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DIFFERENT TYPES OF COMMERCIAL BIOFERTILIZERS EFFECTS ON GROWTH PERFORMANCE OF ZEA MAYS PLANTED IN PEAT SOILS

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Abstract:

Increasing cost of chemical fertilizers as well as their harmful effects on the soil has directed attention to other sources of soil fertilization. As such, alternative approaches which are sustainable and environmentally friendly are needed. Therefore, this study was carried out to evaluate the growth performance of *Zea mays* planted in peat soil treated with different types of commercial biofertilizers. The effects were investigated by using four different treatments, T0: control (chemical fertilizer), T1 (Biofertilizer A), T2 (Biofertilizer B) and T3 (Biofertilizer C), with three replications. The experiment was conducted using completely randomized design (CRD) design under greenhouse conditions. The height of the plants, number of leaves and number of fruits were all recorded for growth performance. The findings showed that T3 (Biofertilizer C) and T1 (Biofertilizer A) grew much faster and gave the best results, compared to other treatments. T0: control (chemical fertilizer) responded the least in terms of growth and yield. As a conclusion, *Zea mays* that are treated with commercial biofertilizer showed better growth performance than chemical fertilizer.

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Keyword:

Biofertilizer, Chemical, Nutrient, Peat Soil, Sustainable

Introduction

The long-term use of chemical fertilizers to boost crop yields without a balance of organic matter utilization often encounters significant challenges and contributes to soil deterioration (Xing et al., 2025). The use of ecologically friendly fertilizers, such as biofertilizers, can assist in improving soil fertility and supply nutrients that are unavailable to plants as a substitute for other methods of resolving this issue (Nosheen et al., 2021). Biofertilizers are compounds that have living cells from microorganisms in them. It acts through invading the plant's rhizosphere and boosts the nutrients of the host plant (Nisar et al., 2021). In addition, the microbes in biofertilizers are able to fix the nitrogen in air and phosphorus to enhance plant development by synthesized growth-promoting chemicals (Ahmad et al., 2006). Biofertilizer, which generally consists of a substance with microorganisms introduced to the soil to make specific nutrients directly or indirectly available to plants for their sustenance (Chaudhary et al., 2022). Biofertilizers come from a variety of sources, such as nitrogen fixers, rhizobacteria that promote plant development and phytostimulators that solubilize phosphate (Shekh, 2006). Additionally, biofertilizers contain beneficial bacteria and fungi that improve soil chemical and biological characteristics, phosphate solutions and agricultural production (Yosefi et al., 2011). Recently, the use of biofertilizers has become more important to achieve a high-quality output and sustainable environment (Shevananda, 2008). The availability of nutrients that plants can extract from soil has a significant influence on the physiology of plants' growth and development (Das et al., 2022). Although phosphate and nitrogen are necessary for plant growth, plants are only partially capable of extracting them from the environment (Timofeeva et al., 2023). As a result, plants depend on microbes engaged in "nutrient recycling" to assist them in absorbing these nutrients at their optimal concentrations while also providing food for the microbes. Plants have bigger and stronger roots because of this symbiotic interaction. The roots of the plants grow larger as they do, providing microorganisms with additional habitat and food. Microorganisms act somewhat as biofertilizers (El-kholy, 2005). Even though the positive effects of biofertilizer are renowned in the agricultural industry, the effects might differ due to different types of formulation as well as the microbes contained in the biofertilizer (Saif et al., 2021). On top of that, the effects of different types of biofertilizer applications on peat soils are unknown and the information is limited especially in tropical peat soils scope. Hence, this study aims to evaluate the effects of different types of commercial biofertilizers on growth performance of *Zea mays* planted in peat soils.

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Research Methodology

The experiment site was located at the greenhouse in the Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA (UiTM) Jasin Campus, Melaka from early March 2023 until the end of June 2023. The peat soil samples used in this study were collected from Parit Lapis Semarang, Batu Pahat, and Johor. The soil is verified as peat if the depth of organic layer >50cm in 100 cm profile and has a soil organic matter content of >65% (Paramananthan, 2016). The former criteria are confirmed in-situ by using the Eijkelkamp peat auger and the latter is analyzed in the laboratory following the loss on ignition method (LOI), where the soil is dried using oven (Binder: Model FD115E3.1) and dry-ashing using the muffle furnace (Naberterm: Model LE6/11B150). The seeds of *Zea mays* from the variety sweet corn were germinated for 7 days before being transplanted into polybag. The general field maintenance including watering and weeding was carried out according to standard procedure of planting *Zea mays*.
The following Table 1 indicates the treatment applied in this study:

Table 1: List of Treatments

Treatment	Description
T0	Peat soil + 10g NPK Fertilizer
T1	Peat soil + 20g Biofertilizer A
T2	Peat soil + 20g Biofertilizer B
T3	Peat soil + 20g Biofertilizer C

Note: Due to the confidentiality, the brand name of the biofertilizer is labelled A, B and C in this study.

The following Table 2 shows the list of nutrient contents, microbes and other ingredients in each respective chemical fertilizer and biofertilizers applied in this study.

Table 2: List of Ingredients for Each Treatment

Treatment	List of Ingredients
T0 (Chemical fertilizer)	NPK (9:6:18)
T1 (Biofertilizer A)	N=1.7%, P=2.5%, K=4.4%, MgO=1.2%, B=0.03%, CaO=5.5%
T2 (Biofertilizer B)	Mycorrhizae=5.0%, Trichoderma=0.1%, Bacteria NPK=0.1%, Dolomite=5.0%
T3 (Biofertilizer C)	N=5%, P=5%, K=5%, MgO=2%

Note: The percentage (%) of nutrients is as shown on the fertilizer bag

The treatments were arranged using the completely randomized design (CRD) with three replications for each treatment. The biofertilizer was applied every 2 weeks while the chemical fertilizer was applied according to the standard recommendation for *Zea mays* by the Department of Agriculture Malaysia (DOA, 2008). The plant growth performance measures include plant height, number of leaves and number of fruits. All data is statistically analyzed using IBM SPSS software where the differences among treatments were tested using analysis

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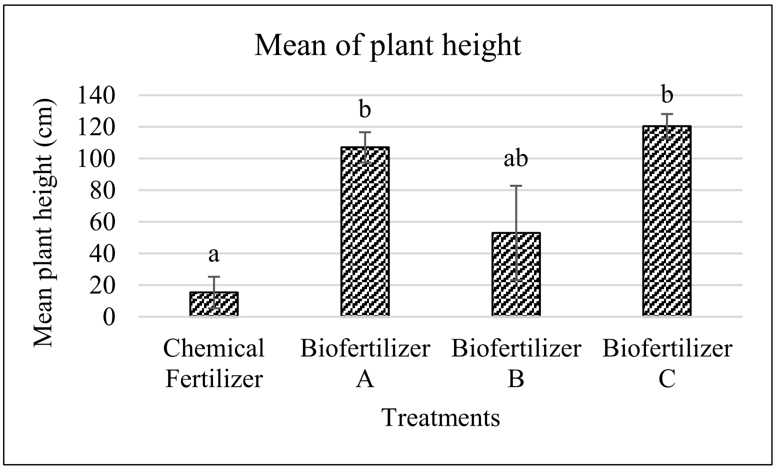
of variance (ANOVA) and the significant treatments were further identified using a post-hoc test.

Result and Discussion

This study was carried out to evaluate the growth performance of *Zea mays* planted in peat soil treated with four different treatments, T0: control (chemical fertilizer), T1 (Biofertilizer A), T2 (Biofertilizer B) and T3 (Biofertilizer C). The growth performance was measured using several parameters, specifically the plant height, number of leaves and number of fruits.

Plant Height

From the ANOVA, there is a significant difference observed between treatments where the p-value=0.008 (p-value<0.05). The following Figure 1 shows the mean plant height of the plant for different treatments. From the figure, the highest mean plant height was achieved by *Zea mays* treated with Biofertilizer C (T3) with mean height of 120.33 cm, followed by Biofertilizer A (T1) with μ=107 cm, Biofertilizer B (T2) with a μ=53 cm and chemical fertilizer (T0) with μ=15.33 cm, respectively. There is a significant difference between T0 with T1 (Biofertilizer A) and T3 (Biofertilizer C) but shows no significant differences with T2 (Biofertilizer B). The findings suggest that the application of biofertilizer is able to enhance the elongation of the plant height compared to chemical fertilizer. As stated by Sindhu et al., (2010) in their study, the application of biofertilizer enables microorganisms to release the plant growth stimulating hormones which help in elongation of root and shoot, further leads to plant growth and crop yield improvement.



Note: Chemical fertilizer=T0, Biofertilizer A=T1, Biofertilizer B=T2 and Biofertilizer C=T3

Figure 1: Mean of Plant Height for Different Treatments

This also in line with the characteristics features and applications of microorganisms where the microbial inoculants help in growth directly or indirectly by fixing nitrogen (N), by solubilization of phosphorus (P) and potassium (K), by secreting siderophores, antibiotics, enzymes, antifungal, and antibacterial substances, and by releasing plant growth promoting hormones to enhance productivity and adaptability to overcome biotic and abiotic stresses (Chakraborty and Akhtar, 2021). These natural processes of excretion and fixation can therefore contribute significantly to sustainable agriculture as they are intrinsically environmentally friendly (Ali et al., 2021).

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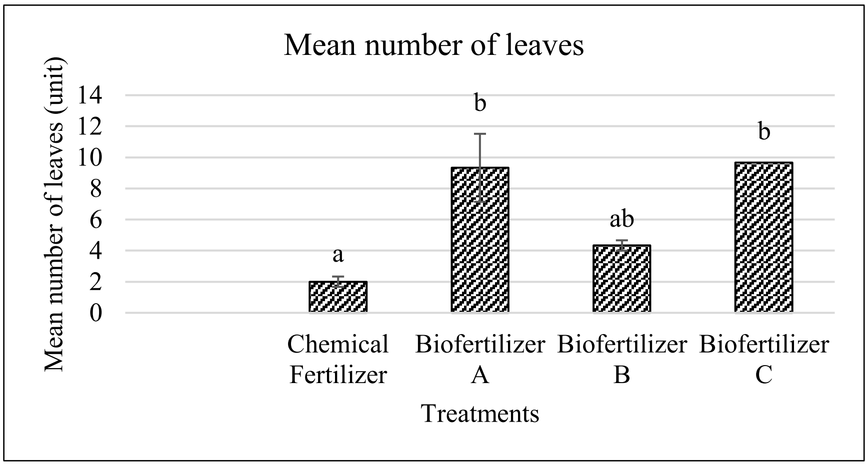
Number of Leaves

From the ANOVA, there is a significant difference observed between treatments where the p-value=0.006 (p-value<0.05). The following Figure 2 shows the mean number of leaves of the plant for different treatments applications. The mean number of leaves as shown in Figure 2 indicates that Zea mays treated with Biofertilizer C (T3) able to produce highest mean number of leaves with μ=9.67 unit, followed by Biofertilizer A (T1) with μ=9.33 unit, Biofertilizer B (T2) with μ=4.33 and chemical fertilizer (T0) with μ=2 unit. There is a significant difference observed between T0 with T1 (Biofertilizer A) and T3 (Biofertilizer C) whereas no significant differences are observed between T0 and T2 (Biofertilizer B).



Note: Chemical fertilizer=T0, Biofertilizer A=T1, Biofertilizer B=T2 and Biofertilizer C=T3

Figure 2: Mean Number of Leaves for Different Treatments

This finding suggested that the application of biofertilizers is able to increase the leaves production of *Zea mays* and the use of Biofertilizer C (T3) is capable of doubling the number of leaves produced compared to T0 and T2. Even though the percentage of NPK in the biofertilizers is slightly lower than those in chemical fertilizers, the supply of microbes into the soil is believed to improve the nutrient availability in peat soils. This is well explained in the research conducted by Yadav et al., (2021), stating that the existence of different groups of soil microbes plays a naturally significant role including nutrients cycling, recycling of ground water, maintenance of soil fertility and decomposition of organic matter. In addition, various composition and microbial activities give positive impacts to soil quality status, health, and nutrient enrichment. Through their varied functions, they stimulate plant growth and reduce diseases (Nabi, 2023).

Number of Fruits

From the ANOVA, there is no significant difference observed between treatments where the p-value=0.085 (p-value>0.05). The following Figure 3 shows the mean number of fruits of the plant for different treatments applications. The mean number of fruits as shown in Figure 3 indicates that *Zea mays* treated with Biofertilizer C (T3) able to produce highest mean number of fruits with μ=1 unit, followed by Biofertilizer A (T1) with μ=0.67 unit, Biofertilizer B (T2) with μ=0.67 and chemical fertilizer (T0) with no fruit production. This finding showed that the positive growth of plant height and number of leaves do have an impact in fruit production, even though the yield is quite low compared to normal production. The reason is suspected to

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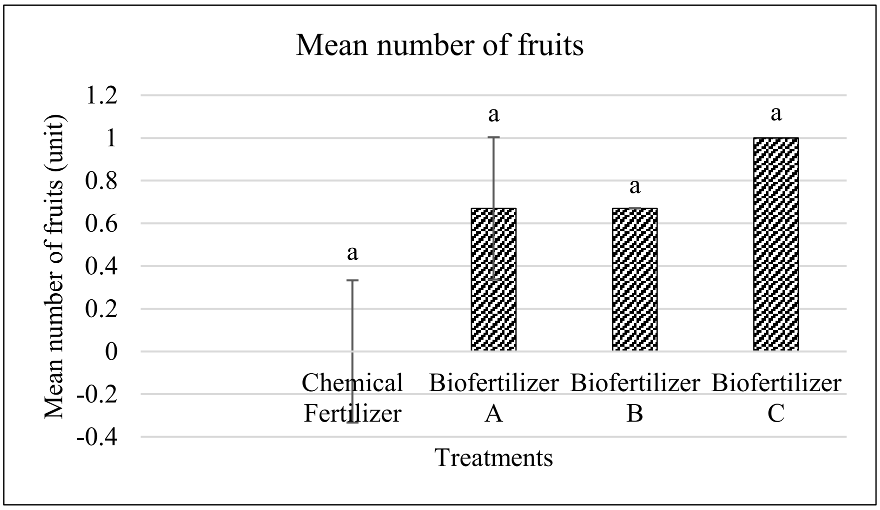
be due to the properties of the peat soils which have low exchangeable bases, especially potassium (K), which plays an important role in fruit production. It is renowned that the peat soils are typically acidic and nutrient-deficient, which negatively impacts the growth, yield, and quality of fruits. The acidity and lack of essential nutrients like nitrogen, phosphorus, and potassium limit plant growth and fruit development. Hence, the application of soil amendment needs to be considered when dealing with peat soils to improve the nutrient availability (Choo et al., 2022). Additionally, the application of K-fertilization regime could improve the quality and condition of fruits at harvest and post-harvest even though the impacts can significantly vary depending on season and locality (Bustamante et al., 2021).



Notes: Chemical fertilizer=T0, Biofertilizer A=T1, Biofertilizer B=T2 and Biofertilizer C=T3

Figure 3: Mean Number of Fruits for Different Treatments

Conclusion and Recommendation

In conclusion, this study found that the application of biofertilizer able to enhance the growth performance of *Zea mays* planted in peat soils, with Biofertilizer C (T3) shows the most significant impact for all parameters studied, namely the plant height, number of leaves and number fruits. However, the scope of this study is limited to the plant growth performance, and it is recommended to expand the scope into the soil parameters where the contribution of soil properties and microbial population are taken into consideration.

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Author Contribution Statement: All authors contributed significantly to the development of this manuscript. Nur Izzah Hasrul was responsible for early conceptualization, conducting the experiment and drafting the early write-up. Nur Masriyah Hamzah was responsible for the data collection, analysis, and interpretation of results. Nurul Hidayah Mohd Khairlani contributed to the literature review and proofreading of the manuscript. Nur Qursyna Boll Kassim drafting handle the overall supervision of the study. All authors read and approved the final version of the manuscript prior to submission.

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