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THE EFFECT OF EMPTY FRUIT BUNCH (EFB) BIOCHAR AND *TRICHODERMA* BIOFERTILIZER (TBF) COMBINATION ON THE GROWTH, YIELD, AND SELECTED NUTRIENT CONTENT OF CHILI PLANT (*CAPSICUM ANNUUM* L. VAR KULAI)

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ABSTRACT

The use of chemical fertilizers, specifically in chili cultivation, has increased crop yield. However, excessive application and improper management adversely affect the soil quality, ecosystems and human health. In addition to reduce the detrimental effect of chemical fertilizer, the use of organic amendments, such as EFB biochar and TBF, also solves the waste management issues in the oil palm industry. This study analyzed EFB biochar to determine its characteristics and selected nutrient content. Furthermore, the research evaluated the best ratio for the various applied combinations of EFB biochar and TBF to the growth and yield performance of chili plants. Besides, this study also investigated the effect of combined EFB biochar and TBF on soil physico-chemical properties and plant nutrient content of chili plants. This research employed a Randomized Complete Block Design (RCBD) with six treatments and four replications. The treatments include T1= 100% chemical fertilizer, T2= 100% EFB biochar, T3= 100% TBF, T4= 75% EFB + 25% TBF, T5= 50% EFB + 50% TBF, and T6= 25% EFB + 75% TBF. The chili plant was used as an indicator plant and cultivated in Red-yellow Podzolic Soil. The data collected for the characterization of EFB biochar included Fourier Transform Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA), Field Emission Scanning Electron Microscopy (FESEM), and Nitrogen-Phosphorus-Potassium (NPK) content analysis. The growth performance was assessed by collecting data at bi-weekly intervals, which comprised measurements of plant height (cm), stem diameter (cm), chlorophyll content, and plant biomass at harvest. The data acquired for the yield performance included the number of fruits per plant, the weight of fruit per plant (g), and the number of harvests. Soil analysis encompasses Nitrogen (N), Phosphorus (P), Potassium (K), Organic Carbon, Calcium (Ca), Magnesium (Mg), and Cation Exchange Capacity (CEC). Macronutrients and micronutrients such as Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Copper (Cu), Zinc (Zn), Iron (Fe), Manganese (Mn), and Boron (B) were analyzed in both shoot and root tissues of plants. The results revealed that EFB biochar contains high moisture content (65.79%) but low yield (34.03%), which only 6.81kg was successfully converted into biochar from 20kg of raw EFB. Various functional group was found in EFB biochar, such as the hydrogen-bonded hydroxyl group, alkane and alkene. The percent weight of EFB biochar was decreased at a temperature above 300°C. Meanwhile, the FTIR analysis shows high porosity and large surface area, which increase nutrient uptake. This study also revealed the positive impacts of EFB biochar combined with TBF on chili growth and yield compared to the control with the treatment T6 (25% EFB + 75% TBF) demonstrated promising results as the best ratios among other treatments. The study also reflected a positive effect of the combined application on the soil physico-chemical properties and plant nutrient content. These findings provide valuable insights into EFB biochar and TBF application for alternative chili production, reducing reliance on chemical fertilizers. However, further in-depth studies are essential before making recommendations for commercial settings.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

The United Nations has adopted the Sustainable Development Goals (SDGs) to address global sustainable development objectives, with SDG2 specifically focusing on ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture. This goal recognizes the need to modernize agricultural systems to ensure sustainable food security and long-term development, emphasizing the adoption of sustainable agricultural practices (FAO, 2016).

Conventional practices in chili (*Capsicum annuum* L.) cultivation, particularly chemical fertilizers, have increased crop yields and ensured food availability (Gou et al., 2020). Chemical fertilizers provide direct nutrients, mainly nitrogen (N), phosphorus (P), and potassium (K), which are essential for plant growth because the amount of nutrients, specifically NPK, in the soil such as Red-Yellow Podzolic Soil is insufficient compared to the number of nutrients the plant needs (Mohidin et al., 2009; Pahalvi et al., 2021).

However, the excessive use and improper management of chemical fertilizers have raised concerns about their long-term sustainability and impact on the environment, human health, and food systems (Bonanomi et al., 2020; Castellini et al., 2021; Kandpal, 2021; Mahmud & Chong, 2021; Parihar & Sharma., 2021; Rehman et al., 2022; Yang et al., 2021). Reducing and replacing chemical fertilizers is necessary to address these concerns and promote sustainable agriculture in line with the SDGs.

Organic inputs, such as biochar, offer a sustainable approach to mitigate the destructive effects of chemical fertilizers (Maitra et al., 2020; Etminani et al., 2020). Biochar is a carbon-rich product derived from organic materials, such as agricultural residues, produced through pyrolysis under oxygen-restricted conditions (Zhou et al., 2021). In Malaysia, the oil palm industry generates significant waste, including the fibrous outer layer surrounding the palm fruit known as Empty Fruit Bunch (EFB). Generally, EFB is produced approximately 26 to 30 million tons annually in the palm oil milling process (Zainuddin et al., 2018).