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Original Research Paper

Comparing Several Mangrove Seedlings

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Mangrove forest nowadays had been badly damaged due to people's activities to fulfil their needs, without conserving the forest. The low growth rate of the vegetation makes worse the mangrove condition. A deep study about the mangrove seedling must be undertaken in order to examine the seedling growth of various mangrove species. The present study employs experimental methods implementing ex situ conservation design using fresh water as a particular condition. The types of mangrove vegetation involved are those species, mostly used by local people, such as *Rhizophora apiculata*, *Bruguiera gymnorrhiza*, *Xylocarpus moluccensis*, and *Osbornia octodonta*. The growth parameters observed are the growth of first bud and the increase in leaf number. The data are analyzed qualitatively. The results of the study showes that the ability of *R. apiculata* to sprout is better compared to other species. *X. moluccensis* is considered having slowest growth. The increase of leaf number of R. apiculata and *B. gymnorrhiza* during the first week is the highest one. The increase rate of leaf number up to the seventh week, is dominated by *B. gymnorrhiza* and *O. octodonta*. At the end of the experiment *X. moluccensis* has the more leaves, yet only two seed growth.

Keywords: Mangrove, mangrove seedling, *R. apiculata*, *B. gymnorrhiza*, *O. octodonta*, *X. moluccensis*.

INTRODUCTION

Indonesia is a very large archipelago country having a sea line of about 81,000 km (Abdullah et al., 1990). Mangrove forest can be found on most of the sea line. Mangrove forest is a transition ecosystem found between land and sea always intentionally submerged in sea water.

Mangrove forest is also considered as the main ecosystem supporting life in the coastal as well as marine areas. Mangrove forest has many ecological functions like; providing nutrients for aquatic biotas, to protect and to care for various marine biotas, to absorb waste, to prevent sea water intrusion to land, as well as to be a shield for abrasion, hurricane, tsunami, and so on. On the other hand, mangrove forest has economic functions such as; to provide woods, leaves for medical purpose, and so on (Dahuri, 2001).

Because of the important role of mangrove forest in the balance of the coastal area, the existence of mangrove forest needs to be protected. The development of mangrove forest function as the environmental preserver should be extended, in terms of to be the wind and wave shield, waste absorbent, and habitat for various sea creatures such as fish, shrimp, and others (Theo, 2010).

Irmayeni (2011) reported that most of mangrove forest in Sumatera and other parts of Indonesia have been badly damaged because of human activities in surrounding areas who take the mangrove forest resources to fulfil their needs without conserving the forest. These activities reduce some mangrove populations like *Rhizophora sp., Nypa futicans,* and *Xylocarpus sp.*

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Tolangara and Corebima (2014) stated that the livelihood of most of the people in Jailolo, West Halmahera depends on woods from the mangrove forest. The exploitation of mangrove woods by local people was done to fulfil their needs of fire woods, fencing, house poles, dock poles, and inner wall and floor of ships. Due to over exploitation, mangrove species are decreasing and have become endangered. Such condition is caused by the over exploitation of mangrove trees by the local people without any effort to conserve or reforest the mangrove areas.

Beside the damage caused by the local people's activities, there is another factor that contributes to the low mangrove state rehabilitation rate due to the damage, that is the hamper growth of the mangrove vegetation itself. Lutfi (2005) once reported that based on the experience and the observation, mangrove vegetation, such as mangrove tree, is a commercial commodity. However, the rate of diameter stem growth of mangrove trees is really slow. In fact, mangrove forest in the coastal area of Gita village, North Oba, Tidore Archipelago consists of *Rhizophora* sp*.* and *Bruguiera sp.* The observation done during 12 months, found that the stem diameter growth was 0.5 cm – 1 cm in a month. Thus, the mangrove growth is very slow.

In line with the previous research report, Wardaya and Prihastuti (2005) confirmed that one problem related to mangrove, is its growth. Mangrove germination takes much time, even it can reach 10 weeks to grow from the beginning of the seedling process to become mangrove sprout with 2 leaves. Regarding ~~to~~ this phenomenon, it is necessary to conduct a deep study related to mangrove seedling effort in order to examine the ability of each mangrove species growing in a specific period of time. It is expected that it can be a concrete effort in conserving the remaining mangrove forest so it does not undergo endangered state or even to be extinct in the future.

RESEARCH METHOD

The study employed experimental method applying *ex situ* conservation design (by using fresh water) (Ridho, 2009). The species of mangrove vegetation were those that were mostly used by local people to fulfil the daily needs, such as *R.apiculata* (soki), *B. gymnorrhiza* (dao), *X. moluccensis* (buah kira-kira), and *O. octodonta* (pos-pos bo). The seedling process was carried out by utilizing soil taken from the surrounding area and fresh water taken from well. The seedling process was carried out on March 26th, 2014.

The observation of the seed growth metric included the first bud growing period, as well as leaf growth period carried out by counting the number of the opened leaves. The observation was conducted weekly until all seeds grew up to the seventh observation. The data were analyzed by implementing descriptive qualitative as well as descriptive quantitative method.

The seedling process was carried out in the polybag. Figure 1 shows the layout of the seedling study related to the four mangrove species which was done in replication 5.

FINDINGS AND DISCUSSION

The results of the observation beginning from seedling until the first bud growth up to the seventh week of the four mangrove species is presented in Table 3.1.

In order to discuss the growth of mangrove seedlings as seen in Table 3.1, the different characteristics of the four species of mangrove seeds, should be clarified before *X. moluccensis* seeds as well as the seeds of *O. octodonta* will germinate after falling from a tree. While related to *R. apiculata* and *B. gymnorrhiza*, both included in the family Rhizophoraceae, the fruits (hypocotyl) have germinated while still on the tree, then the hypocotyl will fall (propagules).

Without considering the early time of seed dormancy breaking of the mangrove seedlings of *X. moluccensis* and *O. octodonta* the first leaf of *X. moluccensis* seedling appeared at the age of 45-64 days after planting, and the first leaf emergence of *O. octodonta* was at the age of 29-38 days after planting. Thus it can be said that the first leaf seedling emergence of *X. moluccensis* was slowest compared to that of *O. octodonta*, although the age of the seeds of the two species are not known. Germination of a seed is characterized by the appearance of leaves called plumule. According to Kramer, Paul and Kosloswski (1960), Irwanto (2007) stated that germination is the process by which the embryo grows into sprouts marked by the growth of the roots and leaves out of the seed coat.

Kamil (1982) suggested that visually and morphologically, a germinating seed is generally characterized by the emergence of root candidate (radicle) or leaves (plumule) from the seed. According to Soekotjo (1976), Kamil (1982) stated that the physiological processes associated with seed germination is: (a) the absorption of water, mostly done by imbibitions, (b) the beginning of cell enlargement and cell division, (c) the increasing of enzyme amount and enzyme activity in order to digest the food reserves, (d) the transport of foodstuffs to the growth area, (e) the increase of respiration and assimilation, as well as the growth of new cells and protoplasm, (f) the increase of cell division, and (g) the differentiation of cells into various tissues and parts of a sapling.

Related to the seedling of *R. apiculata* and *B. gymnorrhiza,* the breaking up time of dormancy until the formation of propagules is unknown, because the process was already undergone when the hypocotyl was still in the tree. After *R. apiculata* propagules are planted, the first leaves would emerge at the age of 25-38 days, whereas related to *B. gymnorrhiza,* the first leaf would emerge at the age of 29-49 days after planting. It can be said that the first leaf of *R. apiculata* emerge more quickly compared to that of *B. gymnorrhiza*. This fact is in line with Ridho (2009) stating that *R. apiculata* is one of the species of mangrove having leaves that emerge faster at ex situ breeding provided with the fresh water.

According to Onrizal (2005), physiologically the mangrove plants also need fresh water, for their growth; the salt excess in the plant body will be regulated by a specific mechanism, so that the excess salt does not interfere with the process of plant growth. The mechanism can be described as follows; the cell membrane of the plant itself is a fundamental barrier to external factors. According to Basyuni *et al*., (2012), the cell membrane lipids play an important role in adaptation to different salinity through changes in the composition of sterol, lipid and triterpenoid.

In the overall, seedling growth of these four species of mangrove leading to the first leaf emergence, the time needed by *X. moluccensis* is the slowest one, that is at the age of 45-75 days after planting, whereas the time needed by *O. octodonta* is the fastest one that is at the age of 29-38 days after planting. This fact is in line with Clough (2013) saying that

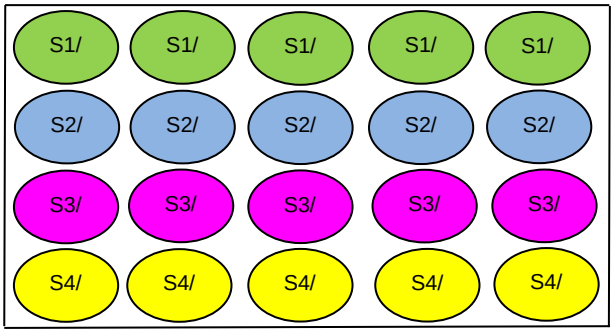

Figure 1. The Sketch of Experimental Unit Site

S1/1 - S1/5 refers to *R. apiculata*
S2/1 - S2/5 refers to *B. gymnorrhiza*
S3/1 - S3/5 refers to *X. moluccensis*
S4/1 - S4/5 refers to *O. octodonta*

Table 3.1 The Result of the First Bud Growth and Leaves Growth within 7 Weeks to the Four Mangrove Seed Species

Species Code / replication	The first bud	Leaf Growth for 7 Weeks							Total Leaves
		1	2	3	4	5	6	7	
S1/1	4th May	1	-	-	-	-	-	-	1
S1/2	25th April	1	-	-	-	-	-	-	1
S1/3	29th April	1	-	-	-	-	-	-	1
S1/4	26th April	1	-	-	-	-	1	-	2
S1/5	26th April	1	-	-	-	-	-	-	1
S2/1	15th May	-	3	2	-	-	-	-	5
S2/2	18th April	1	-	-	-	-	-	-	1
S2/3	3rd May	1	-	-	-	-	-	1	2
S2/4	20th April	2	-	-	1	-	-	-	3
S2/5	21st April	1	-	-	-	-	-	-	1
S3/1	11th May	1	-	1	-	1	-	1	4
S3/2		-	-	-	-	-	-	-	
S3/3	30th May	-	-	-	1	1	1	1	4
S3/4		-	-	-	-	-	-	-	
S3/5		-	-	-	-	-	-	-	
S4/1	25th April	1	-	-	-	-	1	1	3
S4/2		-	-	-	-	-	-	-	
S4/3	4th May	1	-	-	-	1	-	-	2
S4/4	4th May	1	-	-	1	-	-	1	3
S4/5		-	-	-	-	-	-	-	

Xylocarpus has a weakness related to the relatively slow growing and it is difficult to be planted on a large scale.

The emergence of second leaf of the four mangrove species seedlings occurred at different time. The second leaves of *X. moluccensis* emerge at the age of 59-75 days after planting, whereas the second leaves *O. octodonta* emerge at the age of 66-75 days after planting, so that it can be said that the second leaves of *X .moluccensis* emerge more faster compared to the emergence of the second leaves of *O. octodonta*. On the other hand the second leaves of *R. apiculata* emerge at the age of 67 days after the propagule planting, and the second leaves of *B. gymnorrhiza* emerge at the age of 56 days after the propagule planting, so that it can be said that the second leaves of *R. apiculata* emerge more slower compared to the emergence of second leaves of the *B. gymnorrhiza*.

Furthermore, the total number of leaves up to the 75th day after planting is different among the four species. *X. moluccensis* has 4 leaves, but *O. octodonta* has 2-3 leaves. On the other hand *R. apiculata* has 1-2 leaves and *B. gymnorrhiza* has 1-5 leaves. Related to the leaf total number of *R. apiculata* this research result is in line with the research of Clough (1984); Jennings (1976); Greenway and Munns (1980) and Yeo and Flower (1980). They reported that the slow growth of Rhizophora in fresh water, might be due to the halophyte inability to accumulate enough inorganic ions

needed for osmoregulation, at the time when the sodium chloride was deficient in the substrate.

In most plants the osmoregulation involved sodium chloride the synthesis and the accumulation of enough organic solutes, to lower the osmotic potential of cells and to increase the turgor pressure required for growth. Kusmana (1997) also stated that some environmental factors were assumed to affect the growth and development of the mangrove, suck as salinity, tides, climate, soil, dissolved oxygen and nutrients. Istomo (1992) confirmed too that the success of mangrove adaptation to these factors will appear on the growth.

Based on the leaf total number, as well as on the emergence rate of the leaf and on the regularity of the leaf emergence, it can be said that the research results are in line with the zonation distribution of those mangrove species in nature. In nature *X. moluccensis* and *O. octodonta* live in the rear area of the mangrove habitat having enough fresh water supply; whereas *R. apiculata* lives in the front area and *B. gymnorrhiza* always lived in the middle area flooded by the salt water.

According to Irwanto (2007) there were three mangrove zone division based on the inundation area and the type of plants growing there. First zone is called as the proximal zone or the most front zone. *R. apiculata*, *R. mucronata* and *Sonneratia alba* are often found in the proximal zone. Second zone is called as the middle zone, and *Sonneratia caseolaris*, *Bruguiera gymnorrhiza*, *Aviccenia marina*, *Aviccenia oficinalis* and *Ceriops tagal* are commonly found in this zone.

Third zone is called as the distal zone or rear zone, usually inhabited by *Heritiera litoralis*, *Pongamia* sp, *Xylocarpus* sp, *Pandanus* sp and *Hibiscus tiliaceus*. Of course substrate factors as well as the tidal wave significantly influence the emergence of mangrove leaves. Onrizal (2005) also stated that a variety of extreme environmental conditions, suck as namely saline environments, water saturated soil, solar radiation and high temperatures would cause the disruption of plant metabolism eventually leading to the productivity decrease or the rate decrease of plant growth. Dahuri (2001), stated that the rate of mangrove growth was strongly influenced by the fresh water supply, salinity, nutrient supply, as well as the stability of the substrate.

CONCLUSIONS

Based on the above research result discussed some conclusions will be described further:

1. *X. moluccensis* seedlings emerge at the age of 45 days after planting, but *O. octodonta* seedling emerge at the age of 29 days after planting.

2. The first leaves of *X. moluccensis* emerge at the age of 45-64 days after planting and the first leaf of *O. octodonta* emerge at the age of 29-38 days after planting. While *R. apiculata* first leaf emerges at the age of 25-38 days after the propagule planting, and *B. gymnorrhiza* first leaf emerge at the age of 29-49 days after the propagule planting.

3. After 75 days of planting the total number of seedling leaves of *X. moluccensis* are 4 leaves, but *O. octodonta* seedlings have 2-3 leaves at the age; while the total number of leaves of *R. apiculata* after 75 days of propagule planting is 1-2 leaves and *B. gymnorrhiza* seedlings have 1-5 leaves at the age.

4. *X. moluccensis* has the fastest and the most regular rate of the leaf number increase, starting at the age of 59-75 days after planning, but *O. octodonta,* has the slowest rate of the leaf number increase, starting at the age of 66-75 days after planting; whereas the rate of increase of *R. apiculata* leaves is quite long and irregular ie at the age of 67 days after the propagule planting, as well as the increase rate of the leaf number of *B. gymnorrhiza* is quite fast, i.e. at the age of 46 days after the propagule planting.

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