

Impact of Charcoal Husk and NPK Fertilizer on The Optimization of Palm Seedlings (*Elaeis Guineensis Jacq*) in Marginal Land

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ABSTRACT

This study aims to evaluate the effectiveness of the use of burnt husk charcoal and NPK fertilizer on the growth of oil palm seedlings (*Elaeis guineensis Jacq*). The research method used is an experiment with a Complete Random Design (RAL) in which various treatments of burnt husk charcoal and NPK fertilizer are applied to the planting medium. The results showed that the combination of husk charcoal with manure, especially with a 1:1 ratio, contributed significantly to the increase in oil palm seedling height compared to other treatments. Statistical analysis using the ANOVA test showed that the difference in treatment had a significant effect on seedling growth, with P2 treatment producing the highest growth. These findings underscore the importance of using the right planting media for the optimization of oil palm seedling growth, which can have practical implications for oil palm plantation management.

Keywords: Burnt Husk Charcoal, NPK Fertilizer, Planting Media, Oil Palm Seed Growth

INTRODUCTION

Oil palm is one of the mainstay plantation products in most parts of Indonesia.(Aji et al., 2023) This type of plant is one of the fastest growing crops in the tropics due to the high economic value of palm oil.(Santi & Manto, 2022) Palm Oil (*Elaeis guineensis Jacq.*) It has the highest vegetable oil content compared to the 17 main oil and fat-producing crops in world trade.(Aji et al., 2020) The demand for vegetable oils continues to increase due to the increasing world population. The global market is currently dominated by Indonesia as the world's largest

exporter of CPO, sharing with Malaysia.(Suhartono et al., 2023)

Oil palm plantation production can be good if plantation companies have used good and efficient production factors to obtain high production of fresh fruit bunches. Fresh fruit bunches of palm oil are produced from palm oil as raw materials for palm oil processing plants to produce crude palm oil. To increase the productivity of oil palm plantations, various supporting factors are needed, such as planting management practices, drainage and soil physical properties, climate, rainfall, nutrient fulfillment, and pest and disease control.

Oil palm plantation management by applying best management practices by large companies produces fresh fruit bunches 33% higher than smallholder plantation management.(Krishnan et al., 2016)

All influencing production factors must be tried at optimal conditions to obtain optimal production.(Fatmawati et al., 2024) Climatic factors and the environmental suitability of an area are very important for oil palm cultivation. However, there are several factors limiting production that cannot be controlled by humans, including the age of the plant. Plant age is an important factor that affects the production of oil palm fruit bunches.(Nurcahya et al., 2023) Palm oil produces at about three years of age and reaches its peak of production between 6 and 10 years. Oil palm seeds can now be harvested at the age of 30 months after planting with good management practices and produce fruit bunches throughout the year continuously until the age of 25 years or more until the plant is rejuvenated. Oil palm calculation and age estimation are essential for oil palm plantation management. Oil palm plants produce different palm fruits at different ages. Calculation of the age of oil palm trees is very important for production monitoring and replanting planning.(Arumugam et al., 2020)

In order for oil palm plantations to be managed properly and efficiently, it is necessary to know the production trend of oil palm fresh fruit bunches at each different plant age so that resource allocation can be adjusted to produce optimal output in each other crop period.(Zolkefli et al., 2020)

The growth process of oil palm starts from the nursery stage to reaching maturity and productivity. The growth of these plants is influenced by various factors, such as soil conditions, moisture, sunlight, and nutrients.(Permata et al., 2023) The right planting medium, as well as adequate nutrition through fertilizer, is essential to ensure optimal growth and increased oil palm yields.(Sui Kim et al., 2020)

Planting media is a material or substrate used to grow plants by providing physical support as well as the supply of water, air, and nutrients that plants

need. The main function of the planting medium is to provide a place for plant roots to anchor and absorb the nutrients needed in the growth process.(Zolkefli et al., 2020)

There are various types of planting media that are commonly used in plant cultivation, such as soil, compost, sand, cocopeat, and husk. Each type of planting medium has its own advantages and disadvantages, depending on the physical and chemical characteristics of the media and the specific needs of the plants being grown.

Burnt husk charcoal is made through a controlled rice husk burning process, resulting in charcoal with a light and porous texture. This process involves burning the husk in low oxygen conditions, which aims to maintain the structure of the husk without burning it completely into ashes.

Burnt husk charcoal has various benefits in agriculture, especially as a component of the planting medium. This charcoal is able to improve the aeration and drainage of the planting medium, as well as help maintain soil moisture. In addition, husk charcoal can also increase the cation exchange capacity (KTK) of the media, making it easier for plants to absorb nutrients.(Khadaroo et al., 2020)

Burnt husk charcoal plays an important role in improving the physical properties of the growing medium by increasing porosity, which in turn improves the movement of air and water in the medium. Chemically, husk charcoal can lower soil acidity (pH), thereby creating better conditions for nutrient absorption by plant roots.(Ng et al., 2020)

NPK fertilizer is a type of compound fertilizer that contains three main nutrients needed by plants, namely Nitrogen (N), Phosphorus (P), and Potassium (K). Nitrogen functions to support vegetative growth, phosphorus plays a role in the formation of roots and fruits, while potassium is important for plant health and resistance to disease.(Abu Bakar et al., 2020)

The proper use of NPK fertilizer can significantly increase plant growth, as it provides a balanced amount of essential nutrients. Nitrogen helps accelerate leaf growth, phosphorus improves root development, and potassium improves yield quality and increases plant resistance to less than ideal environmental conditions.

The dosage and application of NPK fertilizer must be adjusted to the type of plant, growth phase, and soil conditions. Overuse or improper use can negatively affect the plant, such as stunting growth or causing damage to the roots. Therefore, understanding the specific needs of the plant and applying the appropriate dosage is essential to optimize agricultural yields.

However, one of the persistent challenges in palm oil cultivation is optimizing the early growth of seedlings, particularly in marginal land areas where soil conditions are often poor, acidic, and low in nutrients. This study seeks to answer the question: Can the combination of burnt husk charcoal and NPK fertilizer significantly enhance

the growth and development of oil palm seedlings in marginal land conditions. Therefore, this study aims to evaluate the effectiveness of the use of burnt husk charcoal and NPK fertilizer on the growth of oil palm seedlings (*Elaeis guineensis* Jacq). Understanding this relationship is crucial because it can provide an affordable and scalable solution for increasing palm oil productivity from the nursery phase, especially in areas with suboptimal land resources. The findings of this study are expected to contribute not only to the scientific knowledge base regarding soil amendments and fertilizer interactions, but also to practical guidelines for oil palm nursery management in marginal environments.

RESEARCH METHODS

This research was carried out at the KP2 Garden, Yogyakarta Plantation Community Academy Campus. This research was carried out for 3 months from May to July 2023.

The materials used are D X P Tenera oil palm seedlings $\pm$ 4 months old (Characteristics of D X P Tenera Palm Oil), burnt husk charcoal, top soil (Ultisol), TSP fertilizer, NPKMg fertilizer, Dithane M-45 and Decis. Meanwhile, the tools that will be used are hoes, machetes, polybags measuring 40 cm x 50 cm, padlocks, meters, calipers, rafia ropes, ovens, analytical scales, sieves, machetes, scissors, shovels, wood, stationery, hand sprayers and cameras.

This study uses an experimental method with the aim of testing the influence of independent variables on the bound variables, which in this case involves burnt husk charcoal and NPK fertilizer as independent variables and the growth of oil palm seedlings as bound variables. In this study, each treatment was carefully designed to provide a deep understanding of how each of these factors contributes to plant development. This experiment was also carried out with strict control, where all other conditions were kept constant, such as environmental conditions and the type of seedlings used, so that any changes that occurred in the growth of seedlings could be directly attributed to

the given treatment. Through this experimental approach, it is hoped that strong empirical evidence can be obtained to answer the formulation of the problem and research objectives that have been set previously.

The experimental design used is a Complete Random Design (RAL) to control possible variations between samples, with the random distribution of treatments across experimental units so that each unit has an equal chance of getting a specific treatment. This approach is designed to minimize the potential for bias that can arise due to differences in environmental conditions or the characteristics of the oil palm seedlings themselves, so that any changes observed in the bound variables can be directly related to the treatment given. In addition, the use of RAL in this study allows for more robust statistical analysis because the random distribution of treatments helps reduce unwanted side effects from external factors. RAL also provides flexibility in adding or subtracting experimental units as needed, without having to change the overall structure of the experiment, ultimately supporting the accuracy and validity of the research results.

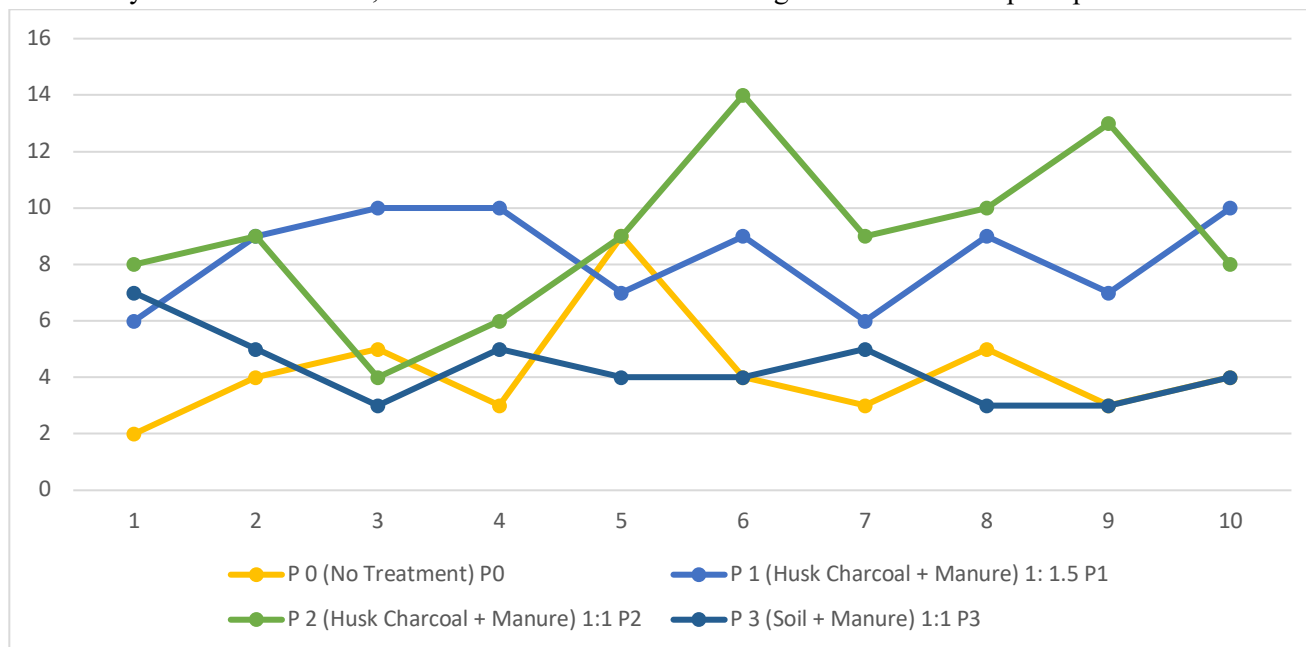
RESULTS AND DISCUSSION

Treatment	Code	Deuteronomy									
		1	2	3	4	5	6	7	8	9	10
P 0 (No Treatment)	P0	2	4	5	3	9	4	3	5	3	4
P 1 (Husk Charcoal + Manure) 1:1.5	P1	6	9	10	10	7	9	6	9	7	10
P 2 (Husk Charcoal + Manure) 1:1	P2	8	9	4	6	9	14	9	10	13	8
P 3 (Soil + Manure) 1:1	P3	7	5	3	5	4	4	5	3	3	4

The table shows the results of observation of the growth of oil palm seedlings with several different treatments on various replicates. In this table, seedling growth is measured in units of height (cm) at each replicate (1-10) for each treatment. The results vary between treatment, where the P1 and P2

treatments tended to show higher growth compared to P0 (control) and P3.

For example, at the 6th replicate, the P2 treatment resulted in the largest seedling height (14 cm), while the P0 treatment resulted in consistently lower growth across multiple replicates.



The bar chart above shows the seedling height data (in cm) resulting from four different treatments with 10 replicates. From the diagram, it can be seen that the P0 treatment (no treatment) consistently produces seedlings with a lower height than other treatments, with the average height of seedlings ranging from 2 to 7 cm. The P1 and P2 treatments showed better results, with a higher average seedling height, especially in the 6th and 9th replicates, where P2 produced seedling heights of 14 cm and 13 cm, and P1 reached 10 cm. Meanwhile, the P3 treatment,

which uses a mixture of soil and manure in a 1:1 ratio, produces variable seedling heights but tends to be lower than P1 and P2, with a height range of between 3 to 8 cm.

Overall, the P1 and P2 treatments, which used husk charcoal as the planting medium with variations in manure ratios, tended to give better seedling growth results compared to the no treatment (P0) and the P3 treatment which only used soil and manure.

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Mr.
1	Regression	106.725	3	35.575	4.196	.064a
	Residual	50.875	6	8.479		
	Total	157.600	9			

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Mr.
		B	Std. Error	Beta		
1	(Constant)	4.049	20.236		.200	.848
	P1	.167	.193	.206	.867	.419
	P2	.643	.183	.840	3.517	.013
	P3	-.043	.350	-.029	-.122	.907

Based on the results of the variance analysis (ANOVA) in the regression model, it is known that the independent variable is able to explain most of the variation in the dependent variables, with the Sum of Squares Regression of 106.725 and the Sum of Squares Residual of 50.875. The F-statistic value obtained was 4.196, with a significance level of 0.064. Thus, it can be concluded that the regression model used is quite good in explaining the relationship between independent variables and dependent variables. Although the significance level of 0.064 is slightly above the commonly used alpha level (0.05), the significant F-statistical value indicates that the independent variable significantly affects the dependent variable. Therefore, it can be concluded that the regression model used is a valid and trustworthy model.

Although these results indicate a relationship between the variables in the model, the significance value is slightly above the 0.05 threshold, so the model has not been fully considered significant at the

95% confidence level. However, if using a 90% confidence level, this result can be more considered. However, keep in mind that a lower level of trust also means a higher risk of error. Therefore, further analysis should be carried out to ensure the accuracy of this regression model before making a final conclusion. In addition, other factors such as multicollinearity and heteroscedasticity also need to be considered in evaluating the reliability of this regression model. Thus, although this model shows promising results, further research is still needed to validate these findings.

To improve the accuracy of the model, several steps can be taken including increasing the number of samples, reviewing the variables used, or evaluating the possibility of other influencing factors. With these adjustments, the model can provide more robust and convincing results. In addition, the use of cross-validation techniques can also help in identifying whether this regression model can be applied to different data. By paying

attention to all these factors, further research can provide more solid and trustworthy conclusions. Therefore, it is important for researchers to not only rely on the initial results of the regression model, but also conduct in-depth analyses to ensure its reliability and validity.

Based on the results of linear regression analysis, it is known that each independent variable (P1, P2, and P3) has a different influence on the dependent variable.

The value of the unstandardized regression coefficients shows that when the independent variable increases by one unit, the dependent variable will undergo a change by the value of the coefficient. Specifically: P1 has a coefficient of 0.167, which means that every increase of one unit in P1 will increase the dependent variable by 0.167, P2 has a coefficient of 0.643, which indicates that every increase of one unit in P2 will increase the dependent variable by 0.643, P3 has a coefficient of -0.043, which means that an increase of one unit in P3 will actually decrease the dependent variable by 0.043.

From the results of the standardized coefficients (Beta), it can be seen that P2 has the strongest influence (Beta = 0.840) compared to P1 (0.206) and P3 (-0.029). A negative value in P3 indicates that this variable has an opposite relationship with the dependent variable, although the effect is very small.

The significance test showed that only P2 had a significant effect (Sig. = 0.013) at a 95% confidence level. In contrast, P1 (Sig. = 0.419) and

P3 (Sig. = 0.907) are not significant, so their effects on the dependent variables cannot be statistically ascertained.

Based on these results, it can be concluded that P2 is the most dominant factor in influencing the dependent variable, while P1 and P3 do not have a significant influence. Therefore, this model can be improved by reconsidering the relevance of variables P1 and P3 or adding other variables that are more influential.

Linear regression analysis showed that the independent variables (P1, P2, and P3) had different influences on the dependent variables. Unstandardized regression coefficients show that as independent variables increase, dependent variables will change according to their coefficients. The specific values for the independent variables (P1, P2, and P3) include coefficients of 0.167, 0.643, and -0.043. The normalized coefficient (Beta) shows that P2 has a greater influence (Beta = 0.840) than P1 (0.206) and P3 (-0.029). A negative value for P3 indicates that the variable has a close relationship with the dependent variable, although the effect is small. The significant value (Sig. = 0.013) shows that P2 is the most dominant factor in influencing the dependent variable, while P1 and P3 have no significant effect. Therefore, the model can be improved by adjusting the relevance of the independent variables P1 and P3 or adding other variables that have a greater influence.

CONCLUSION

Overall, the results of the ANOVA test and post-hoc analysis showed that there was a significant difference in the growth of oil palm seedlings affected by the various treatments given. Based on the statistical analysis, the P2 (Husk Charcoal + Manure with a ratio of 1:1) and P1 (Husk Charcoal + Manure with a ratio of 1:1.5) consistently showed better results in increasing the height of oil palm seedlings compared to other treatments, namely P0 (no treatment) and P3 (Soil + Manure with a ratio of 1:1). The P2 treatment, in particular, provided the highest average seedling

height among all treatments, followed by the P1 treatment, which also showed significant growth but was slightly lower than that of P2. In contrast, P0 and P3 treatments resulted in lower average seedling heights, suggesting that without treatment or with the use of soil as the primary medium, seedling growth tends to be less than optimal. Thus, the results of this study provide strong evidence that the combination of husk charcoal with manure, especially with the right ratio, can make a significant positive contribution to the growth of oil palm seedlings, which in turn can

have important implications for cultivation practices in the field. This shows that P1 and P2

give significantly better results than P0 and P3, with P2 showing the highest results.

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