The Effect of Plant Distance on Mangrove Plant (*Rhizophora Apiculata*) in Selected Coastal Coast in Indonesia

Y Yunasfi[1], Isma Fibrina Putri[1], Ippana Enggar Susetya[2]
{yunasfijamhar@yahoo.co.id}

[1]Faculty of Forestry, Universitas Sumatera Utara, Medan, Indonesia
[2]Faculty of Agriculture, Universitas Sumatera Utara, medan, Indonesia

Abstract. Mangroves are a unique ecosystem in coastal areas and are influenced by tides. This study aims to study and determine the effect of plant spacing that is useful for increasing growth for the mangrove ecosystem of *R. apiculata*. This research was conducted from December 2020 to February 2021 on the coast of the Langkat Regency, Pangkalan Susu District, Pulau Sembilan, North Sumatra. This study employed a totally random design (CRD) with distance treatment (J) consisting of (a) A1 (plant distance beach 37 m), (b) A2 (plant distance 38 m), (c) A3 (plant distance 39 m), (d) A4 (distance from the beach 40 m) (e) A5 (plant distance 41 m). Based on the results, the study showed that the highest average value of height was at A1 (plant distance 37m) with value 44.23 cm, the highest average of diameter was at A1 (plant distance 37m) with value 12.35 mm and the highest growth of number of leaf was at A1 (plant distance) with value 36 leaves. The percentage of plant growth was obtained at 100%. Observational data on measurements of height, diameter, number of leaves, and leaf area, showed that the treatment at the spacing of the plants could increase the growth of *R. apiculata* seeds. Based on the study's results, the ideal spacing for use in planting or rehabilitating mangroves on *R. apiculata* seedlings was in treatment A1 (plant distance 37 m)

Keywords: Distance, mangrove, Pulau Sembilan, *Rhizophora apiculata*

1. Introduction

As we know that currently mangrove forests have experienced a lot of damage. either by human activity or by natural disasters. the high amount of damage that occurs requires us to find a solution to how the damage can be handled. The damage is unavoidable, but we can find ways to repair the damage. One of the things we can do is to do research. as is the case with spacing treatment for R. apiculata plants, we can breed these plants to grow well so that later they can restore damaged land

R. apiculata is one of the most common types of mangrove species planted with a tree shape that can reach 15 meters in height with a prop type of root and has a viviparous seed type. Another character that can be seen is the relatively small leaf size when compared to other types of Rhizophora mangroves for various other purposes. The main function of this mangrove can be received optimally if the mangrove forest is overgrown by species that can grow and adapt well in the area.

Mangroves are crucial for the environment and socio-economic value as a center for tropical marine life. The mangroves are also one of the most abundant sources of biological

SRICOENV 2022, October 05-06, Palembang, Indonesia

DOI 10.4108/eai.5-10-2022.2329064

diversity in the entire globe. Furthermore, 90% of marine life is mostly found in the mangrove habitat, and mangroves are necessary for 80% of the world's fish catches [1]. This ecosystem has unique qualities and multiple valuable human functions beings and other species. For the ecological functions of mangroves to be preserved, a rational mangrove utilization strategy involving the community is crucial. local area involvement is regarded as the first stage in the sustainable preservation of mangroves. This approach can be made to keep mangroves in their natural state and make its creating a buffer zone for the mangrove ecosystem by integrating the area [2]. R. apiculata a species of the Rhizophoraceae family where The oil one of the mangrove forest's most important species ecosystem. R. apiculata has very hard, fast-growing wood mangroves), have breath roots, types of oposit leaves, and up to 15 meters high. R. apiculata has type viviparous seeds where the underside of the leaves is colored yellowish green. One of the characteristics of R. apiculata What is different from other types of mangroves is the leaves that are tend to be smaller [3].

2. Materials and Methods

2.1 Time and location

This study was carried out in Sembilan Village's mangrove forest in Pangkalan Susu, with experiments on R. apiculata seedlings and at the Forest Cultivation Laboratory and Forest Resources Conservation Laboratory, Faculty of Forestry, University of North Sumatra. This research project was completed from December to February 2021.

2.2 Materials

The equipment to do field research are caliver, marker, tape measure, oven, stationery, Laptop, ruler, SPSS application and camera. Then the material utilized is seeds of R. apiculata can contain up to 30 seeds and are similar in size. The SPSS used is SPSS 17.

2.3 Research procedure

2.3.1 Measurement of the Distance from the coastal lip and measurement of the cardinal direction

Establishing the cardinal directions is carried out on the beach, using a compass, and then points towards the southeast, calculating the distance between the nursery and the beach location as far as 37-41 m, measured using a measuring tape.

2.3.2 Cultivating *R. apiculata*

Select seeds *R. apiculata* seeds as many as 30 seeds with the same size take the seeds out of the polybag do it slowly to avoid damaging the roots of the seeds, plant the seeds with a 1 meter between each one and five seeds per plot. Then install placing stakes on the seedling's sides will prevent doesn't break when exposed to tides in the sea and can stick to every measurement from the start of the research period to the end.

2.3.3 Experimental design

R. apiculata was planted on Mangroves of Sembilan Island in the District of Pangkalan Susu in the Langkat. This research utilized a completely randomized design (CRD) with 6 replications.
Data gathering occurs after seeds in the field sown, during the resultant times:

a. 15th Day c. 45th Day
b. 30th Day d. 60th Day
e. 75th Day f. 90th Day

This research is experimental in nature using Completely Randomized Design (CRD). linear model in completely randomized design is:

$Yij = \mu + \alpha i + \sum ij$

Yij = Observations in the i-th and j-th treatments
μ = General mean importance of observations
αi = Effect of the i-th spacing factor; i= 1,2,……. t and j= 1,2,……r
∑ij = Effect of the repeated faults in the i-th and j-th.

2.3.4 Parameters of R. apiculata Seeds measured

In the present research project, For three months, observations were made every two weeks. Six times of data collection were done by keeping track of various parameters, namely: Seedling height (cm), Seedling diameter (mm), Number of leaves (strands), Plant wet weight (g), Plant dry weight (g), and Leaf area (mm)

2.3.5 Plant Growth Rate (LPT) analysis

The method used to calculate growth rate value is carried out by subtracting the value in the last observation data from the value at the first observation, so that the value in the result of the reduction will be the growth rate value for *R. apiculata* seedlings.

2.3.6 Data analysis

Analysis of Variance analyzed the data obtained from the results of the study, and if there were significantly different results ($P < 0.05$) between treatments, a Duncan Multiple Range Test (DMRT) was carried out with a significance level of 5% [5]

3. Results and Discussion

3.1 Seedling Height (cm)

The impact of seedling height variation show the treatment giving A1 (plant distance 37 m), A2 (plant distance 38 m), A3 (plant distance 39 m), A4 (plant distance 40 m) A5 (plant distance from the beach 41 m) had no obvious impact on the rise in seedling the R. apiculata's height but at each observation there was height growth of the seedlings. Table 1 shows the development of the typical height of seedlings.

Table 1. *R. apiculata* Seedlings' Average Height after 12 weeks

Treatment[1]	Repetition[2]						Total	Average
	I	II	III	IV	V	VI		
A1	38,18	47,38	35,72	36,43	63,43	49,77	270,91	44,23
A2	40,1	45,27	37,72	31,73	45	33,62	233,44	39,96
A3	36,78	49,32	47,53	32,58	50,13	40,08	256,42	43,27
A4	37,23	41,85	46,95	48,53	35	49,95	259,51	41,91
A5	45,87	44,98	43,97	34,43	37,83	47,48	254,56	41,42
Total	198,16	228,8	211,89	183,7	231,39	220,9	1274,84	210,79

[1]The treatment given is P0 (plant distance 43 m), P1 (plant distance 44 m), P2 (plant distance 45 m), P3 (plant distance 46 m), P4 (plant distance 47 m).

[2]The amount of observation time

Table 1 shows that in treatment A1 (plant distance 37 m) the highest seedling height growth value was obtained compared toother treatments are with a value of 270.91 cm with a typical of 44.23 cm. and treatment of A2 plant seeds (plant distance 38 meters) produces the lowest seedling height growth compared to treatment options is 233.44 cm with an average of 39.96. This can be caused by the survival ability of *R. apiculata* plants and the absorption of plant nutrients can cause this. This causes it to experience a slowdown in the increase in height the seeds of the plant. In the A1 treatment, the nutritional gain was higher so that. Soil nutrient content in treatment A1 was higher than treatment A2. Usually plants that experience a lack of light are taller than plants where there is sufficient light. This is in accordance with the journal [6] which said that the nature of sunlight can damage auxin. Auxin more on mangrove seed plants that receive little sunlight, as a result faster growth of plant stems.

Plant spacing is an important factor to provide adequate growth space optimal for increasing the height of *R. apiculta* seedlings. Considering the conclusions of study on observations of the first 15 days of the week, the growth of *R. apculata* seedlings is still low while on the 15 day observation the third week the better seedling growth. This is thought to be a result of the research site's environmental influences. location, according to [7], states that the. The environment can influence the growth of plant seed height.

3.2 Seedling diameter (mm)

The impact of seedling diameter variation show the treatment giving A1 (plant distance 37 m), A2 (plant distance 38 m), A3 (plant distance 39 m), A4 (plant distance 40 m) A5 (plant distance from the beach 41 m), had no discernible impact on the rise in the diameter of *R. apiculata* but at each finding there was a growth in seedlings diameter. Table 2 shows the result of the average growing diameter of seedlings.

Table 2. *R. apiculata* Seedlings' Average Diameter after 12 weeks

Treatment[1]	Repetition[2]						Total	Average
	I	II	III	IV	V	VI		
A1	10,32	11,00	14,83	8,78	16,83	11,37	73,13	12,35
A2	9,35	12,48	9,58	8,67	8,38	8,30	56,76	9,69
A3	9,90	15,07	10,20	7,82	13,63	8,52	65,14	11,32

A4	8,27	9,35	11,23	10,60	7,72	13,73	60,90	9,43
A5	11,47	9,23	9,07	8,03	8,72	10,77	57,29	9,30
Total	49,31	57,13	54,91	43,9	55,28	52,69	313,22	52,11

[1]The treatment given is P0 (plant distance 43 m), P1 (plant distance 44 m), P2 (plant distance 45 m), P3 (plant distance 46 m), P4 (plant distance 47 m).

[2]The amount of observation time

Table 2 shows that in treatment A1 (plant distance 37 meters) gave rise to the highest increased seed diameter when compared to treatment options with a total of 73.13 with an average diameter of 12.35. And the treatment on the provision of A2 (plant distance 38 meters) produces the lowest diameter increase value compared to the treatment others, namely 56.76 with an average of 9.69. This can be influenced by the seeds planted are from different parent plants, which results in difference in the size of the diameter of the seeds when planting in the field. This is in line with the journal [8] explained that the difference in seed diameter different because of differences in the nutrients obtained by plants in each plant planting hole, so the results have no significant effect.

The results above show that the responses received by each seedling to the spacing treatment can be different. Bar diameter difference in *R. apiculata* seedlings was not much different between one distance and the same planting distance Others can be caused by the size of the seeds used. Seed size has role in the availability of carbohydrates or food reserves in seedlings. So The bigger the size and age of the seed, the better the growth will be seeds. Follows the literature stating that growth or increase in diameter in trees is very important in forestry [9]. The growth of the annual circle in trees results from the development of the cambium and layers of meristematic tissue.

3.3 Number of leaves (strands)

A variation in the number of seedling leaves' results show the treatment giving A1 (plant distance 37 m), A2 (plant distance 38 m), A3 (plant distance 39 m), A4 (plant distance 40 m) A5 (plant distance from the beach 41 m), had No obvious impact on the growth in the number of seedling leaves *R. apiculata* but at each observance there was an increase in the number of leaves seeds.

Table 3 shows that the effect of spacing on the treatment A1 (plant distance 37 m) resulting in leaves having a higher value than before with other treatments equal to 35.99 with an average of 5.73 and treatment with A3 (plant distance 39 m) had the lowest increase in the number of leaves compared to other treatments with a total value of 29.33 with an average of 4.70. Based on the results of observations for 12 weeks, it shows that the development of. The number of leaves is affected by the spacing of the plants, the difference is not much different. Table 3 shows the results of the increase in the normal number of leaves on seedlings.

Table 3. *R. apiculata* Seeds' average leaf over 12 weeks

Treatment[1]	Repetition[2]						Total	Average
	I	II	III	IV	V	VI		
A1	26	36	38	36	36	44	216	36
A2	26	40	41	34	16	30	187	31,16
A3	16	42	18	26	39	35	176	29,33
A4	29	29	43	27	31	23	182	30,33
A5	50	36	32	30	27	40	215	35,83
Total	147	183	172	153	149	172	976	162,66

[1]The treatment given is P0 (plant distance 43 m), P1 (plant distance 44 m), P2 (plant distance 45 m), P3 (plant distance 46 m), P4 (plant distance 47 m).

[2]The amount of observation time

3.4 Plant Wet weight (g)

The treatment A1 is obvious from the plant wet weight variation data (plant distance 37 m), A2 (plant distance 38 m), A3 (plant distance planting distance from beach 39 m), A4 (planting distance from beach 40 m) A5 (planting distance from beach 41 m) had no discernible impact on the rise in wet weight of seedlings *R. apiculata*. Figure 1 shows the average wet weight yield on the *R. apiculata* seedlings' stems, roots, and leaves.

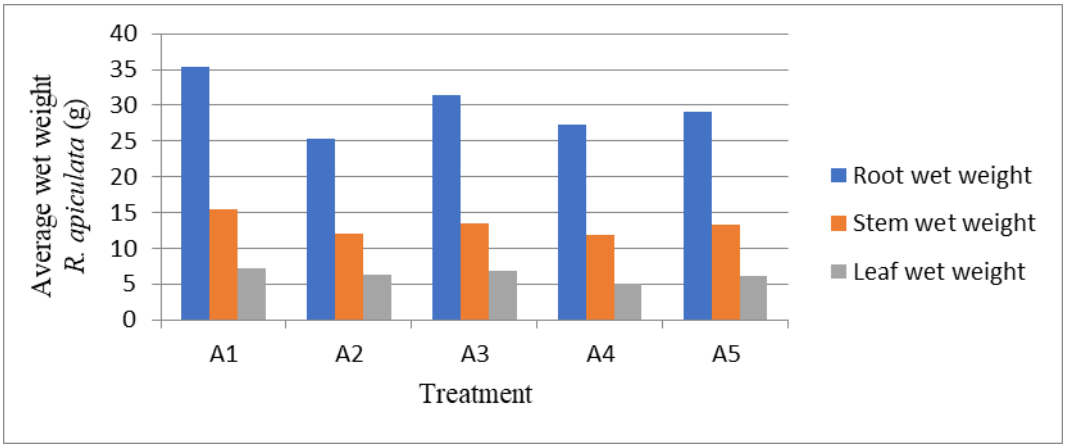

Figure 1. *R. apiculata* seedlings' average wet weight of 12 weeks

Figure 1 shows the roots' wet weight of *R. apiculata* seedlings the highest is in A3 (plant distance 39 m) of 35.28 g, weight wetness at the roots of seedlings of *R. apiculata*, the lowest was in treatment A2 (plant distance 38 m) of 25.31 g. then the seedling's wet weight stem The highest *R. apiculata* was in treatment A3 (plant distance 39 m) of 15.49 g, while the wet weight at the root the lowest seedlings of R. apiculata were in treatment A4 (plant distance 40 m) of 11.80 g. Additionally, the leaves' moist weight of the highest *R. apiculata* seedlings was in treatment A3 (planting distance from beach 39 m) of 7.11 g, and the wet weight of the roots of *R.apiculata* which was lowest in treatment A4 (plant distance 40 m) of 5.10 g.

The low yield of wet weight of plant roots can occur because of the place to grow which is less than optimal, but if the environmental conditions allow then Plant root systems that are not optimal can be caused by genetic factors plant this is in accordance with the statement of [10] which states that the root `system of plants is more influenced by genetic characteristics plants and soil conditions of growing media.

3.5 Plant Dry weight (gr)

The treatment A1 is shown by the variation of plant dry weight data. (plant distance 37 m), A2 (plant distance 38 m), A3 (plant distance planting distance from beach 39 m), A4 (planting distance from beach 40 m) A5 (planting distance from beach 41 m) had no discernible impact on the dry weight gain of *R.apiculata*. Figure 2 shows the average dry weight output of seedlings of *R. apiculata*'s stems, roots, and leaves.

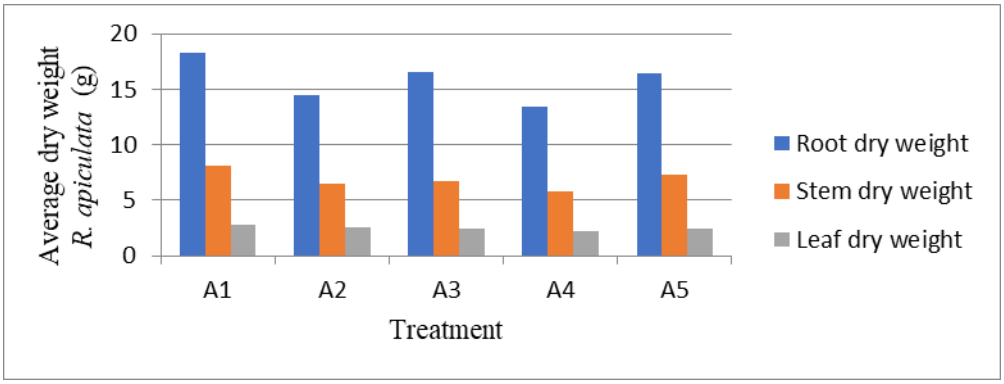

Figure 2. *R. apiculata* seedlings' average dry weight of 12 weeks

From conclusions of observations of the dry weight of the plant which can be seen in the picture 1, it was found that the highest root *R. apiculata* seedlings' dry weight was in the treatment A3 (plant distance 39 m) was 18.27 g, and the lowest root dry weight was in treatment A4 (plant distance 40 m) of 13.37 g. On dry weight The highest number of plants on *R. apiculata* stems was in treatment A3 (planting distance from beach 39 m) of 8.06 g, while the plant's on the *R. apiculata* stems the lowest was in treatment A4 (plant distance 40 m) of 5.82 g. Then the dry weight of the leaves on the highest *R. apiculata* plants was in Treatment A1 (plant distance 37 m) was 2.76 g, and the plant's dry weight was on *R. apiculata* leaves, the lowest was in treatment A4 (plant distance 40 m) of 2.17 g.

Dry weight shows plant's capacity to take elements or nutrients derived from the growth medium in supporting its growth. Plant dry matter has increased is related to plant metabolism or the presence of a more actual stage a development of plants in terms of the metabolic processes of the plant, such as photosynthesis. Therefore, continue to be large dry weight, will continue to be an effective process of photosynthesis. Increasing dry weight, the more productive an activity photosynthesis that occurs and The growth and increase of tissue cells is constant become large and fast, so that the development of plants for the better. In removing the water content is a process in plant material means plants' dry weight. Plants' capacity to absorb chemicals or nutrients, radiation from exposure to the sun, and the uptake of CO_2 and water affects plants' dry weight production [11]

3.6 Leaf area

The results of the wide variety of seedling leaf area show the treatment giving A1 (plant distance 37 m), A2 (plant distance 38 m), A3 (plant distance 39 m), A4 (plant distance 40 m) A5 (plant distance from the beach 41 m), had no discernible impact on the rise in leaf area of *R.apiculata* but at each finding there was an increase in the seedlings' leaf land area. From table 4, shows that the effect of plant spacing on treatment A1 (plant distance 37 m), A2 (plant distance 38 m), P3 (plant distance from the beach 39 m), A4 (plant distance 40 m), and A5 (plant distance 41 m) can increase the *R. apiculata* seedlings'. leaf area in treatment A5 (plant distance 37 m) the highest leaf area value from the treatment other 334.60 cm^2 with an average of 62.47 cm^2 and treatment on A4 (plant distance 40 m) had the lowest leaf area measurement. of other treatments that is equal to 118.29 cm^2 with an average of 18.83 cm^2. Table 4 shows the results of the expansion of the typical leaf area of seedlings.

Table 4. *R. apiculata* Seedlings' Average Leaf Area after 12 weeks

Treatment[1]	Repetition[2]						Total	Average
	I	II	III	IV	V	VI		
A1	21.25	25.21	22,31	17,85	29,92	20,37	136,91	23,31
A2	18.91	28.25	21,18	14,71	19,83	18,4	121,28	20,58
A3	18.03	30.12	18,87	16,90	23,5	18,21	125,63	21,48
A4	22.16	17.75	23,12	14,25	16,87	24,14	118,29	18,83
A5	22.50	26.21	25,56	18,33	19,75	22,25	334,60	62,47
Total	302.85	127.54	111.04	82.04	109.87	103.37	836.71	146.67

[1]The treatment given is P0 (plant distance 43 m), P1 (plant distance 44 m), P2 (plant distance 45 m), P3 (plant distance 46 m), P4 (plant distance 47 m).

[2]The amount of observation time

The environment's temperature and light intensity can have an impact on how much leaf area grows, The growth of leaves if the necessary changes are made light intensity is adequate and what leaf growth will be poor. Light is one of the components of photosynthesis, which is a process carried out by green plants need to grow [12]. Light, how long the radiation was applied for, and light intensity have an impact on the processes of respiration and transpiration as well as the physical makeup of plants.

3.7 Plant growth rate

According to the observations, the average Rate of *R. apiculata*'s growth with 6 replications over a period of three months can be seen. Only vegetative development of plants that cannot be undone or is irreversible to its former quality, height, diameter, and leaf number, is considered when calculating the score growth rate.

Table 5. *R. apiculata* seedling growth rate over a 12-week period

Observation parameters	Treatment					Unit
	A1	A2	A3	A4	A5	
Average height	32.5	39.7	5.4	22	32.4	cm/12 week
Average diameter	12	13.3	9.6	9.9	11.7	cm/12 week
Number of leaves	10	13	15	10	21	helai/12 week

Table 5 shows data on plant growth rates. Based on the results of the rate of growth seen in the given *R. apiculata.* The treatment group experienced the highest growth in seedling height. A2 (plant distance 38 m) and on the parameters of the highest stem diameter in seedlings *R. apiculata* was present in treatment A2 (plant distance 38 m) and on parameter of the The most leaves were discovered to be average number of leaves was in treatment A5 (plant distance 41 m) of 21 leaves for 12 observation week.

4. Conclusion

The results of the research on the spacing of the mangrove seedlings of *R. apiculata* which different during a 12-week observation period, no significant effect was found significant. The percentage of plant growth is 100%. Research results show that the ideal spacing for use in planting or rehabilitating mangroves on *R. apiculata* seedlings is at treatment A1 (plant distance 37 m). Considering the results, the study revealed that the highest average value of height was at A1 (plant distance 37m) with value 44.23 cm, the highest average of diameter was at A1 (plant distance 37m) with value 12.35 mm and the highest growth of number of leaf was at A1 (plant distance) with value 36 leaves. Observation data on measurement of diameter, height, and number of leaves, that the spacing treatment can increase the growth of young *R. apiculata* plants. However, from the Anova's results test Plant spacing treatment on *R. apiculata* plants had no discernible impact on the growth of stem height, diameter and number of leaves of *R. apiculata* seeds during the 12-week study (Sig>0.05).

Acknowledgments

According to the guidelines Inquiry regarding University of North Sumatra Talenta Contract Number : 6789/UN5.1.R/PPM/2021, to the ivestigate Institut the College of North Sumatra, 16 June 2021.

References

1. Sandilyan, S., & Kathiresan K. “Mangrove conservation: a global perspective”. Biodivers Conserv 21, 3523-3542 (2012).
2. Katili, A. S, Ibrahim M., Zakaria, Z. 2017. “Degradation level of mangrove forest and its reduction strategy in Tabongo Village, Boalemo District, Gorontalo Province, Indonesia”. Asian J For 1(1), 18-22 (2017)
3. Kusmana, C., Istomo, Cahyo, W., Sri Wilarso, B. R., Iskandar, Z. S, Tatang T, and Sukristijono ,S. “Manual of Mangrove Silvikulture in Indonesia. The rehabilitation mangrove forest and coastal area damaged by tsunami in Aceh project”. Directorate General of Land Rehabilitation and Social Forestry, Ministry of Forestry, Jakarta and Korea International Cooperation Agency (KOICA), Seoul (2008)
4. Steel, P. G. D. & J. H. Torrie. “Statistical Principles and Procedures a Geometric Approach”. B. Sumantri translation. PT Gramedia. Jakarta (1991)
5. Marjenah. “The effect of differences in shade in nurseries on growth and morphological responses of two types of meranti seedlings”. *Scientific Journal of Forestry “Rimba Kalimantan”* 6(2) (2001)
6. Herdiana, A.R, Rusli and P.B.P, Panjaitan. “The Effect of Plant Distance on Percentage of Life and Growth (*R.stylosa*, Griff) *on Harapan Island, Seribu Islands National Park Center”. Nusa Sylva Journal*. 8 (1) June 9-15 (2008)
7. Marsono, D. S., Sastrosumatro, H.B., Soewarno. “Increment and distribution of tree diameter in standing stands of TPI after maintenance at PT. Jambi STUD”. *Forestry Bulletin*. 6(1), 37-348 (1990)
8. Syah, C. “Growth of Mangrove Plants (*Rhizophora apiculata*) on Mangrove Restoration Land in Angke Kapuk Protected Forest, DKI Jakarta Province”. Bogor Agricultural University Postgraduate Program (2011)
9. Gardner, Franklin, P., Pearce, R.B and Mitchel, R.L. “Physiology of Cultivated Plants”. Ubhara Press. Jakarta (1991)

10. Sitompul, S.M., & Guritno, B. “Analysis of plant growth”. Yogyakarta (ID): Gadjah Mada University Press. 412 (1995)
11. Robertson, A. I. “Leaf-burying crabs: their influence on energy flow and export from mixed mangrove forests (*Rhizophora* sp.) in northeastern Australia”. *Journal of experimental marine biology and ecology*, 102(2-3), 237-248 (1986)