Jurnal Silvikultur Tropika
Vol. 07 No. 3, Suplemen Desember 2016, Hal S15-S18
ISSN: 2086-8227

GROWTH IMPROVEMENT OF *Rhizophora mucronata Lamk* WITH *LATERAL ROOT MANIPULATION* TECHNIQUE (LRM) IN MUARA ANGKE, NORTH JAKARTA

Cecep Kusmana*, Ageng Nurtya, and Yadi Setiadi

Department of Silviculture, Faculty of Forestry, Bogor Agricultural University (IPB)
*Corresponding author: ckusmana@ymail.com

ABSTRACT

Mangrove has a strategic functions as a primer producer that able to support the stability between aquatic and terrestrial ecosystems. The damage mangrove plants needs an intense handling to avoid the destruction of mangrove ecosystem. It requires an environmental modification to increase growth quality of mangrove, one of various techniques that can be applied is lateral root manipulation (LRM). This study was aimed to examine the growth response of *Rhizophora mucronata* seedlings toward the frequency of fertilization by terabuster polymer fertilizer, and addition by rock phosphate and HSC (humate substance complex) fertilizer. Our treatments on this study were different frequency of flushing by 0.5% terabuster polymer fertilizer combined with addition of 500 g rock phosphate, and 0.2% HSC, by using two factorial experiment design on randomized complete block design. The application of LRM combined by addition of rock phosphate and HSC which is flushed by terabuster polymer give a significant effect to the height and stem diameter seedlings. The result of interaction between the treatment fertilization addition and flushing frequency shows that RHF1 (mixed rock phosphate and HSC with flushed by terabuster in a frequency one time in a week) give a significant effect to the stem diameter of seedlings with average growth as large as 0.61 cm (about 254.02% compared to control).

Key words: heigth growth, humat substance complex, lateral root manipulation, *Rhizophora mucronata* Lamk., rock phosphate, stem diameter growth, terabuster.

INTRODUCTION

Mangrove plants which were experienced damage require intensive handling in order to prevent the destruction of mangrove ecosystem. Many techniques can be applied to recovery the growth of damage mangrove plants. One of them is lateral root manipulation (LRM). Lateral root manipulation (LRM) is a technique to cope stagnation plant growth through cutting the lateral roots. This technique serves to stimulate root in absorbing water and nutrients. This technique is applied to modify the soil on planting area of rehabilitation site to become good condition for supporting plant growth.

Difficulty in implementing a land rehabilitation is unfavorable land to be planted in supporting the plant growth. Soils contains lack of nutrients can impact negatively to the function and development of root growth, such as the root can not develop properly and their function as a means of absorption of nutrients will be disrupted. As a result, the plant can not grow normally, growth remain stunted and pining or stagnated.

The research was done to observe the growth of bakau (*Rhizophora mucronata*) seedling treated by LRM combined with the fertilizer of rock phosphate and humic acid substance complex, flushed by terabuster polymer with different frequency.

RESEARCH METHODS

Research Location and Time

This research was conducted at *R. mucronata* planting area of Mangrove North Jakarta Education Center for 3 months (December to February 2012).

Equipments and Materials

Used equipments and materials were measuring tape, ruler, weights 2 kg, tally sheet, spray tanks, stationery, caliper, bucket, 2-year-old bakau (*R. mucronata*) seedlings having yellow and normal leaves, and fertilizer (terabuster polymers, humate substance complex and rock phosphate).

Procedure

Selection research site

The choosen research site is an area grown by 2-year old bakau (*R. mucronata*) in Muara Angke, North Jakarta.

Weeding

Weeding is done manually to weeds grow surrounding the seedlings.

Root cutting

The root of seedlings were cut through creating the hole around the plant as wide as 20 cm with the depth of 10-20 cm based on the borderline of outer canopy projection.

Applying fertilizer

Rock posphate fertilizer mixed with the soil from the furrow was placed into the pits and then covered by soil. Furthermore, it flushed by 0.2% of humate substance complex (HSC). Fertilizer 500 g of rock phosphate and HSC only given once at the beginning of treatment. Application of 0.5% terabuster was accordance with the flushing treatment.

Measurements growth parameter

Data were collected by directly observed and measured parameters of height and stem diameter of seedlings every week after treatment.

Experimental design

This research used factorial experimental design on randomized block with various treatments as shown on Table 1.

Table 1. Combination of different treatment levels

Type fertilizer	The frequency of terabuster flushing			
	F0	F1	F2	F3
K	KF0	KF1	KF2	KF3
RP	RPF0	RPF1	RPF2	RPF3
HSC	HSCF0	HSCF1	HSCF2	HSCF3
RH	RHF0	RHF1	RHF2	RHF3

K = control; RP = rock phosphate 500 g/hole; HSC = humate substance complex 1L/50L water; RH = rock phosphate + HSC.
F0 = without flushing; Fl = flushing frequency once a week; F2 = flushing frequency once for 2 weeks; F3 = flushing frequency once for 3 weeks.

Research site consisted of 16 level treatments repeated for 5 times. So that, there are 80 units plants set up by using random block factorial experimental design such as follows:

$$Y_{ijk} = \mu + \alpha_i + \beta j + (\alpha\beta)ij + \varepsilon_{ij}$$

Y_{ijk} : observations on the treatment of the-i fertilizer type, the-j fertilizing frequency and block of -k
μ: the average of the common value
α_i : the effect of fertilizer type treatment
βj: the effect of frequency treatment
$(\alpha\beta)ij$: the effect of interaction between factor of the-i fertilizer type and the-j flushing frequency of fertilization.
ε_{ijk}: random effect on the treatment of the-i fertilizer type,the-j fertilization frequency and the-k block.

Data Analysis

The experimental design used in this study is a factorial randomized block design with two factors. Factor A is fertilizer type consisting of rock phosphate, HSC (humate substance complex), and terabuster, and Factor B is the flushing frequency of terabuster. Measured data is analyzed by Statistic Analysis Software System (SAS 9.1). If the treatment is significant, then proceed with the Duncan's Multiple Range Test, which aimed to find the average difference between treatments.

RESULTS AND DISCUSSION

Result

Obtained results showed that the both treatment of fertilization and flushing frequency by terabuster has significantly effect to the height of seedling, while for stem diameter, significant effect given by both treatments of fertilizer type and flushing frequency of terabuster and its interaction (Table 2).

Table 2. Results of variance analysis of parameters observed

Paremeter	Fertilizer type	Fertilization frequency	Fertilizer type X flushing frequency
Height	**	**	ns
Diameter	**	**	**

**: highly significant by F test at P-value 0.01
*: significant by F test at P-value 0.05
ns: not significant

Advance statistical test with Duncan Multiple Range to the measured parameters among treatments are presented on Table 3.

Table 3. Duncan test results regarding to the influence of fertilization treatment on height and stem diameter seedlings growth

Treatment	Seedling height (cm)	Stem seedling diameter (cm)
RH	4.80^{a}	0.35^{a}
RP	4.40^{a}	0.33^{ab}
HSC	4.30^{a}	0.30^{bc}
KO (Control)	3.30^{b}	0.26^{c}

Different letters behind the numbers indicate significant different. RP = rock phosphate 500 g/hole, HSC = humate substance complex 1 L / 50 L water, RH = RP + HSC.

Regarding to the treatment of flushing frequency of terabuster to the height and stem diameter seedling growth can be shown on Table 4.

Table 4. Duncan test result regarding to the influence of flushing terabuster polymer frequency to the height and stem diameter seedling growth

Flushing frequency	Seedling height (cm)	Stem seedling diameter (cm)
F1 (once a week)	5.36^{a}	0.45^{a}
F2 (once every 2 weeks)	4.46^{b}	0.33^{b}
F3 (once every 3 weeks)	3.69^{c}	0.24^{c}
F0 (control)	3.35^{c}	0.22^{c}

Different letters behind the numbers indicate significant different.

Recapitulation result of Duncan test of the interaction between fertilization and flushing frequency is shown on Table 5.

Table 5. Recapitulation of Duncan test of the interaction between the treatment of fertilization by rock phosphate and HSC, and flushing frequency of terabuster to the height and stem diameter seedling growth

Interaction	Stem diameter (cm)	% Compared to control
KOF0	0.17^{h}	-
KOF1	0.39^{bc}	125.30
KOF2	0.30^{cdfge}	75.90
KOF3	0.20^{gh}	18.40
RPF0	0.26^{defgh}	51.72
RPF1	0.43^{b}	149.42
RPF2	0.35^{bcde}	104.60
RPF3	0.27^{defgh}	58.62
HSCF0	0.2^{defg}	64.40
HSCF1	0.35^{bede}	105.74
HSCF2	0.31^{cdef}	82.80
HSCF3	0.24^{fgh}	37.93
RHF0	0.18^{h}	3.44
RHF1	0.61^{a}	254.02
RHF2	0.36^{bcd}	109.20
RHF3	0.25^{efgh}	47.12

Number followed by the same letter showed no significant different; KO: control; RP = rock phosphate 500 g / holes; HSC = humate substance complex 1 L / 50 L water; RH = RP + HSC; F0 = without flushing; Fl = flushing once a week; F2 = flushing once every 2 weeks; F3 = flushing once every 3weeks.

Discussion

In general, plant organ consists of roots, stems, leaves and flowers. Roots grow into the soil to strengthen the standing of plant. Roots also serve to take water and mineral from the soil. As several other organs in plants, roots also serves to store food.

Roots is the lowest part of the core of plants and usually develops under ground level, although there is also the root which grows above ground. Based on the origin, there are two types of roots, i.e. taproot and fibrous roots. Tap root develops from the tip of embryos,while the fibrous roots growing from the network adult root or from other parts of the plant body such as stems and leaves. Root system of bakau (*R. mucronata*) consists of taproots which develop to forming the root branch of the side of adult roots. Those roots experienced the secondary thickening have function to holder on the ground and to store the resource nutrient (Mulyani 2006).

LRM is a technique to overcome plants stagnation by cutting lateral roots. This technique works for stimulating the growth of new roots to absorb water and nutrients well. Nutrients given to stimulate the root growth namely rock phosphate fertilizer, HSC, and a mixture of both. Those fertilizers is mixed with the soil and then given to the lateral roots that have been cut for stimulating the formation of new roots. In addition to applying those fertilizers. Fertilization was also applied the flushing frequency using fertilizer of terabuster polymer 0.5% in order to maximizing the growth of lateral roots.

Growth is a process in plant life, resulting in changes on plant size to be bigger and determine the plant production. Increasing the size of plant body is a result of increasing size of cell bundle because of the increases of cell dimention. In this research, the mesuared growth are the height and stem seedling diameter. Plant height is a measure plants growth that are often observed well as growth indicators as well as parameter which is used to measure the impact of environment or treatment applied. This is based on the fact that the plant height is the easiest growth parameter to be observed (Sitompul and Guritno 1995).

Based on our research results, treatment of fertilizers as well as frequency of fertilization given significant effect on the seedling's height. All fertilizer types (RH, RP and HSC) given to the plants provide proper influence to the seedling height growth (Table 3). According to Hariangbanga (2009), rock phosphate plays to restore soil fertility. In addition, this fertilizer capable maintaining the resilience of the water content in the soil and improve the function of plant roots, while HSC plays improving soil conditions becoming more fertile by stimulating plants and soil microorganisms. Organic acid can increase the permeability of organic membranes and helps accelerate nutrition to penetrate the cell wall. It increasing stimulates the production of chlorophyll, photosynthesis activity, production of hormones, and activity of the enzyme.

The best frequency of fertilizing with terabuster polymer is F1 (flushing frequency once a week). Fertilizer terabuster polymer roles as a provider of nutrients in a form that can be absorbed by plants, stimulating growth and increase plant production, and improve plant photosynthesis, so plant growth to be optimal. The benefits of terabuster polymer is that fertilizer containing NPK, Magnesium, Calcium and chelated micronutrients. Beside, this fertilizer has the ability to dissolve perfectly, so that is easily absorbed by plants and also this fertilizer already in the form of a polymer that resistent to washed out by rain.

The interaction between the treatment of fertilizer type and the frequency of fertilization did not significantly impact on the height growth of seedlings. There are some environmental factors significantly effect on the stem elongation, such as temperature and light intensity. The optimum temperature for stem elongation varies depending types of plants. The rate of stem elongation inversely proportional to the light intensity. Stem elongation more encouraged if the plant grown in places with low intensity of light (Lakitan 1996).

According to Saenger and Hutchings (1987), *R. mucronata* would be good grow at a temperature of 26°-28 ° C, while on the location when at daytime the temperature about 31. 4°C and night 25.4°C *R-mucronata* becomes unappropiate grow. Growth plants is affected by physiological processes that occur in the body of plant, which are the process of photosynthesis, respiration, translocation and absorption of water and minerals (Daniel *et al*. 1989 in Istantini 2012). Those

physiological processes are influenced by environment factors such as sunlight, soil, wind and weather.

Our results showed that the application of LRM with fertilizer and proper frequency fertilization given significantly effect on the growth of stem diameter seedlings. The best treatment is the mixed fertilizers between rock phosphate and HSC (Table 7). This is because those fertelizers contain organic substances for improving soil fertility, tying Al and Fe, and stimulating development of soil microorganisms. Especially, HSC may affecting physical and biological properties of the soil, because this fertilizer can improve soil conditions become more lush, loosening the soil and able generate activity of microorganisms in the soil. Improvement of soil physical properties effect on soil structure, granulation, reduce compaction, improve aeration, and soil well ability to retain water as well as improve soil infiltration, so that the soil can play the role as a good media for plant growth (Hariangbanga 2009).

The creation of a good root system, results in plants can perform photosynthesis smoothly, and take nutrient elements as the nutrients easily, also store water well getting air sufficiantly. Repairing biological properties of the soil should give good effect on the activity of soil mircoorganisms.

Flushing terabuster polymer once in a week to the mixed HSC and rock posphate sprinkling intensive increases growth mangrove seedlings, because the terabuster contained available nutrients readily absorbed by plants. So that, terabuster should improve soil chemical nutrient to more stable which directly absorbed by plants. Repairing the soil chemical properties influence on the source of nutrients, binding trace nutrients and increases CEC (cation exchange capacity).

CONCLUSIONS

The treatment application of LRM with the mixed fertilizer of HSC 0.2% and rock phosphate 500 g/hole with flushing by terbuster 0.5% once in a week gave significantly effect on the good growth of height and stem diameter of seedlings. While the interaction between the treatment of fertilizer and flushing frequency of terabuster gave significantly effect on the stem diameter of seedlings.

Fertilizer type that produces well height growth of seedlings, are RP, HSC, RH, whereas for stem diameter seedlings is RH.

Average height growth of seedlings after being given by the treatment of fertilizer type and fertilization frequency, respectively amounted to 4.80 cm and 5.40 cm. If compared to the controls, the increase of height growth seedlings were 42.50% and 59.70%, respectively.

Interaction between treatments of fertilizers type and the flushing frequency of fertilization shows that RIIFI (combination of rock phosphate - HSC and the frequency of fertilization once a week) give significantly effect on stem diameter seedlings with an average of 0.61 cm (about 254.02% compared to the control).

REFERENCES

Hariangbanga G. 2009. Grebn Earth Products. Bogor (ID): Green Earth Trainer.

Istantini A. 2012. Pengaruh pemberian arang tempurung kelapa dan kotoran sapi (bokashi) terhadap peningkatan pertumbuhan semai jabon pada media tanam tailing tambang emas [skripsi]. Bogor (ID):
Fakultas Kehutanan. Institut Pertanian Bogor.

Lakitan B. 1996. Fisiologi Pertumbuhan dan Perkembangan Tanaman Jakarta: PT Raja Grafindo
Persada.

Mulyani S. 2006. Anatomi Tumbuhan. Yogyakarta (ID): Kanisius.

Saenger P, Hutching P. 1987. Ecology of Mangrove. St. Lucia Australia (AT): University of Queensland Press.

Sitompul SM, Bambang G. 1995. Analisis Pertumbuhan Tanaman. Yogyakarta (ID): UGM Press.