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Optimizing Growth of *Parkia speciosa* Hassk Seedlings: The Synergistic Impact of Chicken Manure Briquette Dosage and Watering Intervals for Supporting Agroforestry Practices

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ABSTRACT

Petai (*Parkia speciosa* Hassk) is a multi-purpose tree species (MPTS) that offers a sustainable solution for perennial cultivation in the Besitang District, within the Gunung Leuser National Park (GLNP) area, particularly in regions currently dominated by oil palm plantations. This study aims to obtain the dose of chicken manure briquettes and watering interval that produce the best growth of Petai seedlings. This study used a Factorial Completely Randomised Design (F-CRD) with observation parameters of height, diameter, number of leaves, shoot fresh weight, root fresh weight and shoot and root dry weight. The results showed that the interaction of manure briquette dose treatment and watering interval showed significant results on height, diameter, number of leaves, shoot fresh weight, shoot dry weight, and root dry weight but no significant effect found on the root fresh weight of Petai plants. The treatment 1 kg briquettes and watering every three days gave the best results in the parameters of height (15.57 cm), diameter increase (0.34 cm), number of leaves (103 strands), shoot fresh weight (39.96 grams), shoot dry weight (33.24 grams) and root dry weight (21.98 grams). Therefore, it is recommended to apply organic chicken manure briquette fertilizer at a dose of 1kg and watering frequency of once every three days for the preparation of Petai seedlings to planting in Besitang District.

Keyword: Besitang, MPTS, Organic Fertiliser Briquettes, *Parkia speciosa* Hassk, Watering Interval

1. Introduction

Oil palm planting is the main source of income for the people living near Gunung Leuser National Park (GLNP), particularly in the Besitang District. The Besitang District's land use data from 2024 shows that there are 18,429 hectares of plantation crops, including 4,580 hectares of oil palm plantations, and just 2,247 hectares of community forests or tree-planted land. There is concern that the GLNP area's biodiversity may be lost as a result of this oil palm plantation. The monoculture of oil palm land causes medicinal plants, fruits, and vegetables to vanish, and the number of animals also declines [1].

Multipurpose Tree Species (MPTS) can be a solution for perennial crop cultivation in Besitang District, which has been widely planted with oil palm. Petai (*Parkia speciosa* Hassk) is recommended as an alternative agroforestry plant for lowlands [2]. Planting Petai in the area requires the addition of organic matter to maintain nutrient balance, as the soil type in the area is dominated by Inceptisols and Oxisols. The fertility status of

Inceptisol soil on oil palm land is low, with low cation exchange capacity (CEC) and organic carbon content, and very low total P and total K [3].

The addition of organic fertilizer is key to soil fertility in dryland. Organic fertilizer acts as a nutrient buffer for plants and can restore soil fertility by improving soil properties, both physical, chemical, and biological [4]. One source of organic matter that can be used as organic fertilizer for Petai cultivation is chicken manure in the form of briquettes. Chicken manure provides nutrients that can help plant seedlings grow, because chicken manure contains higher nutrients than other types of manure [5]. The macronutrient and micronutrient content in chicken manure consists of N 1%, P 0.80%, K 0.40%, and water content 55%, which can increase soil nutrient supply and water retention [6]. Applying fertilizer in briquette form can increase soil moisture because the pores contained in the briquettes can retain water, thus prolonging the process of water utilization by plants [7]. Good briquette material uses a ratio of chicken manure to tapioca flour of 2:1.5 [8]. The optimal average dose of briquettes or organic chicken manure fertilizer for the growth of forestry seedlings ranges from 1.0–2.0 briquettes per seedling [9;10]. Excessive application of organic fertilizer has shown a 35% higher seedling mortality rate in mahogany, but applying 2 kg of organic fertilizer resulted in better growth [11].

Plants need water for their survival. The appropriate water needs can be determined by the watering interval, which has a significant impact on the growth of breadfruit plants in terms of height (cm) and the moisture content percentage of the lower parts of the plant [12]. Watering little but often and regularly allows water to always be present and available to the plants [13]. Watering once a day to every 2-3 days is generally recommended for forest seedling nurseries, with variations depending on the type of plant and environmental conditions. For plants that are more sensitive to water, more frequent watering (daily) may be necessary, while those that are more drought-tolerant can use less frequent watering [14;15;16;17;18]. Therefore, this research is expected to provide information on the response of Petai seedlings to different doses of manure briquettes with varying watering intervals.

2. Research Method

The research was conducted at the Greenhouse of the Faculty of Agriculture, University of Sumatera Utara. The study was carried out from February to June 2021. The Petai seedlings used were 3 months old, and the growing medium used was soil sourced from Besitang. The manure briquette materials were chicken manure and tapioca flour. This research used several equipment, namely a polybag size 30x30 cm, a bucket, a ruler, a sowing tub, plant scissors, a caliper, an analytical balance, an oven, and a camera.

The research design used was a Factorial Randomised Complete Block Design (F-CRD) with two treatment factors, namely the dose of manure briquettes (0 kg, 0.5 kg, 1 kg, 1.5 kg, and 2 kg) and the watering time interval (once a day, once every 3 days, once every 5 days and once every 7 days) with three replications. Watering done until the soil is saturated with water. There were twenty combinations of treatment, which are: P0A1 (0 kg and once a day), P0A2 (0 kg and once every 3 days), P0A3 (0 kg and once every 5 days), P0A4 (0 kg and one every 7 days), P1A1 (0.5 kg and once a day), P1A2 (0.5 kg and once every 3 days), P1A3 (0.5 kg and once every 5 days), P1A4 (0.5 kg and one every 7 days), P2A1 (1 kg and once a day), P2A2 (1 kg and once every 3 days), P2A3 (1 kg and once every 5 days), P2A4 (1 kg and one every 7 days), P3A1 (1.5 kg and once a day), P3A2 (1.5 kg and once every 3 days), P3A3 (1.5 kg and once every 5 days), P3A4 (1.5 kg and one every 7 days), P4A1 (2 kg and once a day), P4A2 (2 kg and once every 3 days), P4A3 (2 kg and once every 5 days), P4A4 (2 kg and one every 7 days). Parameters observed include height increase, diameter increase, number of leaves, shoot fresh weight, shoot dry weight, root fresh weight, and root dry weight.

The research procedure begins with the preparation of tools and materials and then proceeds with the manufacture of briquettes, planting media, seedling preparation, and parameter measurement. Briquettes were obtained through a mixture of chicken manure, tapioca flour, and water in a ratio of 2:1.5 and then formed into a size of 3 x 3 cm (Figure 1). According to [8], the ratio of chicken manure and tapioca starch produces optimal seedling growth. Petai seedlings were initially acclimated to the study site before receiving treatment. The process of adapting an organism to a new environment is known as acclimatization [8]. Polybags were filled with soil from the Besitang area, with about half of the contents of the bag. The seedlings were put into polybags, and then chicken manure briquettes were added to each one in different amounts. Then, cover the seedlings with soil and label them with the treatment.

Figure 1. Preparing and processing briquette manure fertilizer

Analysis of variance (ANOVA) was then used to examine differences between treatments applied to seedling growth characteristics. Duncan's Multiple Range Test (DMRT) was then performed at the 5% level to determine whether groups showed variations across varieties.

3. Results and Discussion

Briquettes are a type of slow-release compound fertilizer. This fertilizer has advantages, including reducing nutrient loss, increasing nutrient availability, reducing plant stress due to excessive fertilizer use, reducing the risk of environmental pollution, and reducing planting application costs. Watering interval treatment is closely related to the level of water availability in plants. The results showed an interaction between the addition of manure briquettes and watering interval as shown in Table 1.

Table 1. Recapitulation of analysis of variance of observation parameters in the treatment of briquette dose and watering interval and their interaction

Parameters	Treatment	F-calculation
Height Increase	PA	10.72*
Diameter Increase	PA	7.00*
Number of leaves	PA	2.72*
Shoot fresh weight	PA	4.35*
Root fresh weight	P	14.35*
	A	47.04*
Shoot dry weight	PA	4.82*
Root dry weight	PA	5.35*

Notes: P: Dose of Manure Briquettes
A: Watering Interval
PA: Interaction of Briquette Application with Watering Interval
* : Significant treatment at 0.05 level

The results of the analysis of variance showed that the interaction between the addition of manure briquettes and watering intervals significantly affected the parameters of height, diameter, number of leaves, shoot fresh weight, shoot dry weight, and root dry weight, but had no significant effect on the average root fresh weight of plants (Figure 2). Therefore, the DMRT test was continued at the 5% level, and the results are presented in Figures 3-9.

Figure 2. Petai seedling before treatment (left); Petai seedling after treatment (right)

3.1. Height Increase

The addition of manure briquettes and watering intervals significantly affected the height increase of Petai seedlings. The results of further tests in Figure 3 show that all treatments can increase the height of seedlings.

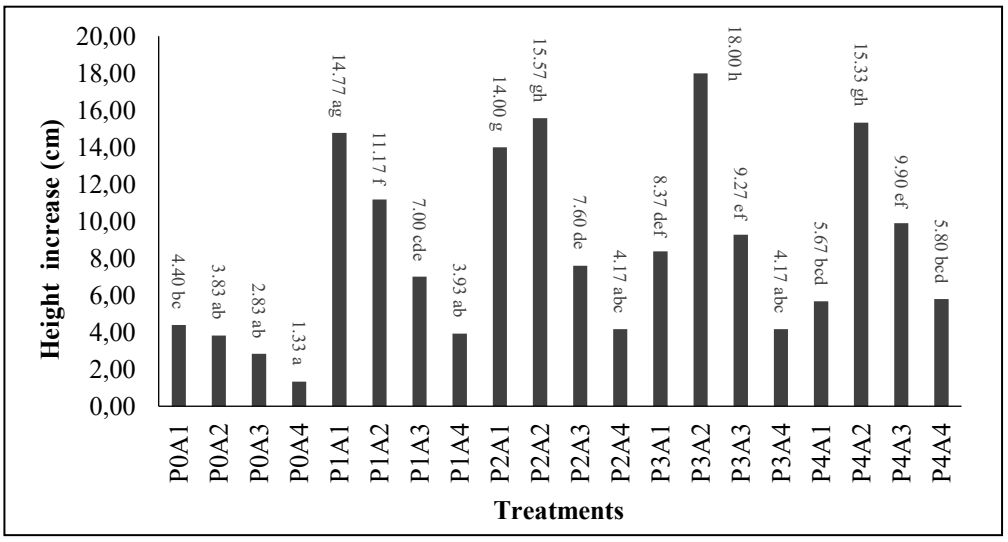

Figure 3. DMRT test of average height increase of Petai seedlings. Notes: Numbers followed by the same letter indicate not significant difference in DMRT test at 5% α level

The P2A2, P3A2, and P4A2 treatments showed the highest increase in plant height. However, the P2A2 treatment was more efficient because it used less briquette material (1 kg) and watering every 3 days was sufficient to increase height by 15.57 cm. This indicates that with a dose of 1 kg of petai seedlings, the nutrient requirements have been met. The composting and fermentation process of organic fertilizer is important to reduce phytotoxic potential and ensure optimal nutrient availability [19;20]. The pores contained in the briquettes can retain water, thus prolonging the process of water utilization by plants [6]. The application of briquettes as an organic material can improve the physical properties of the soil, allowing air and water to easily enter and aiding plant growth [11]. The nutrient requirements of each plant species vary and also depend on the soil medium used. Sukun showed the best height growth with the application of 2 kg of organic fertilizer briquettes [8;9], while Macadamia exhibited optimal height growth with the application of 1 kg of chicken manure briquettes during land rehabilitation activities in Simalungun Regency [10].

Petai is a plant belonging to the Leguminosae (Fabaceae) family, known for its excellent adaptability to marginal soils or less fertile land. Therefore, plants from this family are often used as one of the land rehabilitation plants [21]. The main advantage of Leguminosae is their ability to form a symbiotic relationship with nitrogen-fixing bacteria, especially Rhizobium, which results in the formation of root nodules

(nodulation). Through this biological process, nitrogen from the air can be effectively bound and converted into a form that plants can absorb [22;23]. As a result, petai plants and other legumes can increase the nitrogen content in the soil, which in turn improves the absorption of other nutrients and supports optimal plant growth even in marginal or less fertile soil conditions [24]

3.2. Diameter Increase

The need for water that is fulfilled with the appropriate amount, the plants will grow well [13]. The increase in diameter of seedlings given the dose of briquettes and watering interval showed a greater value than the control (Figure 4).

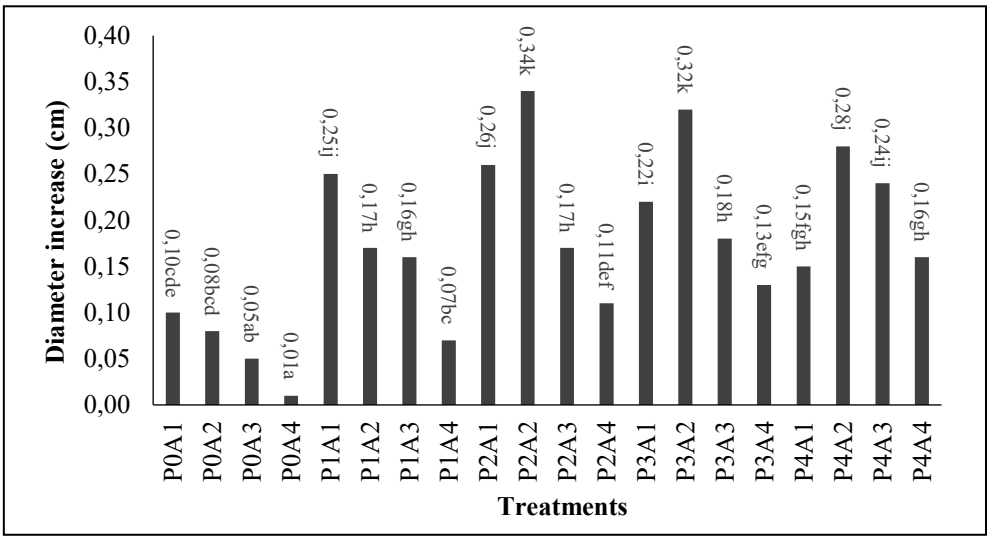

Figure 4. DMRT test of mean diameter increase of Petai seedlings. Note: Numbers followed by the same letter indicate no significant difference in the DMRT test at 5% α.

The P2A2 and P3A2 treatments showed the highest increase in plant diameter. However, the P2A2 treatment was more efficient because it used less briquette material (1 kg) and watering every 3 days was sufficient to increase the diameter by 0.34 mm. Research shows that applying fertilizer with organic fertilizer briquettes made from chicken manure at a dose of approximately 1 kg per seedling significantly improves the stem diameter growth of Petai seedlings in the nursery. The nutrients from the organic fertilizer provide a sustainable source of nutrients and help improve the growing medium structure, allowing the seedling roots to develop optimally [19;20]. Additionally, the optimal watering interval significantly affects the effectiveness of nutrient absorption and seedling growth. Watering every 3 days has been proven to provide the best results for diameter growth, maintain the moisture of the planting medium without causing waterlogging that damages the root system, and maintain the balance of plant metabolism [19; 25]. The combination of briquette fertilizer at a dose of 1 kg/seedling with watering every 3 days resulted in a significant increase in stem diameter compared to other treatments that did not use this combination. This indicates the importance of the interaction between sufficient nutrition and media moisture as key factors in optimizing the diameter growth of Petai seedlings during the nursery stage [19;20].

3.3. Number of leaves

Based on the results of further tests in Figure 5, the best number of leaves is in the treatment of PP1A1, P2A1, P2A2, P3A2 and P4A2. The P2A2 treatment was more efficient because it used less briquette material (1 kg) and watering every 3 days was sufficient to increase number of leaves, its indicates that aeration conditions run well and root respiration optimally.

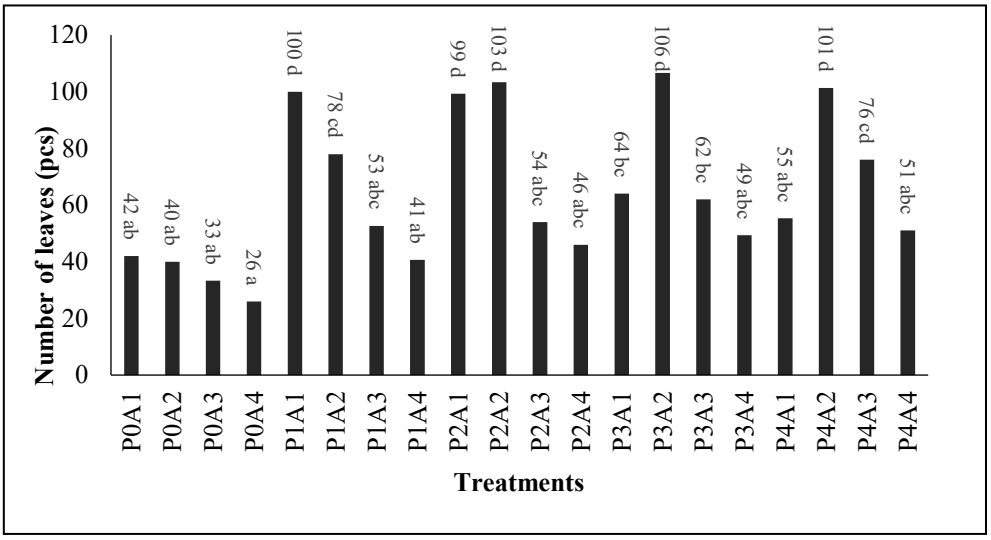

Figure 5. DMRT test of mean number of leaves of Petai seedlings. Note: Numbers followed by the same letter indicate no significant difference in the DMRT test at 5% α.

Macronutrient content such as nitrogen, which plays an important role in photosynthesis and leaf tissue formation, is key to increasing leaf number [26]. In addition, the application of organic fertilizer in the form of briquettes at a dose of approximately 1 kg per seedling, combined with watering intervals every 3 days, has been proven to provide the best leaf growth in Petai seedlings. This is because the balance between nutrient supply and growing medium moisture allows for optimal nutrient absorption and maximum leaf development [19;20]. Proper watering frequency prevents water stress and supports plant metabolism, leading to a significant increase in leaf count during the seedling phase. Therefore, the interaction between the organic fertilizer application and the appropriate watering interval is a key determining factor in increasing the number of Petai seedling leaves, which is an important indicator of forest seedling quality.

The low number of leaves observed with the 7-day watering interval was primarily due to the extended duration between watering. Although one of the functions of briquettes is to retain moisture in the soil, the long interval caused water stress, leading the plants to adapt by shedding leaves to conserve water. This response aligns with the findings [39], which state that plants reduce leaf area and shed leaves as mechanisms to minimize water loss under drought conditions.

3.4. Shoot fresh weight

The application of 1 kg manure briquettes with watering every 3 days (P2A2) had the efficient treatmenton shoot fresh weight of 39.96 grams while 0 kg manure briquettes and watering every 7 days (P0A4) showed the lowest top fresh weight of 10.04 grams (Figure 6).

The application of chicken manure briquettes and watering intervals significantly affects the shoot fresh weight of Petai seedlings in the nursery. Fertilizing with a dose of 1 kg of briquettes per seedling has been proven to provide a sustainable supply of nutrients and maintain the moisture stability of the growing medium, thus optimizing the growth of fresh shoot mass. Meanwhile, the watering interval provided every 3 days is very supportive of sufficient water availability for the plants without causing waterlogging conditions that can damage the roots. This combination of fertilizer dosage and watering interval resulted in the best fresh shoot weight growth, as sufficient nutrients and optimally maintained moisture accelerated the processes of photosynthesis and cell division in the shoots. These results are consistent with research showing that treatment with 1 kg of fertilizer briquettes and a 3-day watering interval yielded the best parametric growth results, such as height, diameter, number of leaves, and fresh and dry weight of shoots and roots, in Petai seedlings [19;20; 25].

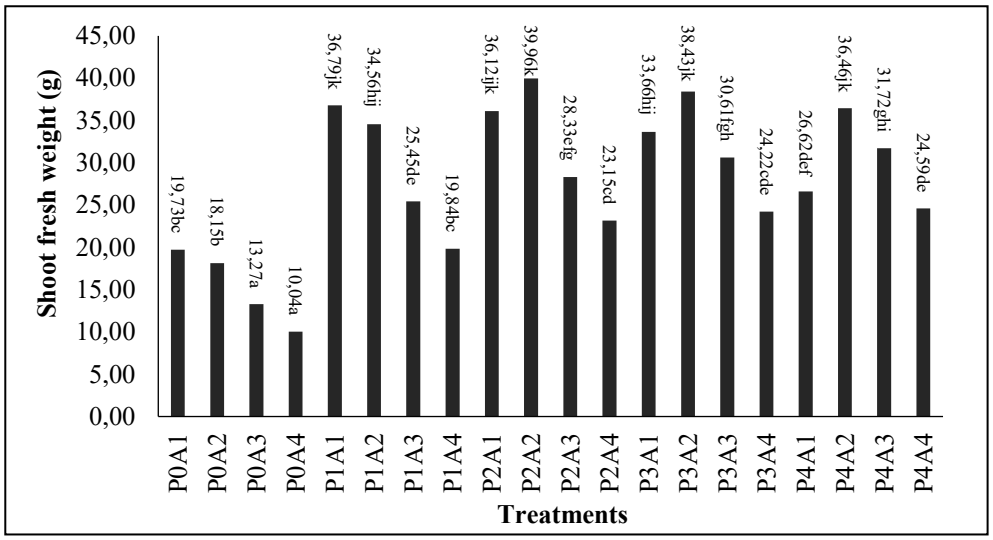

Figure 6. DMRT test of the mean number of shoot fresh weight of Petai seedlings. Note: Numbers followed by the same letter indicate no significant difference in the DMRT test at 5% α.

3.5 Root fresh weight

Table 1. shows that there was no significant interaction between the application of chicken manure fertilizer briquettes and watering intervals on root fresh weight measurement. This indicates that an increase in root fresh weight can be achieved by applying either treatment alone. Applying chicken manure briquettes at a dosage of 1–2 kg can increase the fresh weight of roots, but the most efficient dosage is 1 kg per seedling. Additionally, watering intervals of once every 3 days proved to be the best watering frequency to support seedling root growth. Fertilizing with a dose of 1 kg of briquettes per seedling provides an organic nutrient supply that helps increase the activity of soil microorganisms and improve the gwing medium structure, thus supporting healthier root development and higher fresh weight. The optimal watering interval, which is every 3 days, ensures sufficient water availability without causing waterlogging, thus providing the ideal moisture conditions for nutrient absorption and active growth for the [19;20]. Other studies also support the finding that applying organic fertilizer in the form of briquettes can increase the fresh weight of roots compared to treatments without fertilizer, which is caused by a more stable nutrient supply and increased soil biological activity [25]

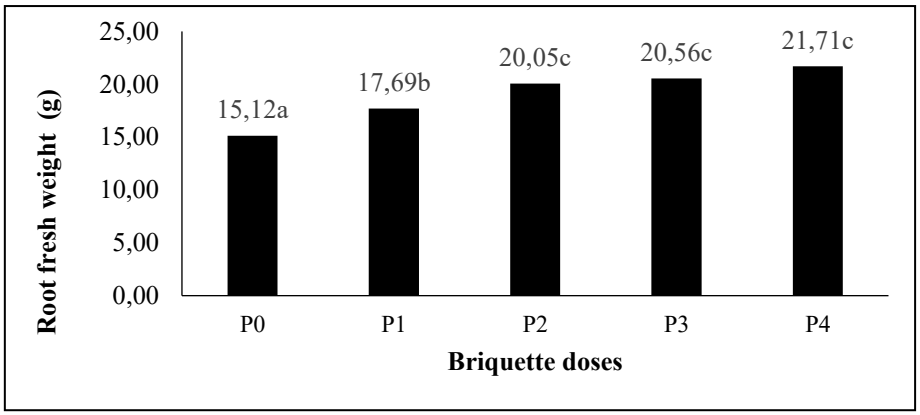

Figure 7. DMRT test of mean number of root fresh weight of Petai seedlings. Note: Numbers followed by the same letter indicate no significant difference in the DMRT test at 5% α.

Watering once every 3 days produced is the best root fresh weight of 23.71 grams. This shows that water plays a role in the growth of Petai seedlings. If the availability of water is lacking, the physiological process of plants will be disrupted [33] (Figure 8).

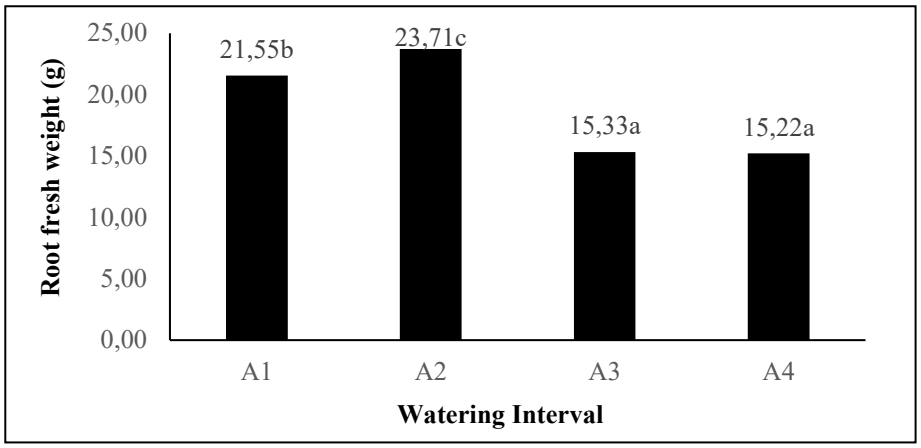

Figure 8. DMRT test of mean number of root fresh weight of Petai seedlings. Note: Numbers followed by the same letter indicate no significant difference in the DMRT test at 5% α.

3.6 Shoot dry weight

Based on the results of the DMRT test in **Figure 8**, the highest shoot dry weight is found in theP1A1, P2A1, P2A2, P3A2 and P4A3 treatment, but the efficient treatnebt was P2A2 namely 1 kg of manure briquettes with watering every 3 days, namely 33.24 grams while the lowest weight data is found in P0A4 (0 kg of manure briquettes and watering every 7 days), namely 3.26 grams. This is because the soil used comes from Besitang dominated by Oxisol soil. Oxisol soil has very low nutrient reserves, and has a very high clay fraction [35] resulting in the dry weight of the top of the plant being low compared to those given briquettes. This is in accordance with the statement [36], the optimal availability of nitrogen, phosphorus, potassium and magnesium nutrients for plants can increase chlorophyll, so that it will increase photosynthetic activity that produces more assimilates which will support the dry weight of plants.

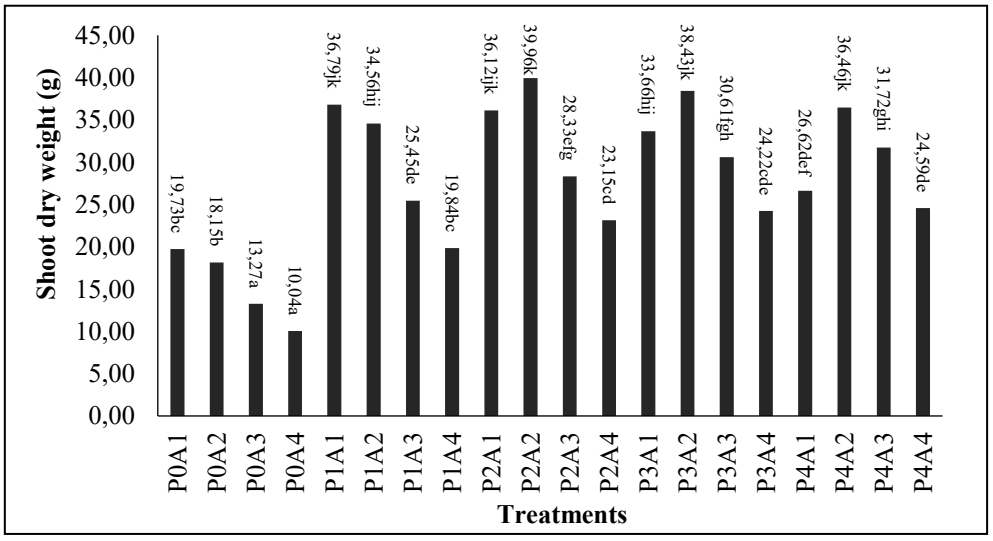

Figure 9. DMRT test of mean number of shoot dry weight of Petai seedlings. Note: Numbers followed by the same letter indicate no significant difference in the DMRT test at 5% α.

3.7 Root dry weight

The P2A2 and P3A2 has the heaviest of root dry weight, but P2A2 giving a dose of 1 kg of briquettes and a watering interval of 3 days once the largest dry weight value of 21.98 grams as presented in **Figure 10**. The treatment of this dose of briquettes shows that briquettes are not only a water barrier for Petai plants but also a source of nutrients.

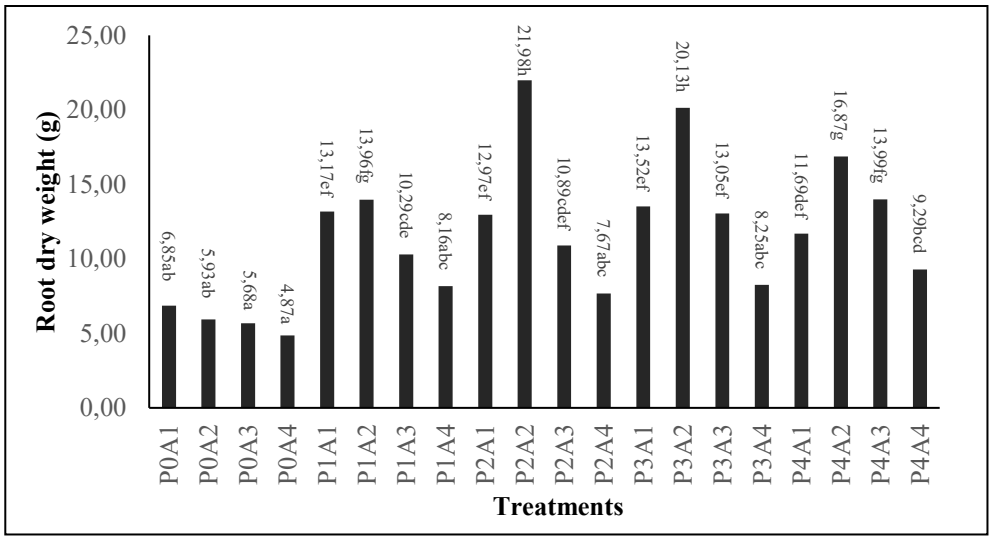

Figure 10. DMRT test of mean number of root dry weight of Petai seedlings. Note: Numbers followed by the same letter indicate no significant difference in the DMRT test at 5% α.

The high dry weight of plants shows that the growth of these plants is getting better because more nutrients and water can be absorbed [37]. The watering interval of every 3 days is optimal enough to obtain the dry weight of the lower part of the Petai seedlings. Plant dry weight reflects the tissue that is formed after water is removed [38]. When water is short, the plant will extend its roots to the soil layer that has sufficient water availability and the volume of roots in plants decreases in response to water shortage [39].

4. Conclusion

The interaction of the treatment dose of chicken manure briquettes and watering interval gave significant results on height, diameter, number of leaves, shoot fresh weight, shoot dry weight, root dry weight, but had no significant effect on the root fresh weight of Petai seedlingss. The P2A2 treatment (1 kg briquettes and watering every 3 days) gave the best results on the growth of Petai seedlings during observation. This finding indicates an effective balance between nutrient availability from the briquette fertilizer and moisture supply from watering, which together optimize seedling growth parameters during the early development stage. Regular watering every three days likely maintains adequate soil moisture without causing waterlogging, while the 1 kg briquette dose supplies sufficient organic nutrients for the Petai seedlings.

References

[1] Sutarno dan A. D. Setyawan, "Biodiversitas Indonesia Penurunan dan Upaya Pengelolaan untuk Menjamin Kemandirian Bangsa", *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia*, 1-13 Maret 2015, Surakarta, pp. 1-13. 2015.

[2] I. Rafi, P. Lestari, M. R. Hariri, A. F. Maulana dan E. Prasetyo, "Pertumbuhan Organ Vegetatif Tanaman Multifungsi Petai (*Parkia speciosa*) dari Biji hingga Siap Tanam", *Jurnal Agrifor*, vol. 22, no. 01, pp 133-142. 2023.

[3] Suhemi, R. Hayati dan R. W. Nusantara, "Status Kesuburan Tanah Inceptisol pada Penggunaan Lahan Kelapa Sawit di Desa Pengadang Kecamatan Sanggau", Pedontropika: *Jurnal Ilmu Tanah dan Sumber Daya Lahan*, vol. 08, no. 02, pp. 25- 35. 2022.

[4] Marjaenah, W. Kustiawan, Keren, K.H Sembiring dan Ediyono, "Pemanfaatan Limbah Kulit Buah Buahan sebagai Bahan Baku Pembuatan Pupuk Organik Cair", *Jurnal Hutan Tropika*, vol. 01, no. 02, pp. 120-127. 2017.

[5] K. Tarigan, "Profil pengusahaan (Budidaya) Gaharu". Departemen Kehutanan Pusat Bina Penyuluhan Kehutanan. Jakarta. 2004

[6] H. Walida, D. D. Harahap dan M. Zuhirsyan, "Pemberian Pupuk Kotoran Ayam dalam Upaya Rehabilitasi Tanah Ultisol Desa Janji yang Terdegradasi", *Jurnal Agrica Ekstensia*, vol. 14, no. 01, pp. 75-80. 2020.

[7] C. P. Ginting, A. Dalimunthe dan B. Utomo, "Penggunaan Berbagai Dosis Pupuk Kandang terhadap Pertumbuhan Bibit Sukun (*Artocarpus communis*. Forst) pada DTA Danau Toba", *Peronema Forestry Science Journal*, vol. 04, no. 03, pp. 269- 272. 2015.

[8] A. Dalimunthe, "Pengaruh Perbandingan Dosis Pupuk Kandang Ayam dan Tepung Tapioka sebagai Briket Pupuk Kandang terhadap Pertumbuhan Bibit Sukun (*Arthocarpus communis*)" [Skripsi]. Medan : Universitas Sumatera Utara., 2019. [Online]. Available: Repositori USU.

[9] M. Padang, "Pengaruh Berbagai Dosis Briket Pupuk Kandang Ayam Terhadap Pertumbuhan Bibit Sukun (*Arthocarpus communis*)" [Skripsi]. Universitas Sumatera Utara., 2018. [Online]. Available: Repositori USU.

[10] P. Tamba,"Pemanfaatan Briket Pupuk Kandang terhadap Pertumbuhan Bibit Makadamia (*Macadamia integrifolia*) di Kabupaten Simalungun" [Skripsi]]. Universitas Sumatera Utara., 2021. [Online]. Available: Repositori USU.

[11] I. Yassir, RA Ommon, "Pengaruh Dosis Pupuk Organik Terhadap Pertumbuhan Mahoni (*Swietenia macrophylla* King) Pada Lahan Alang-Alang Di Samboja, Kalimantan Timur". *Jurnal Penelitian Hutan Dan Konservasi Alam*. 4 (4) : 377-384. 2007.

[12] A. Dalimunthe, B. Utomo dan R. Fransiska, "Pengaruh Ketebalan Mulsa Ampas Tebu dan Interval Penyiraman terhadap Pertumbuhan Tanaman Sukun (*Arthocarpus communis* Forst)", *TALENTA Conference Series:* Agriculturan and Natural Resources, vol. 03, no. 01, pp. 76-84. 2020.

[13] S. H. Jafar, A. Thomas, J. I. Kalangi dan M. T. Lasut, " Pengaruh Frekuensi Pemberian Air terhadap Pertumbuhan Bibit Jabon Merah (*Anthocephalus macrophyllus* (Roxb) Havil), *Jurnal Cocos*, vol. 02, no. 02, pp. 1-12. 2013.

[14] N. Melfian, "Pengaruh Intensitas Cahaya dan Interval Penyiraman terhadap Semai Tanaman Sengon Laut (*Paraserianthes falcataria* (L.) Nielsen)". [Skripsi]. Universitas Mataram. 2015. [Online]. Available: Repositori UNRAM.

[15] D. Baiyaturidwan, "Pengaruh Frekuensi Penyiraman terhadap Pertumbuhan dan Pembentukan Bintil Akar Semai *Acacia auriculliformis* A. Cunn ex Benth dari Dua Sumber Benih". [Skripsi]. Universitas Gadjah Mada. 2022. [Online]. Available: Repositori UGM.

[16] DU. Parwati, Pengaruh Frekuensi Penyiraman dan Lama Penyimpanan terhadap Pertumbuhan Bibit Jarak Pagar (*Jatropha curcas* L.)". *Prosiding*. Bayumedia Publishing. Kementerian Pertanian.2008. [Online]. Available: Repositori Kementerian Pertanian.

[17] NM Audina, Y.Maxiselly, S.Rosniawaty, "Pengaruh kerapatan naungan dan frekuensi penyiraman terhadap pertumbuhan bibit kemiri sunan (*Reutealis trisperma*(Blanco) airyshaw)", *Jurnal Kultivasi* Vol. 15(2). 2016.

[18] Aliyah, TNB Santosa, TM Astuti, "Pengaruh Dosis Pupuk NPK dan Frekuensi Penyiraman terhadap Bibit Kakao (*Theobroma cacao* L)". *Jurnal Agromast*, Vol.2, No.1. 2017.

[19] Hamzah, RA Hardiyanti,R Handayani,J Rumondang,IT Utari, "Pengaruh Penambahan Berbagai Bahan Organik pada Media Tanam Sub Soil terhadap Pertumbuhan Bibit Petai (*Parkia speciosa*)", *Jurnal Silva Tropika*, Vol. 8,No. 1, 2024.

[20] Ridwan, Wardah, R Wulandari, D Wahyuni, "Pengaruh Kompos Kotoran Ayam pada Media Tumbuh terhadap Pertumbuhan Semai Glodokan (Polyalthia longifolia Sonn)". *Jurnal Warta Rimba*,Volume 8. Nomor 1, 2020.

[21] KE Giller, "Nitrogen Fixation in Tropical Cropping Systems.". 2nd ed. CABI Publishing. 2001.

[22] B. B. Bohlool, J. K. Ladha, D. P. Garrity and T. George, "Biological nitrogen fixation for sustainable agriculture: A perspective"*Plant and Soil* 141: 1-11, 1992.

[23] JI Sprent, "Nodulation in Legumes". Royal Botanic Gardens, Kew, 2001.

[24] Herridge, D. F., Peoples, M. B., & Boddey, R. M. (2008). "Global inputs of biological nitrogen fixation in agricultural systems." *Plant and Soil*, 311(1-2), 1-18. https://doi.org/10.1007/s11104-008-9668-3.

[25] FP Zaery, "Respon Pengujian Ekoenzim dan Interval Penyiraman terhadap Pertumbuhan Bibit Petai (Parkia speciosa)" di PT. Agincourt Resources, [Skripsi]. Universitas Sumatera Utara., 2023. [Online]. Available: Repositori USU.

[26] MM, Masafu, "The evaluation of Leucaena leucocephala (Lam) De Wit. : a renewable protein supplement for row-qualiy forages" [Dissertation]. University of South Africa. 2006.[Online].

Available:https://uir.unisa.ac.za/server/api/core/bitstreams/0afe003f-c87c-4d4b-8d97 f4cc61108d71/content.

[27] Yewa, A. Umbu, U. P. Jawang, dan L. D. Lewu, "Pengaruh Bahan Organik Rumput Laut Cokelat (*Sargassum polycystum*) terhadap Karakteristik Fisik Inceptisol", *Jurnal Tani Sandalwood*, vol. 01, no. 01, pp. 50-56. 2023.

[28] H. Ardian, Tuyuk, Burhanuddin dan Marwanto, "Pengaruh Media Tanam dengan Penambahan Pupuk Kotoran Sapi terhadap Pertumbuhan Semai Nyamplung (*Calophyllum inophyllum* LINN)", *Jurnal Hutan Lestari*, vol. 10, no. 04, pp. 973-981. 2022.

[29] Mamonto, Rinna, J. A. Rombang, dan M. T. Lasut, "Pengaruh Media Tanam terhadap Pertumbuhan Semai *Aquilaria malaccensis* Lamk. di Persemaian", *Jurnal In Cocos*, vol 10, no. 03. 2019.

[30] Purnamawati, "Pengaruh Media Tanam dan Pemberian Dosis Pupuk NPK terhadap Pertumbuhan Bibit Jati Putih (*Gmelina arborea*). [Skripsi]. Mataram : Universitas Mataram. 2015.

[31] Ridwan, Handayani, I. Riastiwi, Witjaksono, "Bibit Jati Tetraploid Lebih Toleran terhadap Cekaman Kekeringan daripada Bibit Jati Diploid Asalnya", *Jurnal Penelitian Kehutanan Wallacea*, vol. 07, no. 01, pp. 1-11. 2018.

[32] Mustaha, R. Poerwanto, A.D. Susila dan J. Pitono, "Respon Pertumbuhan Bibit Manggis pada Berbagai Interval Penyiraman dan Porositas Media", *Jurnal Hort*,vol. 22, no. 01, pp. 37-46. 2012.

[33] L. N. Firdaus, S. Wulandari dan G. D Mulyeni, "Pertumbuhan Akar Tanaman Karet pada Tanah Bekas Tambang Bauksit dengan Aplikasi Bahan Organik", *Jurnal Biogenesis*, vol. 10, no. 01, pp. 53-64. 2013.

[34] Wiryono, Ekologi Hutan dan Aplikasinya. Bengkulu: Unib Press, January 2020.[Online] Available: Research Gate.

[35] H.B. Simbolon, Pembenahan Sifat Fisika Tanah Oxisol dengan Perlakuan Kompos. [Skipsi]. Medan : Universitas Sumatera Utara. 2017. [Online]. Available: Repositori USU.

[36] U.K.P. Sitorus, B. Siagian, dan N. Rahmawati, "Respon Pertumbuhan Bibit Kakao (*Theobroma cacao* L.) terhadap Pemberian Abu Boiler dan Pupuk Urea pada Media Pembibitan, *Jurnal Agroekoteknologi* Universitas Sumatera Utara, vol. 02, no.03, pp. 1021-1029. 2014.

[37] P. M. Krisdayani, M.W. Proborini dan E. Kriswiyanti, "Pengaruh Kombinasi Pupuk Hayati Endomikoriza, Trichoderma sp dan Pupuk Kompos terhadap Pertumbuhan Bibit Sengon (*Paraserianthes falcataria* (L.) Nielsen, *Jurnal Sylva Lestari*, vol. 08, no. 03, pp. 400-410. 2020.

[38] Y. F. Nahak, A. Ndiwa dan M. Pellondo'u, "Pengaruh Komposisi Media Tanam Sekam Bakar dan Pupuk Kandang Kotoran Sapi terhadap Pertumbuhan Semai Jati Putih (*Gmelina arborea* Roxb), *Jurnal Wana Lestari*, vol. 03, n0. 02, pp. 106-114. 2020.

[39] S. A. Nio, dan P. Torey, "Karakter Morfologi Akar sebagai Indikator Kekurangan Air pada Tanaman, *Jurnal Bioslogos*, vol. 03, no. 01, pp. 31-39. 2013.