The Growth of Oil Palm Seeds (*Elaeis guineensis* Jacq.) at Main Nursery through Giving Biofertilizers Consortium of Cellulolytic Bacteria

Hapsoh, Isna Rahma Dini*, Desita Salbiah, and Randizki Syahputra

Department of Agrotechnology, Faculty of Agriculture, Universitas Riau
Riau Indonesia

**Corresponding author's email: isnarahmadini19 [AT] gmail.com*

ABSTRACT—*Oil palm (Elaeis guineensis Jacq.) plays a very strategic role in the economy in Indonesia. Plants that have reached economic age of 25 years need to be rejuvenated by replacing quality oil palm seeds. Quality seeds are obtained through proper fertilization. One of the efforts that can be done is to utilize biofertilizers based on cellulolytic bacteria and combined with organic liquid waste. This study aims to obtain the best formulation of organic liquid waste-based cellulolytic bacteria for the growth of oil palm seeds (Elaeis guineensis Jacq.) in the main nursery. This study used a Complete Randomized Design consisting of 12 treatments namely (20, 30, 40) ml of rice washing water biofertilizer, (20, 30, 40) ml of coconut water biofertilizer, (20, 30, 40) ml of tofu waste biofertilizer, (20,30,40) ml of liquid waste of oil palm biofertilizer. The results showed that the provision of biofertilizers based on all organic liquid waste with various doses does not affect all the observation parameters of oil palm growth. However, the use of biofertilizers with various organic materials can be applied to oil palm plants to reduce the use of inorganic fertilizers.*

Keywords— Oil palm seeds, organic liquid waste, cellulolytic bacteria

---

1. INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) plays a very strategic role in the Indonesian economy [1], namely as a producer of edied oil, industry, and biofuels (biodiesel). Oil palm is derived from the processing of palm fruit grown in several regions in Indonesia. Riau Province is one of the provinces in Indonesia that has a large oil palm plantation. [1] shows that in 2017 the area of oil palm plants reached 2,776,500 ha, out of the total land area that is mostly already undergoing a phase of replanting because the plant has reached the ecomonical age of 25 years. According to [2], the government will begin the replanting of 25,423 ha of people's oil palm plantations for Riau Province in 2018. The replanting activities require quality oil palm seeds in order to be used as a substitute for crops that are no longer productive. Quality seeds become the main factor that affects the productivity of plants. This is in line with [3] stated that the real investment for commercial plantations is in the plant material to be planted in the form of seeds or seeds, because it is a source of profit in the company.

One of the efforts that can be done in improving the quality of oil palm seeds is by utilizing bioactivator cellulolytic microorganisms combined with liquid organic waste, so that it is expected to increase the growth of oil palm seeds. Biofertilizers are fertilizers containing living microorganisms and it is expected that their activities will affect soil ecosystems and produce a beneficial substance for plants. Biofertilizers play a role in influencing the availability of macro and micro nutrients, nutrient efficiency, enzyme system performance, increasing metabolism, growth, and crop yields. The provision of biofertilizers by using microorganism bioactivators can accelerate decomposition and increase land productivity so that agricultural products will increase both the quality and the number of crops [4].

Cellulolytic bacteria is one of the microorganisms as a bioactivator in biofertilizers that can produce cellulase enzymes to decompose cellulose into derivative compounds such as glucose, maltose and so on [5]. Cellulolithic bacteria is a heterotrophic bacteria that belongs to the saprophyte group that has the ability to hydrolyze cellulose into glucose monomers. Saprophyte bacteria can take advantage of dead plant remains to meet cell needs [6]. According to [4], the decomposition process of organic matter by a collection of bacteria that interact synergistically in the form of consortiums can accelerate the decomposition process. In this study used a consortium of six potential cellulolytic bacterial isolates consisting of two bacterial isolates from oil palm empty fruit bunches *Proteus mirabilis* OPEFB3 and *Proteus mirabilis* OPEFB7, two isolates of *Bacillus cereus* JP6 genus and *Bacillus cereus* JP7, and two acacia litter isolates genus *Providencia vermicola* SA1 and *Bacillus cereus* SA6 [7]. This is based on the ability of the six isolates in producing the enzyme selulase seen from the high cellulolytic index in qualitative tests in previous research. The six isolates are expected to be bioactivators of biofertilizers from some of the wastes used so as to provide nutrients for the growth of oil palm seeds.

The use of cellulolytic bacteria as biofertilizers is certainly needed organic matter to support its growth. The organic material can be rice laundry waste, tofu liquid waste, coconut water waste and oil palm liquid waste. This waste can also be used as an organic fertilizer that can improve soil fertility, increase plant growth and production and contain compounds or elements that can be used as a source of nutrients for microbes. Therefore, the aim this research is to influence the formulation of biofertilizers consortium of cellulolytic bacteria based on organic liquid waste on the growth of oil palm seeds (*Elaeis guineensis* Jacq.) in the main nursery.

2. MATERIALS AND METHODS

This research has been conducted in the Experimental Garden of the Faculty of Agriculture, Riau University, Pekanbaru, Indonesia. Some of the materials used in the study are marihat oil palm seeds (DxP) Tenera varieties aged 3 months, rice washing water, waste water tofu, liquid waste oil palmplant, coconut water waste, ultisol soil materials, cellulolytic microorganisms, alcohol 70%, aquades, so that nutrients, molasses, water, (Urea fertilizer, SP-36 and KCl with a dose of half of the recommendations), insecticides, and fungicides.

This study was conducted in an experiment compiled according to the Complete Randomized Design (RAL) non factorial consisting of 12 treatments with 3 tests so that there are 36 experimental units. Each unit consists of 3 plants. The data obtained from this study was systematically analyzed with a variety of analyses, after which further tests were carried out with Duncan Multiple Range Test (DMRT) at a rate of 5%. the treatment in this study consisted of the use of several doses of biofertilizers at the level of (20, 30, 40) ml of biofertilizer rice washing water, (20, 30, 40) ml biofertilizer of coconut water, (20, 30, 40) ml of biofertilizer waste tofu water, (20,30,40) ml of liquid waste biofertilizer of the oil palm. Biofertilizers based on all organic waste was given 3 times.

3. RESULTS AND DISCUSSION

3.1 Physiological Responses

The results of various analyses showed that the provision of biofertilizers consortium of cellulolytic bacteria based on organic liquid waste had an unreal effect on the rate of photosynthesis, the amount of chlorophyll, the rate of transpiration, the delivery of stomata and the concentration of CO_2. Further test results of physiological response with DMRT test at a rate of 5% can be seen in Table 1.

Table 1: Physiological response of oil palm seeds aged 3 months with the provision of biofertilizers consortium of cellulolytic bacteria based on organic liquid waste

Treatments	Rate of Photo synthesis (µmol CO_2 m^{-2} s^{-1})	Number of Chloro phyll (µmol m^{-2})	Stomata's Delivery Power (mol H_2O m^{-2} s^{-1})	Trans piration Rate (mmol H_2O m^{-2} s^{-1})	CO_2 concentra tion (µmol CO_2 mol^{-1})
20 ml rice washing water biofertilizer	23,03a	35,03a	0,52a	1,14a	1,88a
30 ml rice washing water biofertilizer	22,26a	38,40a	0,62a	1,30a	1,64a
40 ml rice washing water biofertilizer	18,63a	34,16a	0,51a	1,10a	2,31a
20 ml coconut water biofertilizer	20,06a	30,20a	0,60a	1,34a	1,70a
30 ml coconut water biofertilizer	18,65a	32,73a	0,63a	1,40a	1,87a
40 ml coconut water biofertilizer	22,58a	32,33a	0,65a	1,35a	1,85a
20 ml waste water tofu biofertilizer	19,44a	44,86a	0,62a	1,32a	1,83a
30 ml waste water tofu biofertilizer	20,41a	43,70a	0,66a	1,41a	1,92a
40 ml waste water tofu biofertilizer	21,48a	32,26a	0,59a	1,28a	1,63a
20 ml liquid waste of oil palm biofertilizer	21,61a	29,90a	0,68a	1,55a	1,93a
30 ml liquid waste of oil palm biofertilizer	23,13a	36,06a	0,56a	1,20a	1,93a
40 ml liquid waste of oil palm biofertilizer	25,54a	37,40a	0,62a	1,27a	1,76a

Notes: The numbers followed by the same lowercase letter are not significantly different according to the DMRT test at the 5% level.

Table 1 shows that all the application of biofertilizer by consortium of cellulolytic bacteria based on organic liquid waste with several doses gave insignificantly different results. This is presumably because the consortium of cellulolytic bacteria has not been optimal in degrading organic matter into nutrients that can be needed by plants. This is also seen in

[8] which reported that the provision of some biofertilizer waste does not have an effect on some observation parameters on red chili. Based on the results of analysis of biofertilizers obtained pH and nutrients N, P and K can be seen in Table 2.

Table 2: Results of biofertilizers analysis

No	Biofertilizers	pH	N (%)	P (%)	K (%)
1.	Rice washing water biofertilizer	4,85	0,04	0,028	0,10
2.	Coconut water biofertilizer	5,02	0,04	0,023	0,23
3.	Waste water tofubiofertilizer	5,02	0,04	0,021	0,09
4.	Liquid waste of oil palm biofertilizer	4,61	0,02	0,017	0,12

Based on the analysis of biological fertilizers (Table 2), it can be seen that the N content in biological fertilizers is still very low and does not differ in some of the liquid waste used. This is why the physiological parameters produced are almost the same for each biological fertilizer with various doses given. Other than that, the growth of bacteria in biofertilizers in some organic materials is suspected to be not optimal so it has not been able to function to provide nutrients for plants. [9] stated that biofertilizers have not been able to increase soil fertility because the bacteria contained in the concentration have not been able to work optimally in overhauling and facilitating the intake of nutrients needed by plants. This causes photosynthesis rate, stomata delivery power, CO_2 concentration, transpiration rate, and chlorophyll amount of oil palm seeds to give different results not real to the provision of biofertilizer consortium of cellulolytic bacteria based on organic liquid waste.

The rate of photosynthesis is influenced by elements N, P, and K. According to [10], element N acts as the constituent of leaf tissue, element P plays a role in photosynthesis reactions, while element K acts as an enzyme activator in the process of photosynthesis. In addition to the availability of nutrients, optimum watering of oil palm can affect the physiological response of oil palm seedlings. [11] stated that H_2O in plant physiology process is a very important material in the process of photosynthesis and very influential on the presence of CO_2 in plant leaves. [12] added that more water in plants can cause turgor pressure to increase. Increased turgor pressure is able to encourage the opening process of stomata in plants, so that the rate of photosynthesis increases. [13] reported taht the rate of photosynthesis in oil palm plants can increase with the increasing availability of groundwater.

In addition to water availability, potassium elements play a major role in increasing the rate of transpiration. According to [12], element K is a dissolved material in the cell plays a role in spurring the entry of water into the guard cell that causes the opening of stomata resulting in an increase in the rate of transpiration. So if the element of potassium in an optimum state will affect the opening of the stomata so that the rate of transpiration is not too high. [14] added that if K is sufficient, it can regulate various enzyme activities, regulate the movement of stomata and accelerate the growth of plant tissues.

Increased amounts of chlorophyll and photosynthesis activity are also influenced by the synthesis of amino acids in plants. According to [15], amino acids can also regulate stomata optimally so that they can control plant transpiration and increase the reduction of carbon dioxide to be converted into carbohydrates. The low nutrient in all formulations of liquid biofertilizers resulted in inhibition of the synthesis of amino acids and proteins so that in the end it could not improve the physiological response of oil palm seeds.

3.2 Growth Response

The results of variety analysis showed that the provision of biofertilizer consortium of cellulolytic bacteria based on organic liquid waste has no real effect on the height of seedlings, number of leaves, diameter of stem, dry weight of seedlings, and root header ratio. Further test results of growth response with DMRT test at a rate of 5% can be seen in Table 3.

Table 3 shows that all biofertilizers are given to a consortium of organic liquid waste-based cellulolytic bacteria with multiple doses giving different results is not real. In the average parameter of high growth of oil palm seeds, it ranges from 26.06-29.87 cm. The average number of leaves ranges from 5.44-6.66 strands, and the average diameter of the stem ranging from 1.56-1.95 cm. The high growth of seedlings, the number of leaves, and the diameter of the stems of oil palm seedlings is not in accordance with the standards of growth of oil palm seedlings marihat age of 6 months. This is due to the content of macro nutrients in all biofertilizers consortium of cellulolytic bacteria based on organic liquid waste is relatively low with concentration is almost the same. One of them is that the N element contained in this biological fertilizer is only 0.2-0.4%, so it is not able to support the growth of oil palm seedlings. Whereas the N element is a very important element in supporting both physiological processes, growth and yield in oil palm plants [16]. Apart from the low N content, the P element contained in this biological fertilizer is also relatively low so that it is not able to support the growth of oil palm seedlings. [17] that the element P is an element that plays a role in increasing the number of leaves and leaf chlorophyll content [18] added that organic fertilizers contain complete nutrients both macro and micro but the amount is relatively low.

Table 3: The growth response of oil palm seeds aged 3 months with the provision of biofertilizers consortium of cellulolytic bacteria based on organic liquid waste

Treatments	Height of seedlings (cm)	Number of leaves (strands)	Trunk diameter (cm)	Dry weight of seedlings (g)	Root canopy ratio
20 ml rice washing water biofertilizer	26,06a	5,77a	1,66a	17,96a	4,52a
30 ml rice washing water biofertilizer	26,31a	5,78a	1,74a	22,43a	4,29a
40 ml rice washing water biofertilizer	26,83a	5,66a	1,56a	17,40a	3,73a
20 ml coconut water biofertilizer	26,37a	5,66a	1,65a	19,70a	3,11a
30 ml coconut water biofertilizer	26,72a	5,89a	1,68a	19,49a	4,44a
40 ml coconut water biofertilizer	27,15a	6,33a	1,68a	20,90a	4,46aa
20 ml waste water tofu biofertilizer	26,92a	6,66a	1,83a	21,69a	4,37a
30 ml waste water tofu biofertilizer	29,87a	6,44a	1,58a	21,01a	3,74a
40 ml waste water tofu biofertilizer	26,82a	6,00a	1,64a	19,27a	4,08a
20 ml liquid waste of oil palm biofertilizer	26,50a	5,78a	1,95a	20,62a	4,73a
30 ml liquid waste of oil palm biofertilizer	27,15a	6,66a	1,65a	19,93a	4,25a
40 ml liquid waste of oil palm biofertilizer	28,65a	5,44a	1,71a	17,17	3,67a

Notes: The numbers followed by the same lowercase letter are not significantly different according to the DMRT test at the 5% level.

According to [19], if the solution of biofertilizer is applied to plants or soil surface, then the existing microbes are not necessarily able to live and develop. This is due to unsaniable environmental conditions, including ingestible food, excessively high air temperature, poor humidity, excess oxygen and no shade.

The less optimal growth of microbes will affect the process of degradation of organic matter. One of the growth factors of microbes is pH where based on the results of measurement of biofertilizer pH in this study ranges from 4.61-5.02. The pH is relatively low for bacterial development so it will affect the number of bacteria living and accelerate the decomposition process. According to [20], the optimum pH for bacterial growth is about 6.5-7.5 or neutral pH where in the pH bacteria can produce secondary metabolites. Secondary metabolite production of microorganisms is generally produced at an optimum pH state that is optimal for microbes.

In addition to pH, another growth factor that can increase the growth of cellulolytic bacteria is the presence of oxygen. Based on the results of [7], bacteria used in biofertilizers are classified into the group of facultative aerobic bacteria. According to [21], facultative aerobics is a group of bacteria that are able to grow well in cultures that contain oxygen but will convert their metabolic processes into anaerobic metabolism when oxygen is not there. At the time of making biofertilizers, the condition that occurs is anaerobic so that bacteria do not grow optimally because oxygen is not available. This is thought to cause bacteria to not be able to produce enzymes optimally.

Fertilizer used is a biofertilizer so it is expected that there are bacteria that continue to grow can produce compounds needed by plants such as phytohormones. According [22], phytohormones are synthesized organic substances certain organs and can be translocated to other parts of the plant. In addition to being produced by plants, some soil bacteria and fungi are also capable of producing phytohormones. Bacteria produce phytohormones in the form of IAA. In this study using *Bacillus cereus* that can produce hormone IAA (Indole Acetic Acid). According to [23], the hormone Indole Acetic Acid (IAA) is a type of auksin hormone that plays a role in plant vegetative growth. IAA hormones have a role in plant physiological processes such as spur cell division, cell enlargement regulation, and stimulate the absorption of water and nutrients. The inability of bacteria to produce IAA or other metabolite products is strongly influenced by the not optimal growth of bacteria in biofertilizers and in the soil. [24] stated that in general microbes can grow and develop on moist, fertile soils. If the population of microbes in the soil is too small, as a result the metabolites of bacteria are not produced optimally so that it affects the lack of nutrients contained in the soil.

In addition to the presence of microbes in biofertilizers, the conditions and good soil properties for plants also greatly affect the vegetative growth of plants. This is very important for plants to be able to use nutrients in the soil to the maximum [25]. One of the most important elements for vegetative growth of plants is element N [26]. In line with the opinion of [27], which states that element N is the main nutrient for plants, especially vegetative formation and growth that is able to stimulate the growth of roots, stems, leaves, and high growth of plants. Based on the results of the analysis, the content of N in the soil has a low value of 0.19%. The low N element in the soil causes the growth response of oil palm seeds can not increase. Some research shows that the growth of oil palm seedlings tends to increase if given the empty fruit bunch of oil palm compost [28] as well as other compost and vermicompost [29]. This is due to the content of haranya elements is sufficient for the growth of oil palm seedlings. However, the use of biological fertilizer can still be an opportunity to support the growth of oil palm seedlings.

4. CONCLUSION

The provision of biofertilizers based on all organic liquid waste (rice water waste, coconut water waste, tofu liquid waste, and oil palm waste) with various doses does not affect all the observation parameters of oil palm growth. However, the use of biofertilizers with various organic materials can be applied to oil palm plants to reduce the use of inorganic fertilizers.

5. ACKNOWLEDGEMENT

Thanks to KEMRISTEKDIKTI through the Basic Research grant (Contract number: 732/UN.19.5.1.3/PT 01.03/2019) for funding this research. This research is part of the Basic Research grant.

6. REFERENCES

[1] BPS-Statistics Indonesia, Indonesian Oil Palm Statistics 2017, BPS-Statistics Indonesia, Jakarta, 2018.
[2] Plantation Fund Management Agency, https://www.bpdp.or.id/id/, Accessed October 10, 2018, 2017.
[3] Pahan, I, "Panduan Lengkap Kelapa Sawit", Penebar Swadaya, Jakarta, 2007.
[4] Simanungkalit, R. D. M, "Aplikasi pupuk hayati dan pupuk kimia: suatu pendekatan terpadu" Buletin Agro-Bio vol. 4, no. 2, pp. 56-61, 2001.
[5] Saraswati, R, Sumarno, "Pemanfaatan mikroba penyubur tanah sebagai komponen teknologi pertanian", Jurnal Iptek Tanaman Pangan vol. 3, no. 1, pp. 41-58, 2008.
[6] Deviani, S. Yuli H, Christine J, "Isolasi dan uji aktivitas bakteri selulolitik dari air muara daerah aliran sungai siak wilayah Kabupaten Bengkalis", Jurnal Online Mahasiswa vol. 1 no. 2, pp. 78-88, 2014.
[7] Hapsoh, Wawan, I. R. Dini, "Aplikasi Pupuk Organik dengan Teknologi Mikrob Mendukung Pertanian Terpadu Berkelanjutan Berbasis Tanaman Pangan pada Lahan Gambut". Laporan Akhir Tahun Hibah Kompetensi LPPM Universitas Riau, Pekanbaru 2016.
[8] Hapsoh, IR Dini, D Salbiah, Kusmiati, "Growth and pepper yields (Capsicum annum L.) by giving formulation a biological fertilizer of cellulolytic bacteria based on organic liquid waste" in J of Phys: Conf. Ser. no 1351 012097, 2019.
[9] Wahyuningratri, A., N. Aini., S. Heddy, "Pengaruh konsentrasi dan frekuensi pemberian pupuk hayati terhadap pertumbuhan dan hasil cabai besar (Capsicum annum L.)", Jurnal Produksi Tanaman vol. 5 no. 1, pp. 84-91, 2017.
[10] Singh, S. K, V. R. Reddy, "Combined effects of phosphorus nutrition and elevated carbon dioxide concentration on chlorophyll fluorescence, photosynthesis, and nutrient efficiency of cotton", Journal Plant Nutr Soil Sci. vol. 177, pp. 892-902, 2014.
[11] Nio, S. A, "Biomasa dan kandungan klorofil total daun jahe (Zingiber officinale L.) yang mengalami cekaman kekeringan", Jurnal Ilmiah sains vol 11, no.1, pp. 190-195, 2011.
[12] Lakitan, "Dasar-dasar Fisiologi Tumbuhan", PT. Raja Grafindo Persada, Jakarta, 2011.
[13] Darmawan, "Aktivitas fisiologi kelapa sawit belum menghasilkan melalui pemberian nitrogen pada dua tingkat ketersediaan air tanah", Jurnal Agrivigor vol. 6, no. 1, pp. 41-48, 2006.
[14] Rohyanti, M., N. Hayani, "Pengaruh pemberian bokashi jerami padi terhadap pertumbuhan vegetatif tanaman tomat (Lycopersicum esculentum Mill) di tanah podsolik merah kuning", Jurnal Wahana-Bio vol. 6, pp. 26-29, 2011.
[15] Yasin, S.M, "Growth Response of Rice (Oryza Sativa L.) on Various Concentration of Liquid Organic Fertilizer of Gamal Leaves", Jurnal Galung Tropika vol. 5, no. 1, pp. 20-27, 2016.
[16] Purwanto, O. D, Sudradjat, Supijatno, "Determination of Nitrogen Fertilizer Requirement for Four-Year-Old Oil Palm" Asian Journal of Applied Sciences vol. 5, no. 6, pp. 1108-1115, 2017.
[17] Faustina, E., Sudradjat, Supijatno, "Optimization of Nitrogen and Phosphorus Fertilizer on Two Years Old of Oil Palm(*Elaeis guineensis* Jacq.)", Asian Journal of Applied Sciences (ISSN: 2321 – 0893) Vol. 3, no. 3, 2015.
[18] Hapsari, A.Y dan M. Chalimah, "Kualitas dan Kuantitas Kandungan Pupuk Organik Limbah Serasah dengan Inokulum Kotoran Sapi secara Semi Anaerob". Naskah (Tidak dipublikasikan). Universitas Muhammadiyah Surakarta. Surakarta, 2013.
[19] Asroh, A. "Pengaruh takaran pupuk kandang dan interval pemberian pupuk hayati terhadap pertumbuhan dan hasil tanaman jagung manis (Zea mays Saccharata Linn)" Jurnal Agronobis vol. 2, no. 4, pp 144-148, 2010.
[20] Ningtyas, Y.R., Y. Evy dan R. Anna, "Optimization of temperature and ph of phosphate solubilizing bacteria growth media from isolate of thermophilic bacteria". Jurnal Prodi Biologi vol. 6, no. 7, pp. 423-430, 2017.
[21] Jeffrey, C., Pommerville. "Microbial Growth and Nutrition (Chapter 5)". Jones & Bartlett Learning Publisher, Sudbury MA. 2010.
[22] Baca, B.E. dan C. Elmerich, "Microbial production of plant hormones". In C. Elmerich and W.E. Newton (eds.), Associative and Endophytic Nitrogen-fixing Bacteria and Cyanobacterial Associations. Kluwer Academic Publishers. Printed in the Netherlands. 2003.
[23] Harahap, F, "Fisiologi Tumbuhan : Suatu Pengantar". Unimed Press. Medan. 2012.

[24] Wardhani, S., K.I. Purwani., dan W. Anugerahani, "Pengaruh aplikasi pupuk hayati terhadap pertumbuhan dan produktivitas tanaman cabai rawit (Capsicum frutescens L.) varietas bhaskara di PT petrokimia Gresik", Jurnal sains dan seni pomits vol. 2, no. 1, pp. 1-5, 2014.

[25] Aliyenah., A, Napoleon, dan Bambang. Y, "Pemanfaatan limbah cair industri tahu sebagai pupuk cair organik terhadap pertumbuhan dan produksi tanaman kangkung darat (Ipomoea reptans poir)", Jurnal Penelitian Sains vol. 17, no. 2, pp. 102-110, 2015.

[26] Munawar, A, "Kesuburan Tanah dan Nutrisi Tanaman", Penebar Swadaya, Jakarta. 2011.

[27] Napitulu, D, L. Winarno, "Pengaruh pemberian pupuk N dan K terhadap pertumbuhan dan produksi kacang tanah" Jurnal Hortikultura vol. 20, no. 1, pp. 27-35, 2010.

[28] Hapsoh, I. R. Dini, Wawan, A.H Sianipar, "The Growth of Oil Palm Seedlings using a Combination Medium of Organic Oil Palm Empty Fruit Bunch and NPK Fertilizer at Main Nursery", Journal of Tropical Soils vol. 25, no.2, pp. 61-69, 2020.

[29] Surtanto, T., A. Wachjar, Supijatno, "The Growth of Oil Palm (*Elaeis guineensis* Jacq.) Seedlings at Various Media and Containers in Double Stage Nursery", vol. 3, no. 5, pp. 664-671, 2015.