth of the seedlings of mangrove *Rhizophoraceae* species whose nursery utilizes fresh water? The parameters discussed are the life percentage, the number of leaves and the height of the shoots of the *Rhizophoraceae* seedlings during nursery utilizing fresh water. The benefit obtained is the availability of scientific information that the nursery of the mangrove *Rhizophoraceae* can be conducted outside their natural habitat with fresh water. The objective of this experiment is to reveal the growth of the seedlings of the mangrove *Rhizophoraceae* based on the parameters of the number of leaves and the height of the shoots in freshwater nursery.

Methods

The nursery of the *Rhiziphoraceae* was conducted on a laboratory scale, namely in the greenhouse of the Department of Biology, Faculty of Mathematics and Natural Sciences, Sriwijaya University, Indralaya, Ogan Ilir, South Sumatra. The materials used were the mangrove propagules of *Rhizophora mucronata*, *Rhizophora apiculata* and *Bruguiera gymnorrhiza*. The three species have been frequently used as the materials for the rehabilitation of mangrove areas that have been damaged. The planting was done in May and the observation was conducted one month after planting for the growth percentage parameter. The observation of the number of leaves and the height of the shoots was conducted at 3, 4 and 5 months after planting.

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The propagules of each species of the mangrove were planted in polybags already filled with soil. The polybags already planted with the propagules were put into plastic wash basins for their ease of arrangement. The number of propagules for each species observed is 140. The system of irrigation of the mangrove seedlings is arranged in such a way that fresh water availability is maintained and the water is regulated so that it does not exceed the height the polybags. This system ensures that the mangrove seedlings will not experience drought/lacking of water. The fresh water is regulated to continue flowing. Or it can be regulated that the water in the bucket / plastic wash basin is temporarily drained, if desired. This condition is the simulation of the conditions in their natural habitat which is always exposed to the tide. The maintenance of mangrove seedlings from invasive weeds and pests is done manually. The nursery is schematically shown in Figure 1.

The observation of the height of the shoots and the number of leaves of the seedlings for each species of the mangrove is conducted at 3, 4 and 5 months after planting. The parameters observed are the number of leaves and the height of the shoots. The number of seeds observed is as many as 140 seedlings for each species. The data obtained was analyzed by means of analysis of discrimination.

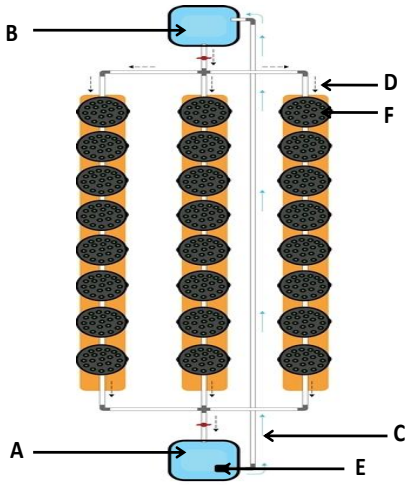

Figure 1. The scheme of mangrove nursery with fresh water; (A and B = freshwater reservoir; C = water flow from A to B; D = water flow from B to A; E = water pump; F = plastic bucket, place of polybags containing mangrove seedlings).

Results

Number of Leaves

Based on the results of the observations, there are differences in the number of leaves of the mangrove seedlings planted in freshwater. Seed *B. gymnorrhiza* shows the most number of leaves in comparison with the seedlings of *R. apiculata* and *R. mucronata* (Figure 2).

Height of Shoots

The results of the study show that there are differences in height among the seedling of *R. apiculata*, *R. mucronata* and *B. gymnorrhiza* with 0.00 significance (Table 3). The average height of the shoots of *R. apiculata* ranges from13.48 to 14.23 cm which are the seedlings of the shortest shoots. The average height of the shoots of *R. mucronata* ranges from 13.72 to 17.50 cm with a tendency to remain elevated and *B. gymnorrhiza* seedlings have an average height of shoots ranges from 15.62 to 16.55 cm (Table 2). The highest shoot of the *R. mucronata* reaches 17.50 cm and does not indicate any loss of buds.

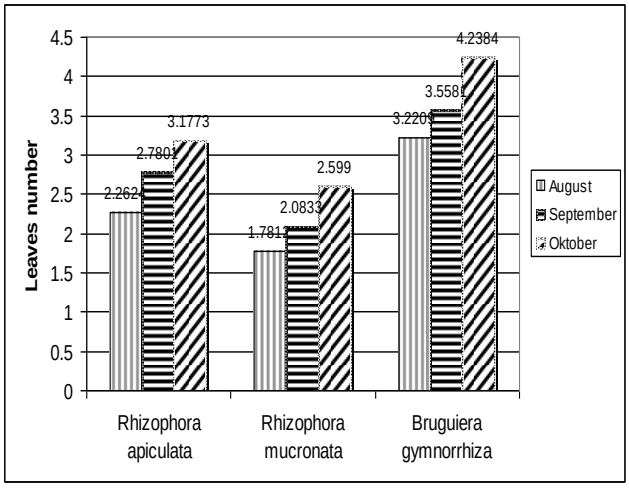

Figure 2. The average number of leaves of *R. apiculata*, *R. mucronata* and *B. Gymnorrhiza*

Table 1. The results of the discriminantion analysis of the number of leaves of *R. apiculata*, *R. mucronata* and *B. Gymnorrhiza*

Species of mangrove	F	Df	Sig.
R. apiculata	320.840	2	0.000
R. mucronata	345.338	2	0.000
B. gymnorrhiza	267.407	2	0.000

Discussion

Mangrove is the most productive ecosystem in the world. However, lately it has frequently undergone pressure or interference that resulted in degradation. The degradation of mangroves is caused by human factors and natural factors causing the functionality and the extent of mangrove to decrease (Donato *et al*., 2011; Giri *et al*., 2011; Kathiresan, 2012; Upadhyay and Mishra, 2012; Kanai *et al*., 2014). The effort to restore the degraded mangrove areas needs seedlings in large quantities. The freshwater mangrove nursery is an alternative and innovative for providing mangrove seedlings. According to Dissanayake *et al*. (2014), the scientific study of the propagules of mangrove nursery is still lacking, indeed this is very important information for mangrove restoration program.

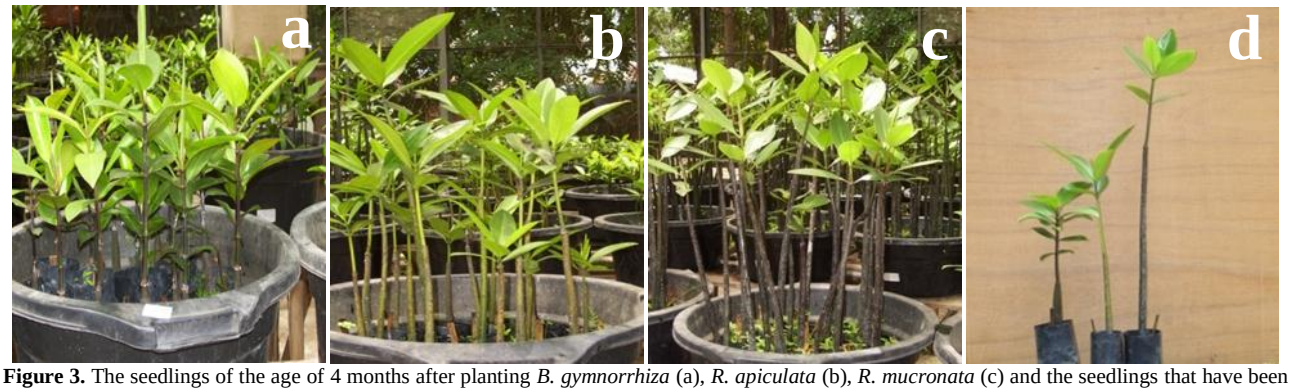

Figure 3. The seedlings of the age of 4 months after planting *B. gymnorrhiza* (a), *R. apiculata* (b), *R. mucronata* (c) and the seedlings that have been removed from the nursery (d), respectively left to right is *B. gymnorrhiza*, *R. apiculata* and *R. Mucronata*

Table 2. The average height of shoots of various kinds of mangrove in the fresh water nursery

Species of mangrove	Month after planting	Number of samples	Average height of shoots (cm)	Standard deviation
***R.* mucronata**	3	140	13.72	6.57
	4	140	15.28	5.53
	5	140	17.50	3.85
R. apiculata	3	140	13.68	6.34
	4	140	13.48	4.72
	5	140	14.23	3.82
B. gymnorrhiza	3	140	15.62	6.57
	4	140	16.36	8.40
	5	140	16.55	3.92

Table 3. Statistical analysis of the height of shoots of various species of mangrove in the nursery with fresh water

Species of mangrove	F	Df	Db	Sig.
R. mucronata	11.329	2	139	,000
R. apiculata	8.375	2	139	,000
B. gymnorrhiza	10.133	2	139	,000

Number of Leaves

The increase in the number of leaves of *R. apiculata*, *R. mucronata* and *B. gymnorrhiza* every month is very significantly different with a significance value of 0.000 (Table 2). The highest increase in the number of leaves occurs in *B. gymnorrhiza*. Until the seedlings are 5-month-old after the planting of the propagules, the seedlings are ready for planting in the field. The mangrove nursery utilizing fresh water can meet the need of seedlings which are ready for planting. In general, the seedlings with 4 or 6 pairs of leaves as the results of the nursery are ready to be planted in the field.

For the rehabilitation of the watershed areas, the species of *B. gymnorrhiza* can be used for the edge area by taking into account the maximum height of the water so that they will not submerge. This means that even if they are already in the form of seedlings, the sizes are still relatively shorter, therefore it is necessary to consider the water level when planting. According to Noor *et al.* (2006) *B. gymnorrhiza* is the dominant species in the mangrove forests which are high and it is the characteristic of late stage development of coastal forests, as well as the initial stage in the transition to become land vegetation species. Based on its zoning (Tomlinson, 1986), *B. gymnorrhiza* is located in a zone close to the land vegetation, adjacent to *Nypa fruticans* zone.

Height of Shoots

The average height of the shoots of *R. apiculata* ranges from 13.48 to 14.23 cm which is the shortest height of the shoots. The average height of the shoots of *R. mucronata* ranges from 13.72 to 17.50 cm with a tendency to keep rising, and the average height of the shoots of *B. gymnorrhiza* ranges from 15.62 to 16.55 cm. The highest shoot reaches the height of 17.50 cm of the species *R. mucronata* (Table 2). The results of the study show that there are differences in the height of the shoots among the seedlings of the species of *R. apiculata*, *R. mucronata* and *B. gymnorrhiza* with a 0.00 significance (Table 3).

The results of the experiments show that the seedlings of *B. gymnorrhiza* have the fastest growth. While the seedlings of *R. mucronata* grew a bit slower, but then increased in the speed of growth. The Seedlings of *R. apiculata* grew relatively quickly at the start of the observation (the 3rd month after planting). During the observation, the seedlings of *B. gymnorrhiza* showed the fastest growth in comparison with those seedlings of *R. mucronata* and *R. apiculata* (Figure 2).

According to Duke (2006) the seedlings of *R. apiculata* and *R. mucronata* with 6 leaves (3 nodes); and *B. gymnorrhiza* with 6 pieces of leaves and nursery age of 3 to 4 months are suitable to be planted in the area near the river where a freshwater stream can flow constantly. While *R. mucronata* is suitable to be planted in the areas affected by the low tide of the sea. Krauss and Ball (2013) state that mangroves can survive in fresh water, an idea which is still maintained that for its survival, physiologically mangrove does not require salt.

Generally mangrove grows in the salinity range of 0-38 ‰ (Tomlinson, 1986). However mangrove is able to survive in the fresh water (Krauss and Ball, 2013). According to Jayatissa *et al*. (2008), the order of tolerance toward salinity of the 7 species of the true mangrove is as

follows: *Avicennia marina* > *R. mucronata* > *R. apiculata* > *B. gymnorrhiza* >*Avicennia officinalis* > *Bruguiera sexangula* > *Sonneratia caseolaris*. The treatment attempted is the salinity at low concentrations (3-5 ‰) and medium salinity (25-27 ‰).

Based on the results of the experiment, the nursery of mangrove of the species of *Rhizophoraceae* can be conducted by using fresh water. In general, the three species of mangrove being experimented can be used as the materials for a regional rehabilitation of watershed. The species of *B. gymnorrhiza* is more suitable for the regional rehabilitation of watershed areas compared with the other two species. Generally, mangrove nursery with brackish water is performed near a natural mangrove habitat. Although conducted on the ground, a nursery with fresh water at a regulated flow of water condition can overcome the problem of watering. Based on the results of the experiments, mangrove nursery can be conducted with fresh water which is conditioned to be always flowing.

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