Growth of palm oil seedlings at various doses of boiler ash and tofu wastewater

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Abstract. The objective of the study is to get the best dose of boiler ash and tofu wastewater to increase the growth of palm oil seedlings in the nurseries. The study used a completely randomized design in factorial with three replications. The first factor is the dose of boiler ash consisting of four levels, namely 0 g, 300 g, 350 g, 400 g, and 450 g per polybag. The second factor is the concentration of tofu wastewater, which consists of four levels, namely 0%, 60%, 80%, 100% per polybag. The results showed that the interaction between boiler ash and tofu wastewater had a significant effect on the growth of palm oil seedlings in the nurseries. Interaction between boiler ash doses 350-450 g per polybag with tofu wastewater concentration 80-100% per polybag can increase seedling height, shoot diameter, root volume, and dry weight of palm oil seedlings.

1. Introduction
The success of planting palm oil is very dependent on the quality of seedlings. Efforts to get good seedlings are through nurseries because if there is an error in the nursery phase, it will harm the growth and production of palm oil in the field. Palm oil nurseries require sufficient nutrients to support seedling growth [1]. So far, inorganic fertilizers are often used. Inorganic fertilizers are relatively expensive and are not environmentally friendly. Therefore, to reduce the cost of fertilization can be used as waste from palm oil mills such as boiler ash.

Boiler ash is a solid waste from a palm oil mill, which results from the burning of shells and fibers in the boiler engine [2]. Boiler ash can be used as an ameliorant to improve the physical and chemical properties of the soil. Boiler ash can neutralize acid soils and increase soil nutrient content [3]. Boiler ash contains many nutrients that can be applied to palm oil in nurseries. Nutrients contained in boiler ash are N 0.74%, P2O5 0.84%, K2O 2.07%, Mg 0.62% [2]. Other ingredients, such as wastewater tofu can be added to complement the availability of nutrients from boiler ash in palm oil nurseries.
Tofu wastewater is obtained from washing, soaking, and liquid disposal in the tofu industry process [4]. Tofu wastewater contains N, P, K, Ca, Mg, and Fe [5,6] so that it is potentially used as a source of nutrition for plants. The nutrient content of tofu wastewater is in the standard required by Permentan Number: 28 / SR.130 / B / 2009 [7]. The use of boiler ash with tofu wastewater in palm oil nurseries is expected to reduce waste problems. In addition, it can increase its value as a source of nutrition for palm oil nurseries. Therefore, this study aims to determine the effect of giving boiler ash and tofu wastewater on the growth of palm oil seedlings in nurseries.

2. Methods

The study used palm oil seedlings aged four months and maintained for three months in the nursery. The study used a completely randomized design in the factorial form with three replications. The first factor is the dose of boiler ash consisting of four levels, namely 0 g, 300 g, 350 g, 400 g, and 450 g per polybag. The second factor is the concentration of tofu wastewater, which consists of four concentrations, namely 0%, 60%, 80%, and 100%. Application of boiler ash is carried out in conjunction with planting media filling, while tofu wastewater is carried out every week with a volume of 500 ml per polybag. Variables are seedling height, tuber diameter, root volume, and seed dry weight. Measurement of seedling height using a measuring bar, tuber diameter using a meter, root volume using the volumetric method, and seed dry weight using a digital balance.

Data were analyzed using analysis of variance (F test) at α level of 5%. If the treatment has a significant effect, it is followed by the Duncan Multiple Range Test (DMRT) [8]. Data analysis was performed using STAR 2.0.1 software.

3. Results and discussion

3.1. Seedling height

The interaction between boiler ash and tofu wastewater has a significant effect on seedling height (Table 1). The results showed that the interaction between 300 g boiler ash + 100% tofu wastewater and 400 g boiler ash dose + 100% tofu wastewater is the highest seedling height. However, it was no different on the interaction between boiler ash 350 g + 60% tofu wastewater. Both interactions increased seedling height by 30.09% compared to controls.

| Boiler ash (g) | 0          | 60         | 80          | 100         |
|---------------|------------|------------|-------------|-------------|
| 0             | 29.17 e    | 29.40 e    | 35.67 bcd   | 32.37 de    |
| 300           | 33.77 bcede| 33.53 bcede| 34.90 bcd   | 41.73 a     |
| 350           | 33.67 bcede| 38.80 ab   | 38.00 bc    | 36.17 bed   |
| 400           | 34.90 bbed | 35.33 bcd  | 35.77 bcd   | 41.73 a     |
| 450           | 33.23 cde  | 33.33 bced | 33.67 bced  | 36.17 bcd   |

Note: The numbers followed by the same letters in the same column show no significant difference using the DMRT test at α of 5%.

Boiler ash and tofu wastewater interactions are able to provide nutrients, especially nitrogen and phosphorus, to support the growth of palm oil seedlings in nurseries. Nitrogen plays an important role in the formation of chlorophyll to support vegetative growth of plants [9], while phosphorus plays a role in cell division in meristematic tissue to increase growth in seedling height [10].

3.2. Hump diameter

The interaction between boiler ash and tofu wastewater has a significant effect on the diameter of the hump (Table 2). The results showed that the interaction between 350 g boiler ash + 80% tofu wastewater
wastewater and 450 g boiler ash + 80% tofu wastewater has the widest bulb diameter. However, there is no difference in the interaction between 350 g boiler ash + 60% tofu wastewater, 300 g + 0%, and 0 g + 60%. Both interactions increased the tuber diameter by 35.32% compared to controls. It is due to the interactions able to provide nutrients, especially potassium, for the growth of palm oil seedling humps. Potassium plays a role in increasing plant humps [11], which acts as an enzyme activator in the formation of carbohydrates through photosynthesis [12].

Table 2. Palm oil hump diameter (cm) at various doses of boiler ash and tofu wastewater.

| Boiler ash (g) | Tofu wastewater concentration (%) |
|---------------|-----------------------------------|
|               | 0       | 60       | 80       | 100      |
| 0             | 6.37 cd | 8.24 abc | 7.64 bcd | 5.82 d  |
| 300           | 8.42 ab | 7.82 bc  | 7.63 bcd | 6.97 bcd |
| 350           | 7.35 bcd| 8.46 ab  | 9.85 a   | 7.26 bcd |
| 400           | 7.51 bcd| 7.44 bcd | 7.63 bcd | 6.97 bcd |
| 450           | 7.24 bcd| 7.57 bcd | 9.85 a   | 7.26 bcd |

Note: The numbers followed by the same letters in the same column show no significant difference using the DMRT test at α of 5%.

3.3. Root volume
The interaction between boiler ash and tofu wastewater has a significant effect on the root volume of palm oil seedlings (Table 3). The results showed that the interaction between 350 g boiler ash dose + 80% tofu wastewater and the interaction of 450 g boiler ash dose + 80% tofu wastewater has the highest root volume and differed from the control. Both interactions increased the volume of roots of palm oil seedlings by 47.28% compared to controls.

Table 3. Palm oil root volume (ml) at various doses of boiler ash and tofu wastewater concentration.

| Boiler ash (g) | Tofu wastewater concentration (%) |
|---------------|-----------------------------------|
|               | 0       | 60       | 80       | 100      |
| 0             | 19.33 b | 26.67 ab | 30.00 ab | 30.00 ab |
| 300           | 26.67 ab| 23.33 ab | 31.67 ab | 33.33 ab |
| 350           | 21.67 ab| 33.33 ab | 36.67 a  | 33.33 ab |
| 400           | 23.33 ab| 26.67 ab | 33.33 ab | 33.33 ab |
| 450           | 23.33 ab| 20.00 b  | 36.67 a  | 33.33 ab |

Note: The numbers followed by the same letters in the same column show no significant difference using the DMRT test at α of 5%.

The higher root volume is due to the application of boiler ash and tofu wastewater, besides providing nutrients for plants, it can also improve the physical condition of the soil so that the roots of the seedlings can develop properly. Boiler ash is ameliorant, which can improve physical properties besides providing nutrients needed by plants [3]. Additional nutrients from tofu wastewater also cause soil structure to become more crumbly and provide nutrients to the nursery media. Tofu wastewater is composed of carbohydrates, proteins, fats, and contains nutrients that can improve soil fertility [5].

3.4. Seedling dry weight
The interaction between boiler ash and tofu wastewater has a significant effect on the dry weight of palm oil seedlings (Table 4). The results showed that the interaction between 450 g of boiler ash + 80% tofu wastewater is the highest dry weight of seedlings. The interaction increased dry seedling weight by 39.17% compared to controls.
Table 4. The dry weight of palm oil seedlings (g) at various doses of boiler ash and tofu wastewater concentration.

| Boiler ash (g) | Tofu wastewater concentration (%) |
|---------------|-----------------------------------|
|               | 0       | 60     | 80     | 100    |
| 0             | 11.52 d | 11.76 d | 15.49 bc | 12.69 cd |
| 300           | 11.61 d | 11.30 d | 14.20 cd | 14.90 bc |
| 350           | 13.50 cd| 13.19 cd| 15.61 bc | 18.04 ab |
| 400           | 12.27 cd| 14.17 cd| 14.20 cd | 14.90 bc |
| 450           | 12.73 cd| 12.17 cd|          | 18.94 a  |

Note: The numbers followed by the same letters in the same column show no significant difference using the DMRT test at α of 5%.

The higher dry weight of seedlings is due to the nutrient, which can improve the physical, chemical, and biological characteristics of the soil. It can support the growth of palm oil seedlings. Organic matter has roles such as increasing cation exchange capacity, increasing solubility of phosphate in soil, providing nutrients, and enhancing the activity of soil microorganisms [13].

4. Conclusion
The interaction between boiler ash and tofu wastewater has a significant effect on the growth of palm oil seedlings in the nurseries. Interaction between boiler ash dose 350-450 g per polybag and 80-100% tofu wastewater concentration per polybag can increase the growth of palm oil seedlings.

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