OPEN ACCES
Vol. 17 No. 2: 215--222
Oktober. 2024
Peer-Reviewed ☑

AGRIKAN - Jurnal Agribisnis Perikanan
(E-ISSN 2598-8298, P-ISSN 1979-6072)
URL: http://www.jurnal.ummu.ac.id/index.php/agrikan
https://doi.org/10.52046/agrikan.v17i2.215-222

Response of Cucumber CU 699 to Solid Organic Fertilizer Waste Meal Worm Frass and Corn Cob Biochar

Saimul Laili [1]✉, Sama'Iradat Tito [2], Khafivatul Fikriyah [3]

[1] *Jurusan Biologi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Islam Malang, Jl. MT. Haryono 193 Malan, 65144, Indonesia.*

Email: saimul.laili@unisma.ac.id

☑ **Article Info:**

Received : 19 Sept. 2024
Accepted : 8 Okt. 2024
Online : 12 Okt. 2024

Article type :

	Riview Article
	Common Serv. Article
√	*Research Article*

Keyword :
Corn Cob Biochar, Frass, Cucumber

✉ **Corresponding Author :**
Saimul Laili
Universitas Islam Malang, Malang, Indonesia

Email :
saimul.laili@unisma.ac.id

Abstract

The cucumber plant (Cucumis sativus L.) is one of the plants that has high economic prospects in Indonesia. The use of cucumber plants is known in various health, beauty, and consumption industries, but over the years cucumber production has decreased due to various things, one of which is the cultivation system. Frass and corn cobs are waste that can be processed into fertilizer and biochar, where this material can restore the revitalization of agricultural land and support growth. The purpose of this study is to analyze the response of cucumber plants CU 699 to the use of solid organic fertilizer for the waste of frass mealworm and corn cob biochar, as well as to determine the best treatment for plant growth. This study uses the Petal Random Design (RAK) method. Data analysis using One Way ANOVA and Tukey HSD follow-up test. The parameters measured include the number of leaves, leaf size, stem height, root length, and dry weight of the plant. The results showed that the application of mealworm frass and corn cob biochar had an effect on plant growth. The best treatment for cucumber growth is at P3B3.

I. INTRODUCTION

Plant production is greatly influenced by the quality of agricultural soil. Horticultural crop cultivation has very bright economic prospects in Indonesia. One of the horticultural crops is cucumber (*Cucumis sativus* L.) because it has many uses in various industries. The CU 699 immune ment plant is a cucumber from one of the superior varieties because it has a sweet, crispy taste, and is suitable for consumption. However, in Indonesia, cucumber production is still relatively low, namely 3.5-4.8 tons/ha, so it is necessary to make efforts to increase the amount of production in order to meet the needs of the national market [1].

The use of meal worm frass into fertilizer and corn cobs into biochar is one of the efforts to increase soil revitalization and support plant growth. Organic fertilizer is able to improve the physical, chemical, and biological properties in the soil without causing adverse effects on the environment [2].

Frass is any form of insect residue (feces, cuticles, and bodies) that is in the form of fine, dry, odorless, and light granules. Frass is rich in citin and has the property of being easily decomposed in the soil. The use of organic fertilizer from the meal worm frass is able to supply the needs of N, P, and K equivalent to manure [3]. Meal worm dung is one of the livestock wastes that has not been utilized optimally. Meal worm manure can be converted into compost by fermentation using EM4. Microorganisms contained in EM4 include *Lactobacillus* sp, *Actinomycetes* sp, *Streptomycetes*, photosynthetic bacteria, and yeast. These microorganisms can help compost by lowering organic C/N until the level is equivalent to soil. In addition, there are changes in chemical elements such as carbohydrates, cellulose, hemicellulose, fats, and waxes that will be converted into CO_2 and H_2O.

Frass also contain exoskeletons formed from the decomposition of insect body parts containing chitin [4]. Chitin that has been degraded by citinolytic bacteria in the soil will turn into certain compounds that are able to increase plant immunity. The result of this degradation is able to create an optimal medium to activate rhizobacteria. Insect frass can provide resistance to plants in several ways, such as increasing microorganisms to induce a resistance system and stimulating plants to maintain the immune system [5].Various studies have proven that the use of insect frass as fertilizer is able to provide organic elements in the form of N, P, and K which are able to stimulate the growth of grass and zucini plants [6]. Plant growth is also driven by soil aeration factors stimulated by active microbes

The corn cob can be processed into biochar which is able to increase soil absorption due to the porous structure of biochar. Biochar is the result of incomplete combustion of organic matter in conditions of low oxygen [7]. Biochar is able to restore soil conditions by adding aeration and retaining heavy metal solvents in the soil [8]. The addition of organic matter in the form of biochar is able to restore soil conditions damaged due to prolonged land use, besides that it can also increase the strength of the soil to hold water so that the nutrient content also increases. The large amount of pore content in biochar can increase the ability of soil to retain water, because the presence of pores indicates good soil aggregation [9].

The process of changing the physical properties of soil is influenced by biochar which occurs through two mechanisms. The increase in soil porosity occurs due to the addition of porous biochar. This process occurs directly immediately after the biochar is applied. Porosity by biochar is able to increase soil capacity to hold water and decrease *bulk density* (BD). The second mechanism occurs due to the indirect addition of biochar. This process takes longer to decompose the biochar material by the soil, so it will form a convenient medium for the propagation of microorganisms. This organism will support the development of plant roots so that this process is classified as a biological change in soil structure [10].

Corn cob biochar has different chemical content and properties when compared to other biochar. Corn cob biochar has a structure that is easier to decompose at a temperature of 300-400°C, this leads to a shorter production time. Corn cob biochar has a neutral pH that is alkaline because there are changes in cellulose and hemicellulose in the pyrolysis process, where this material contains volatile substances that can lower the pH of a material. The conversion of cellulose and hemicellulose into organic and phenolic acids is what is able to produce alkaline properties in biochar. The distribution of phenolic and carboxyl acids on the surface of the biochar determines the KTK value. In addition, the high C content is caused by carbonization by non-carbon atoms [11].

This study is expected to be able to analyze the response of CU 699 cucumber plants to the use of solid organic fertilizer for the waste of meal worm frass and corn cob biochar, as well as determine the best treatment for plant growth.

II. MATERIAL AND METHODS

This research was carried out in an experimental garden on Jl. Kalimalang, Tawangargo, Karangploso District, Malang Regency in March-May 2024. This study used the Petal Random Design (RAK) method by applying corn cob biochar and hongkong caterpillar frass which each consisted of 4 levels. So in this study there were 16 treatment combinations with 3 repetitions. The combination of biochar and fertilizer treatment can be seen in Table 1.

Table 1. Combination of Biochar and Fertilizer Treatment

Biochar	Meal Worm Frass Fertilizer			
	P0 (*0 g*)	P1 (*80 g*)	P2 (*160 g*)	P3 (*240 g*)
B0 (*0 g*)	P0B0	P1B0	P2B0	P3B0
B1 (*80 g*)	P0B1	P1B1	P2B1	P3B1
B2 (*160 g*)	P0B2	P1B2	P2B2	P3B2
B3 (*240 g*)	P0B3	P1B3	P2B3	P3B3

Tools and Materials. The tools used include thermometers, cameras, rulers, shovels, scales, hoes, 35 x 35 polybags, raffia ropes, poles, ovens, buckets, and *a 4 in 1* soil meter. The materials used in this study include cucumber seeds of the CU 699 variety (brand: Bintang Asia), andosol soil, promectin 60 insecticide (BA: abamectin), water, H_3PO_4 14% solution, EM4, corn cob biochar, meal worm frass. The variables in this study include the number of leaves, leaf size, stem height, root length, wet and dry weight of the plant. Soil moisture and light intensity are measured through a table of indications, namely:.

Table 2. Soil Moisture Indication

Dry +	Dry	Nor	Wet	Wet+
Very dry	Dry	Usual	Wet	Very wet

Table 3. Light Intensity Indication

Indication	Information
L-	Very dim
L	Dim
L+	Slightly Dim
N-	A Little Normal
N	Usual
N+	Normal Bright
H-	Slightly Height
H	Tall
H+	Very High

Meal Worm Frass Fermentation and Corn Cob Biochar Manufacturing. Fermentasi begins by preparing meal worm frass obtained. Dissolve sugarcane molasses in clean water at a rate of 10 ml/ 1 L, and add 10 ml of EM4. The solution that has been made is left for 24 hours to activate the bacteria in it. The activated solution is mixed with the meal worm frass until the humidity reaches 40-50%. The fermentation of the meal worm frass is carried out in an airtight and light-proof barrel, and left for 6 weeks until color to blackish-brown.

The corn cobs are then burned for 5 minutes until they turn blackish. The biochar is aerated to lower its temperature, and when it is cold, the biochar is put into sacks to be crushed into smaller shapes. The finely refined biochar is put into a bucket for activation with a 14% H_3PO_4 solution for 24 hours.

Media Preparation and Planting. Prepare polybags filled with soil and biochar that have been activated with a 14% H_3PO_4 solution for 24 hours and compost according to the combination of treatments. Cucumbers are planted and grown until the age of 14 days. Cucumber seedlings were selected for a total of 48 seedlings to receive the predetermined treatment. Cucumbers that are 14 days old are given biochar treatment, and at the age of 21 days cucumber plants begin to be fertilized according to the specified amount.

The 14-day-old cucumber was given a support pole made of bamboo shaped by a T with a length of 150 cm and attached to the edge of the polybag. Pest control by applying abamectin insecticide. Observations were made when cucumbers were 14 days old after planting periodically every 3 days until the plants were 55 days old after planting (HST).

Data Analysis. The data obtained was analyzed with the SPSS application of *the One Way* ANOVA method and continued with Tukey HSD Test to determine the best treatment.

III. RESULTS AND DISCUSSION

3.1. Number of Leaves

The observation of the number of leaves after 55 HST can be seen in figure 1.

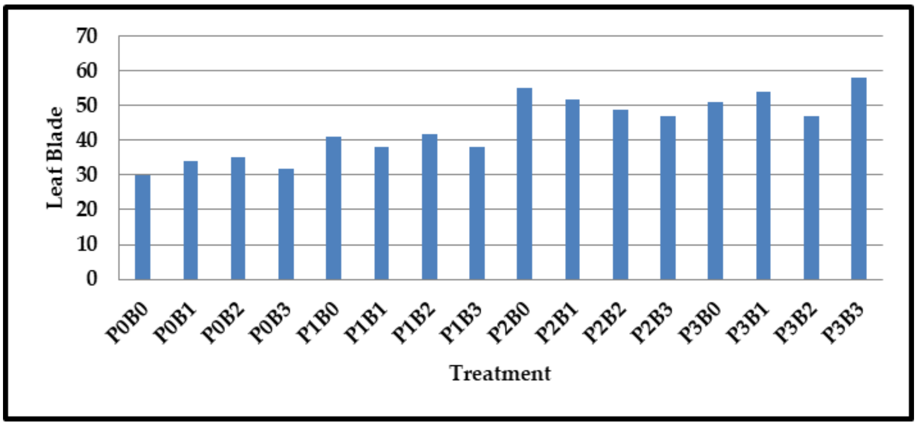

Figure 1. Average Number of Leaves

Based on figure 1, it can be seen that the highest number of leaves is in the P3B3 treatment with a total of 58 leaves, while the lowest number of leaves is in P0B0 or control with a total of 30 leaves. In the amber g, it can be seen that the application of solid fertilizer and biochar has a significant influence on the number of leaves.

Based on the statistical test of anova and tukey HSD, the average number of leaves has significant results. In the Tukey HSD follow-up test, the average number of leaves was divided into

10 different groups. The first group had the same average number of leaves consisting of P0B0 and P0B3 treatments, in this group indicated that the average number of leaves had a low value. While the tenth group which is the highest group is P3B3. Based on the follow-up test, it is known that the average number of leaves is lowest in group one, namely P0B0 and P0B3, while the average number of leaves is the highest in P3B3. Based on figure 7, it can also be seen that the average difference in the number of leaves between the P0B0 and P3B3 treatments is 28 leaves.

The application of hong kong caterpillar frass solid fertilizer and biochar gives significant results in cucumber plant growth. According to [12], insect frass has been shown to have a rhizobacteria content that is able to increase nitrogen and stimulate plant growth. The decomposition of frass and insect larvae is also able to increase microbes in the soil, this material triggers mineralization, accelerates nitrogen immobilization and increases respiration in the soil [13].

The growth of cucumber plants is also supported by the addition of biochar. Biochar is the result of incomplete combustion of various organic materials that contain C, H, O, N, and calcium ash. This element is able to improve the condition of acidic soil and increase pH. The porous structure of biochar also supports the aeration power of the soil in dry land so that the ability of plants to absorb nutrients can be increased [14]. The ability of roots to absorb nutrients has a positive correlation with plant growth, the more nutrients are absorbed, the growth rate will increase.

3.2. Leaf Size

Based on the results of the study after 55 HST, a comparison graph of the average leaf size can be seen in the following figure:

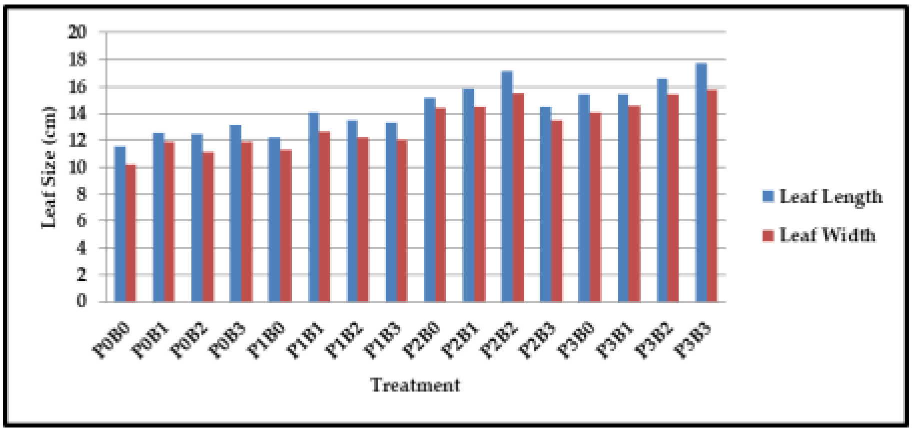

Figure 2. Average Leaf Size

Based on figure 2, it is known that the average size of the leaf and the highest leaf width are in the P3B3 treatment, which is 17.7 cm long and 15.8 cm wide. The lowest leaf size, namely P0B0 treatment, has a lengthof 11.6 cm and a width of 10.2 cm.

The morphology of cucumber leaves has an *orbicularis* shape with a length and width that is not much different. Based on the observation results, the highest leaf length and width were in the P2B2 treatment. Leaves are important organs that are responsible for absorbing sunlight energy because they have chlorophyll and correlate with photosynthesis results. The wider the leaf index, the greater the chlorophyll content in it, so that light absorption also increases. This light will be converted into sugar as a result of the photosynthesis process [15]. The wider the leaf index, the more the weight of the leaf also increases, because the leaf has water content like other plant organs. The increase in leaf weight will also increase the overall plant weight [16].

The addition of frass below 1% is able to increase the chlorophyll index during the growth period of the plant. Although the P and K content is relatively low, high C and N in frass can increase leaf size, so frass is more suitable for foliage, cereals, corn, lettuce, grasses, and chickpeas [17].

3.3. Steam Height

Stem height after 55 HST had a significant difference in each treatment. The observation results can be seen in figure 3, as follows:

Based on figure 3, it can be seen that the average result on the rod height parameter is P3B3 treatment with a rod height of 249 cm. The lowest value is P0B0 with a height of 105 cm. Based on the results of the statistical test, the average height of the rod showed significant results, and in the HSD tukey test it was divided into 6 groups. The first group has the same average height, consisting of P0B0, P0B1, and P0B3. While the sixth group has the same average height, consisting of P1B1, P2B0, P2B3, P3B0, P2B1, P3B1, P1B3, P2B2, P3B3, and P3B2.

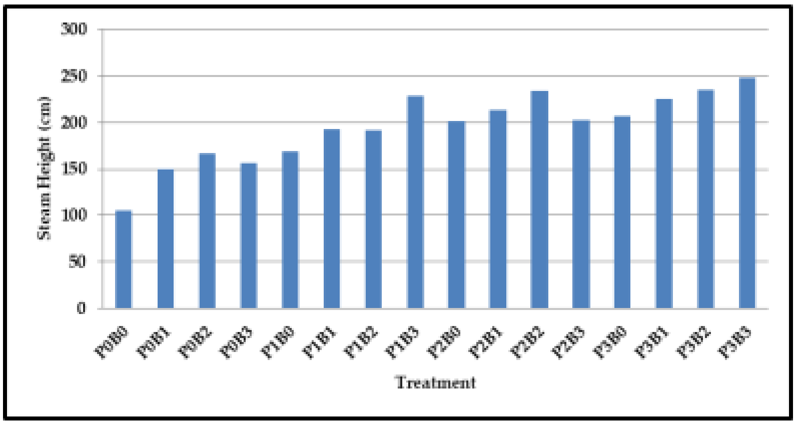

Figure 3. Average Stem Height

Nitrogen is an important element in plant growth. The high N content in the frass of the meal worm is able to increase the plant biomass during the growth period, the higher the supply of N, the more the plant biomass will also be positively correlated. Frass has been tested to have a better ability to supply N and improve root absorption in the short term during the growth process. This is the difference between frass fertilizer and other materials that usually absorb N more slowly. Frass have a structure that is easily degraded by the environment but has complete components as a source of nutrients, so it can be used as an alternative for sustainable fertilizer production [18].

According to [19], it is stated that the N content in frass is better than NPK fertilizer. At a total of 10 tons/ha, it is able to significantly restore the ability of soil microbes and stimulate the use of carboxylic acid. Plant growth is also supported by biochar that is able to maintain pH balance so that soil acidification does not occur, and set the pH within a neutral limit.

Meal worm frass fertilizer has a high N level and is able to stimulate plant growth in the vegetative period. The benefits of nitrogen for plants are supplying protein in the planting medium, increasing the production of foliage plants by increasing the size and weight of fresh, stimulating the proliferation of beneficial microorganisms in the soil, and increasing the synthesis of amino acids in plants [20]. The addition of EM4 in the fermentation process of hongkong caterpillar frass can also minimize pathogenic pests in the planting medium.

3.4. Root Length

The length of the roots is measured from the base of the stem to the tip of the root by dismantling the polybag after the harvest period is complete. The observation results can be seen in the following figure 4:

Based on figure 4, it can be seen that the average root length has different values in each treatment. In the figure, it can be seen that the highest value is in P3B3, which is 122.6 cm, while the lowest value is in P0B0, which is 49. This difference can also be seen from the number of root branches that grow in each treatment. In P0B0, the roots are very easy to pull out because of the small number of branches, in addition to the minimal supply of nutrients so that it has an impact on the strength of the roots in holding or gripping the soil.

In contrast to the treatment that is given high doses of fertilizer and biochar, the roots are very difficult to uproot because their ability to hold the soil is quite high, in addition, in the P2B1 to P3B3 treatment, the roots grow and enter the soil through the gaps in the polybags on the bottom side. In this condition, the researcher must dig the soil as far as the tip of the root grows to determine its length. Hard soil causes the observed roots to break easily.

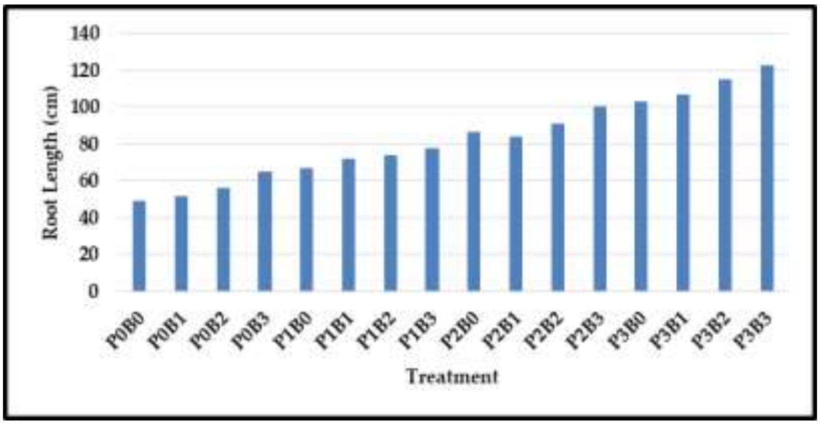

Figure 4. Average Root Length

The root length statistical test, showed significant results in both the anova test and the HSD tukey test between treatments. In the follow-up test, the average root length was divided into 8 groups. Cucumbers need a spacious medium for their root growth, and a suitable size of polybag can optimize root growth. In addition, as many as 75% of the treatment experienced root growth, penetrated the soil and exited through the hole under the polybag. The growth of roots into the soil occurs in the treatment of biochar and fertilizer. The higher the dose given, the harder it is to uproot and the deeper the coverage of the growth direction. Complex nutrients in frass stimulate the root mass of cucumber plant root growth [20].

3.5. Wet and Dry Weight Plant

The measurement of wet weight and dry weight aims to determine the carbohydrate content that occurs through the process of photosynthesis. Dry weight has a lower mass because it is the result of reducing the overall mass of the plant with moisture content. Measurements of the wet weight of the plants are carried out as soon as possible after the plants are uprooted, this is done to avoid reducing the moisture content of the plants. The average wet weight and dry weight are presented in the following figure 5:

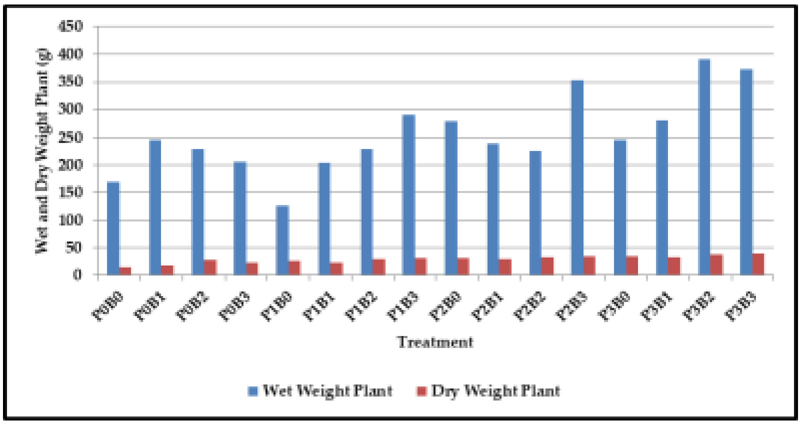

Figure 5. Average Weight Wet and Dry

Based on figure 5, it can be seen that the highest wet weight of the plant is P3B2 treatment with a value of 391 g, while the highest dry weight is P3B3 with a value of 39 g. The lowest result for wet weight was P1B0 treatment with a value of 169 g for wet weight and 14 g for dry weight. Based on statistical tests, the average wet weight and dry weight of anova and tukey HSD showed significant results.

Wet weight is the overall weight of the plant from the crown to the tip of the root without a drying process. Wet weight can also be defined as the total weight of the plant which includes the entire process of photosynthesis and water. Meanwhile, dry weight is the result of photocentite accumulation without water. Based on the results of the study, the wet weight of the plant was the highest, namely the P3B2 treatment, but in this treatment it had a lower dry weight than the P3B3 treatment. This is suspected because the ability of plants to absorb nutrients tends to be low, but the ability to absorb water is quite high.

The highest dry weight of plants is P3B3 treatment, this is suspected because in this treatment the plant has the ability to absorb nutrients well. Frass caterpillars have N, P, and K content equivalent to those found in farm manure, but it is possible that frass also has micronutrients such as Cu and Zn that help stimulate growth [3]. Frass also has the potential as a Ca supply agent, this is proven based on the structure of frass which has an outer layer and isolates Ca minerals.

IV. CONCLUSION

The response of cucumber plants CU 699 to the use of solid organic fertilizer waste from hongkong caterpillar frass and corn cob biochar has a significant effect on plant growth. The best treatment for the response of cucumber plants CU 699 to the use of solid organic fertilizer for the waste of hongkong caterpillar frass and corn cob biochar is the P3B3 treatment.

ACKNOWLEDGMENT

We would like to thank Allah SWT and all parties who support the writing of this article. We realize that there are still many things that need to be improved in writing this article, but we will continue to learn so that in the future it can be even better.

REFERENCES

[1] Dermawan AG (2022) Respon Produksi Buah Timun Terhadap Pemangkasan dan Jenis Mulsa. *Jurnal Ilmu Pertanian*, 1-6.

[2] Sarumaha MD (2022) Edukasi Pembuatan Book Chapter Catatan Berbagai Metode & Pengalaman Mengajar Dosen di Perguruan Tinggi. *Jurnal Pengabdian Kepada Masyarakat* , 3 (2): 150155.

[3] Houben D, Guillaume, D, Michel-Pierre F, dan Anne-Maimiti D (2020) Potential use of Mealworm Frass as a Fertilizer: Impact on Crop Growth and Soil Properties. *naturesearch*, 10(6459): 1-9.

[4] Chavez M, dan Uchanski M (2021) Insect left over substrate as plant fertilizer . *Insect Food Feed*, 7, 683-694.

[5] Barragan-Fonseca KY, Nurfikari A, Van De Zande EM, Wantula M, Van Loon JJ, De Boer W, Dicke M (2022) Insect frass and exuviae to promote plant growth and health. *Trends Plant Sci*, 27: 646-654.

[6] Zim J, Aitikkou A, EL Omari MH, EL Malahi S, Azim K, Hirich A (2022) A new organic amendment based on insect frass for zucchini (*Cucurbita pepo* L.) cultivation. *Environ. Sci. Proc*, 16, 28-35.

[7] Safitri NI, Setiawan T, dan Bowo C (2018) Biochar Dan Kompos Untuk Peningkatan Sifat Fisika Tanah Dan Efisiensi Penggunaan Air. *Jurnal Penelitian: Techno*, 116-127.

[8] Damris, Hidayat AP, dan Prabasari G (2019) Pengaruh Penambahan Biochar dari Batubara Lignite pada Tanah Bekas Pembangunan Batubara Terhadap Konsentrasi Logam Kadmium (Cd) terlarut Menggunakan Kolom Fixed Bed Adsorption. 1-16.

[9] Hanim N, Khairullah, dan Jufri Y (2021) Pemanfaatan Biochar dan Kompos Limbah Pertanian untuk Perbaikan Sifat Fisika Tanah, Pertumbuhan dan Hasil Jagung pada Lahan Kering. *Jurnal Ilmiah Mahasiswa Pertanian*, 6(4): 707-718.

[10] Nurida NL, Dariah A, dan Rachman A (2013) Peningkatan Kualitas Tanah dengan Pembenah Tanah Biochar Limbah Pertanian. *Jurnal Tanah dan Iklim*, 37(2): 69-78.

[11] Sukmawati (2020) Bahan Organik Menjanjikan dari Biochar Tongkol Jagung, Cangkang dan Tandan Kosong Kelapa Sawit Berdasarkan Sifat Kimia . *J. Agroplantae*, 9(2): 82-94.

[12] Poveda J, Jimenes Gomes A, dan Santamaria S (2019) Mealworm Frass as a Potential Biofertilizer and Abiotic Stress Tolerance Inductor in Plants . *Applies Soil Ecology*, 142: 110-122.

[13] van de Zande ME (2024) Soil Amandement with Insect Frass and Exuvie Affects Rhizosphere Bacterial Community, Shoot Growth and Carbon/ Nitrogen Ratio of a Brassicaceous Plant. *Plant Soil*, 495: 631-648.

[14] Mautuka ZA, Astriana M, dan Martasiana K (2022) Pemanfaatan Biochar Tongkol Jagung Guna Perbaikan Sifat Kimia Tanah Lahan Kering. *Jurnal Ilmiah Wahana Pendidikan*, 8(1): 201-207.

[15] Suasarna M, I PP, dan Kadek AG (2019) Pengaruh Konsentrasi Nutrisi Ab Mix terhadap Pertumbuhan dan Hasil Sawi Pakcoy (*Brassica Rapa* L.) dengan Hidroponik Sistem Sumbu (Wick System). *Agro Bali*, 2(2): 98-105.

[16] Antoniadis V, Aikaterini M, Aspasia G, Vaseleios A, Christos GA, Christos IR, dan Efi L (2023) Insect Frass as a Novel Organic Soil Fertilizer for the Cultivation of Spinach (*Spinacia oleracea*):

Effects on Soil Properties, Plant Physiological Parameters, and Nutrient Status. *Journal of Soil Science and Plant Nutrition*, 23: 5935-5944.

[17] Kolton M, Graber ER, Tsehansky L, Elad Y, dan Cytryn E (2017) Biochar-stimulated Plant Performance is Strongly Linked to Microbial Diversity and Metabolic Potential in the Rhizosphere. *New Phytol*, 213: 1393-1404.

[18] Chakraborty A, Chakrabarti K, dan Ghosh S (2011) Effect of Long-Term Fertilizer and Manure Application on Microbial Biomass and Microbial Activity of a Tropical Agriculture Soil. *Biol. Fertil. Soils*, 47: 227-233.

[19] Syahfari H, Hery S, Marisi N, Abdul R, Masriyah, Akas PS, dan Isna (2023) Pembuatan Nutrisi Organik Tanaman (NOT) Bokashi di Kelompok Tani krida Karya Utama Lempaka Jaya Samarinda Utara. *Jaus*, 1(1): 13-28.

[20] Moarrefzadeh N, Hadi K, dan Maryam D (2023) Application of Mealworm Frass, Mycorrhiza, and Vermicompost Agains Rhizoctonia Root Rot Disease and Their Effect on the Growth Parameters of Bean Plants. *J. Crop Prot*, 12(2): 209-225.