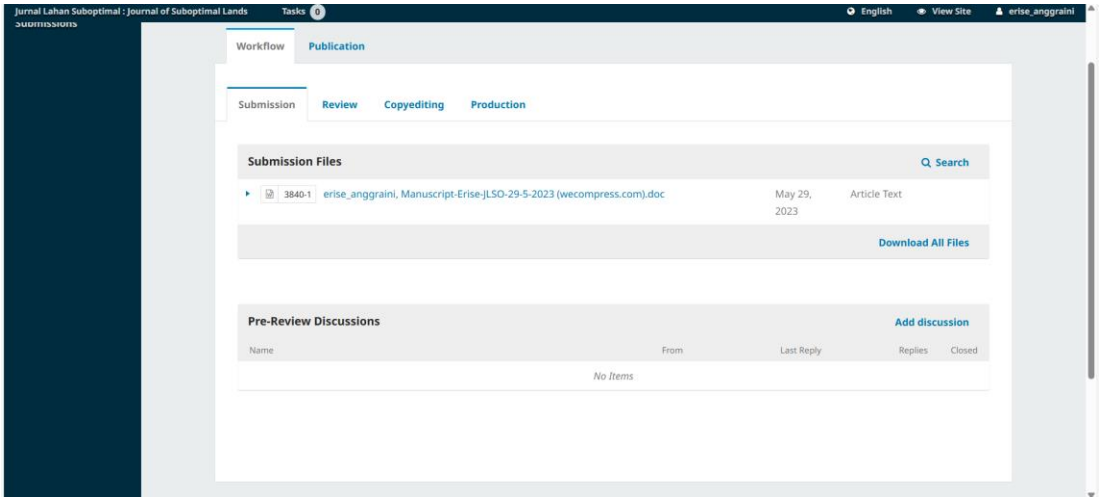
BUKTI KORESPONDENSI RESPONDENSI DAN SUBSTANSI ISI
ARTIKEL JURNAL NASIONAL TERAKREDITASI SINTA 3

Judul : The Application of Compost Extract and Biopesticide in Three Different Varieties of Soybean (*Glycine max* L.)
Jurnal : Jurnal Lahan Suboptimal
Penulis : Erise Anggraini, Nuni Gofar, Teguh Randi Pradana, Wahyu Tri Patria, Diana Sinurat
Kontribusi : Penulis Pertama dan Korespondensi

No.	Perihal	Tanggal
1.	Submission	29 Mei 2023
2.	Peer review round 1	26 Juni 2023
3.	Submission Accepted	2 Oktober 2023
4.	Final Paper	2 Oktober 2023

1. Submission

Submission (29 Mei 2023)



COVER LETTER

Dear Editor-in-Chief,

I herewith enclosed an article,

Title:

THE APPLICATION OF COMPOST EXTRACT AND BIOPESTICIDE IN THREE DIFFERENT VARIETIES OF SOYBEAN (*Glycine max* L.)

Author names:

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For possibility publication on the journal:

Jurnal Lahan Suboptimal : Journal of Suboptimal Lands

Novelty:
(state your claimed novelty of the findings)

This research revealed the alternative solutions in the reuse of shrimp shell waste and mushroom substrate media to be a compost extract. Also the use of compost extract and bioinsecticides could increase soybean productivity and also can suppress the insect pest attacks. The application of compost extracts and biopesticides on soybean plants is expected to reduce the use of chemical fertilizers and pesticides in soybean cultivation.

Statements:

This manuscript has not been published and is not under consideration for publication to any other journal or web hosting either by me or other authors. All the authors have approved the paper for release and are in agreement with its content.

List of three potential reviewers
(Fill in names and email addresses of three potential reviewers that agree to review this manuscript.)

Place and date:

29-05-2023

Sincerely yours,
(fill in corresponding author name)
Erise Anggraini

Jurnal Lahan Suboptimal : Journal of Suboptimal Lands
ISSN: 2252-6188 (Print), ISSN: 2302-3015 (Online, www.jlsuboptimal.unsri.ac.id)
Vol. xx, No.x: xx-xx April 20xx
DOI: 10.36706/JLSO.xx.x.20xx.xxx

THE APPLICATION OF COMPOST EXTRACT AND BIOPESTICIDE IN THREE DIFFERENT VARIETIES OF SOYBEAN (*Glycine max* L.)

APLIKASI EKSTRAK KOMPOS DAN BIOPESTISIDA PADA TIGA VARIETAS BERBEDA TANAMAN KEDELAI (Glycine max L.)

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(Received: DD/MM/2012, Accepted: ...)

Citation: Last_Name F, Last_Name F, Last_Name F. 20xx. Title of paper (English Version). *Jurnal Lahan Suboptimal : Journal of Suboptimal Lands.* xx (x): xx-xx. DOI: 10.36706/JLSO.xx.x.20xx.xxx.

ABSTRACT (Indonesian version)

Kedelai merupakan salah satu tanaman yang memiliki kandungan protein dan minyak nabati yang cukup tinggi. Rendahnya produksi kedelai disebabkan oleh beberapa faktor salah satunya adalah kesuburan tanah. Penelitian ini bertujuan mengetahui perbandingan efektivitas antara pemberian pupuk EKKU (Ekstrak Kompos Kulit Udang) dan EKMTJ (Ekstrak Kompos Media Tanam Jamur) yang dikombinasikan dengan bioinsektisida berbahan aktif *Beauveria bassiana* terhadap pertumbuhan dan produksi kedelai. Metode yang digunakan dalam penelitian ini adalah Rancangan Acak Kelompok Faktorial yang terdiri dari dua faktor yaitu: Faktor 1 adalah ekstrak kompos: P_1: Esktrak kompos kulit udang (EKKU) dan P_2: Ekstrak kompos media tanam jamur (EKMTJ). Faktor 2 adalah dosis bioinsektisida berbahan aktif *Beauveria bassiana*: Taraf dosis B_1: 1 liter ha^{-1} dan B_2: 2 liter ha^{-1}. Hasil penelitian menunjukkan bahwa pemberian ekstrak kompos kulit udang (EKKU) yang dikombinasikan dengan bioinsektisida dosis 2 liter ha^{-1} memberikan hasil terbaik terhadap variabel tinggi tanaman dan berat basah tajuk. Sedangkan pemberian ekstrak kompos media tanam jamur (EKMTJ) memberikan hasil terbaik pada variabel berat basah dan kering polong tanaman serta berat kering tajuk tanaman.

Keywords: Kedelai, Ekstrak Kompos, Biopestisida

ABSTRACT (English version)

Soybean is a plant with a high protein and vegetable oil content. The low soybean production is caused by several factors, one of which is soil fertility. This study aims to compare the effectiveness between EKKU fertilizer (Shrimp Skin Compost Extract) and EKMTJ (Mushroom Growing Media Compost Extract) combined with bioinsecticides with active ingredients from *Beauveria bassiana* on the growth and production of soybeans. The method used in this study was a Factorial Randomized Design consisting of two factors: Factor

1 was compost extract: P1: Shrimp skin compost extract (EKKU) and P2: Mushroom growing media compost extract (EKMTJ). Factor 2 is a dosage of bioinsecticides with active ingredients *Beauveria bassiana*: Dose level B1: 1 liter ha^{-1} and B2: 2 liters ha^{-1}. The results showed that administering shrimp shell compost extract (EKKU) combined with a bioinsecticide dose of 2 liters ha^{-1} gave the best plant height and shoot weight results. Whereas the administration of mushroom growing media compost extract (EKMTJ) gave the best results on the variable wet and dry weight of plant pods and the crop canopy dry weight.

Keywords: *Soybean, Compost Extract, Biopesticide*

INTRODUCTION

Soybean (*Glycine max* L.) is a leguminous plant with high protein and vegetable oil content. Soybean is also one of the most important strategic food crops in Indonesia after rice and corn (Aldillah, 2015). In Indonesia, soybeans can be used in the industrial sector, such as making soy sauce, processed soy milk, tempeh and tofu, and various other products (Krisnawati, 2017).

Various factors cause the low soybean production in Indonesia. One of the examples is the factor of soybean varieties which are already susceptible to changes in weather patterns and more robust pest. Change in weather patterns causes the availability of air for plants, which is difficult to be predicted. In addition, diseases that continue to develop and become increasingly resistant due to the use of chemicals continuously are also an obstacle. For example, the armyworm (*Spodoptera litura*), leaf-rolling caterpillar (*Chrysodeixis chalsites*), the span caterpillar *Lamprosema indicate, Helicoverpa* spp., and the pod ladybug (*Riptortus linearis*), caterpillar) (Marwoto *et al. 2013).*

The increase in soybean plant productivity can be committed in many ways. One of the efforts which affect soybean production is fertilizing and controlling soybean pests. Fertilization is done to increase the available nutrients in the soil (Meirina *et al*., 2009). Meanwhile, control of insect pest attacks that are safe for the environment can be done by applying bioinsecticides (Yuningsih, 2016). The development of fertilization technology and disease control in organic farming has given various new findings. One of its products is the development of composting technology.

On the other hand, there is unused waste, such as shrimp shell waste and mushroom growing media waste in the community. Over the years, most people still assume that waste is useless leftovers, not a resource that can be utilized. To overcome the problems regarding the waste, the waste produced must be appropriately managed by using the right technology. However, many people are still managing waste with the final approach, namely by disposing of the waste directly into the environment (Sulaeman, 2011). The paradigm should be abandoned and replaced with a new paradigm that views waste as a resource that has economic value and can be utilized, for instance, to be made into compost (Bellapama *et al*., 2015).

Production increase can also be conducted by changing the fertilizer given and better planting patterns. The use of inorganic fertilizers, which has been widely used, will impact the soil quality in the planting area. The use of organic fertilizers is one solution to replace inorganic fertilizers. Organic fertilizers can provide nutrients for plants to grow, and can also assist in improving soil quality to keep it healthy. One of the examples is the use of organic materials such as shrimp shell waste and mushroom growing media that is no longer used. The central spread of mushroom cultivation is widely spread in South Sumatra, including shrimp ponds such as those in Ogan Komering Ilir (Ministry of Maritime Affairs and Fisheries, 2016).

In this case, the fertilizers used are EKKU which stands for *Ekstrak Kompos Kulit Udang,* or shrimp shell compost extract. EKMTJ stands for *Ekstrak Kompos Media Tanam Jamur* or mushroom substrate media extract compost. Meanwhile, the bioinsecticide used is an insecticide with the active ingredient *Beauveria bassiana*. Therefore, this field practice needs to be carried out to obtain information about the

effectiveness of EKKU and EKTMJ fertilization and bioinsecticides with the active ingredient *Beauveria bassiana* given to soybean plants.

The results of this study provide alternative solutions for the reuse of shrimp shell waste and mushroom substrate media as organic fertilizer. Also, the combined application of compost extract and bioinsecticides may provide not only for increasing soybean productivity but also can suppress insect pest attack. Applying compost extracts and biopesticides on soybean plants is expected to reduce the use of chemical fertilizers and pesticides in soybean cultivation. This study was aimed to determine the effectiveness of EKKU (*Ekstrak Kompos Kulit Udang*) and EKMTJ (*Ekstrak Kompos Media Tanam Jamur*) fertilizers combined with Bioinsecticide with the active ingredient *Beauveria bassiana* on the growth and production of soybean plants.

MATERIALS AND METHODS

This research was conducted at the Agro Techno Center (ATC) of the Faculty of Agriculture, Sriwijaya University, Indralaya Campus. Bioinsecticide was used in this research from the Department of crop protection, University of Sriwijaya, with the brand "Bioverin". Also, the compost extract of shrimp shell was used in this research from the Department of crop protection, University of Sriwijaya, with the brand "EKKU". Then, the compost extract of mushroom substrate media was conventionally made by this author, Erise Anggraini.

The design used in this study was using a factorial randomized block design (RAKF stands for Rancangan Acak Kelompok Faktorial) with treatments:

B1P1: Bioinsecticide dose of 1 liter ha-1 and shrimp shell compost extract

B1P2: Bioinsecticide dose 1 liter ha-1 and compost extract of mushroom substrate media.

B2P1 : Bioinsecticide dose of 2 liters ha-1 and compost extract of shrimp shell.

B2P2 : Bioinsecticide dose of 2 liters ha-1 and compost extract of mushroom substrate media.

Each treatment had 4 replications; therefore, there were 16 experimental units and 10 plant samples were taken for each experimental unit so that the total The plants observed were 160 plants. Each treatment was applied to 3 soybean varieties, namely Deja 1, Devon 1, and Dena 1 varieties.

Land preparation was carried out by clearing the land of weeds and wood residues in the land. Then the land is plowed using a hand tractor. After plowing, the land was plotted using a hoe as many as 16 plots with a size of 2.5 m x 2.5 m. Before planting the land was given basic fertilizer, namely cow manure as much as 50 kg for 8 plots so that there was a total of 100 kg for 16 plots. Planting is done using a direct seed planting system. The soybean seeds used were the seeds of the Dena 1 variety. The soybean seeds were buried in the soil about 2-3 cm from the soil surface with a distance between planting holes of 30 cm x 20 cm. In one planting hole, 2-3 soybean seeds are buried.

The compost extract was applied to the test plant by spraying it evenly on all leaves up to the neck of the stem of the test plant. The application was carried out with 7 times of spraying with a concentration of 2% Biophytalic, 5% EKMTJ with an interval of 7 days after the first spraying. The first spraying was carried out since the soybean plants were 2 weeks old or after the plants had 5 leaves.

Bioinsecticide with the active ingredient Beauveria bassiana was sprayed onto soybean plants aged 3 weeks after planting, with concentrations of 1 liter ha-1 and 2 liter ha-1, respectively. Spraying was carried out at intervals of 7 days with 7 sprays.

Plant maintenance is carried out by watering regularly every day in the morning and evening and cleaning plants from weeds which grow in the planting area. Observations consisted of: 1) plant

height, 2) wet weight of plant crown and pods and 3) dry weight of plant crown and pods. The data obtained from the measurement results are calculated on the average, then if the results show differences then presented in the form of bar charts and graphs.

RESULTS

The average plant height of soybean varieties Deja 1, Devon 1 and Dena 1 applied with shrimp shell compost extract and mushroom growing media compost extract combined with bioinsecticide doses are presented in Figures 1, 2 and 3:

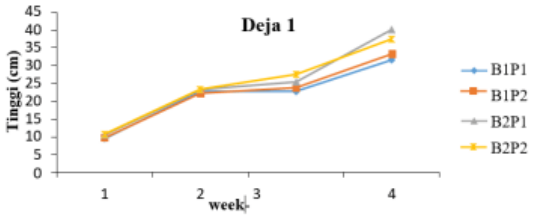

Figure 1: Deja 1 variety soybean growth height.

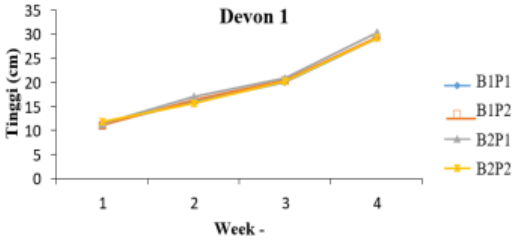

Figure 2: Devon 1 variety soybean growth height.

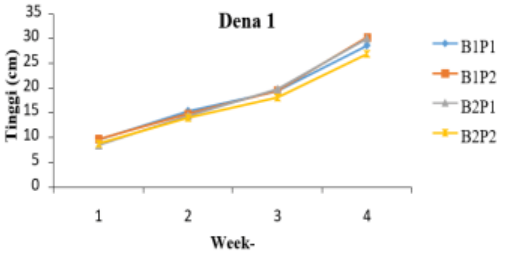

Figure 3: Dena 1 variety soybean growth height.

The average wet weight and dry weight of shoots and pods of soybean varieties Deja 1, Devon 1 and Dena 1 applied with shrimp shell compost extract and mushroom growing media compost extract combined with bioinsecticides are presented in Figures 4, 5, 6 and 7:

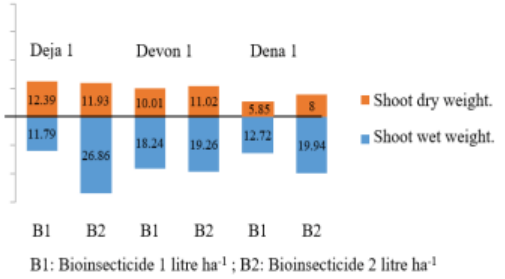

Figure 4: The effect of EKKU on soybean shoot weight.

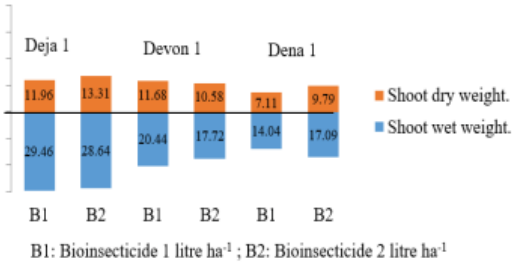

Figure 5: The effect of EKMTJ on soybean shoot weight

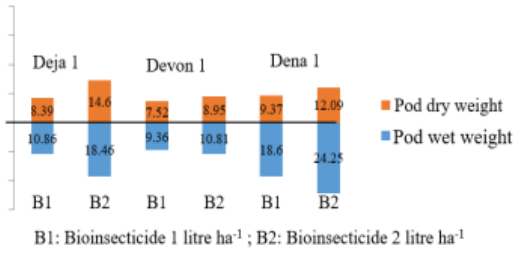

Figure 6 : The effect of EKKU on soybean pod weight.

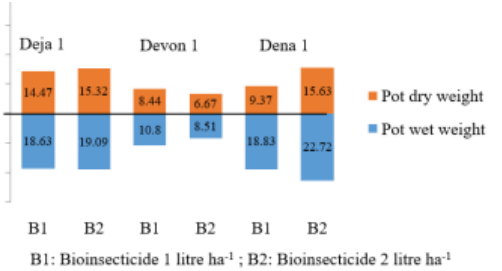

Figure 7: The effect of EKMTJ on soybean pod weight

DISCUSSION

Based on the results of the average data as presented in Figures 1 to 7, it can be concluded that each variety has different growth and production. Differences in growth and production between varieties of the observed variables are thought to be caused by differences in the characteristics or superiority of each variety according to its genotype. As revealed by Saragi *et al.* (2013), that differences in genetic composition and environmental factors are one of the causes of the diversity of plant appearances. Genetics in a plant will be expressed by various plant traits which include the form and function of plants that result in different growth and production.

The growth of soybean plants based on Figures 1, 2 and 3 of the average plant height can be seen that the treatment combination B2P1 is the treatment that has the highest plant height compared to other treatment combinations in each variety. From the combination of these treatments, it was found that giving shrimp shell compost extract had an effect on plant height. This is because shrimp shell waste contains macro and micro nutrients needed by plants (Nurhasanah and Heryadi, 2012). In addition, the chitosan content in shrimp shells can stimulate plant growth by increasing the response to gibberellins and auxin hormones (Uthairatanakij *et al.* 2007 in Ianca, 2010).

The treatments of B1 and B2 are the dose levels used for bioinsecticides. It is known that the bioinsecticide used contains the fungus *Beauveria bassiana* with a carrier material in the form of shrimp shell compost extract, so that in addition to being an ingredient for pest control, the bioinsecticide can also provide additional nutrients for plants. The increase in plant height was in line with the increase in the dose used. This is of course very good for plant cultivation because the plant height at soybeans will affect its ability to produce. As stated by Amali *et al.* (2015), that nutrients, water and sunlight absorbed by plants during the growth process will be translocated in the form of dry matter, then at the end of the vegetative phase there will be accumulation of photosynthetic products in plant organs.

The wet and dry weight of a plant is an indication which determines good or bad the growth of a plant is good. The dry weight of a plant indicates the presence of photosynthesis which occurs in the plant (Rohmah and Saputro, 2016). Based on the average results in Figures 4 and 5, it can be seen that in the variable wet weight of the plant crown, giving EKKU with a dose of 2 liters of bioinsecticide ha-1 had the best results. However, on the canopy dry weight variable, the best results were obtained by administering EKMTJ with a dose of 2 liters of bioinsecticide ha-1.

This is presumably due to the B2P1 treatment using the EKKU application which contains chitosan. Chitosan can help plant root systems in absorbing water in the soil (Ianca, 2010) and in chitosan contains nutrients, especially Ca. In the B2P2 treatment using the EKMTJ application, it contains several nutrients needed by plants, especially nitrogen. This is in line with research by Bellapama *et al.* (2015) which stated that the application of organic material in the form of baglog mushroom waste (mushroom growing media) did not affect the fresh weight of the plant, but did affect the dry weight of the plant.

In Figures 6 and 7 which show the results of the average wet weight and dry weight of plant pods, it can be seen that the administration of EKMTJ with a dose of bioinsecticide 2 liter ha-1 had the best results on wet weight and dry weight of plant pods. This is because the EKMTJ contains nutrients, especially nitrogen which is one of the macro nutrients needed by plants. Nitrogen in plants helps the preparation of amino acids, proteins, coenzymes, and chlorophyll to increase

the dry weight of seeds (Marlina *et al.*, 2015).

CONCLUSSION

Based on the results and discussion, the following conclusions can be drawn:

1. The administration of shrimp shell compost extract (EKKU stands for *Ekstrak Kompos Kulit Udang*) combined with a bioinsecticide dose of 2 liters ha-1 gave the best results on the height observation variable of 3 soybean plant varieties.
2. The administration of shrimp shell compost extract (EKKU stands for *Ekstrak Kompos Kulit Udang*) gave the best results for the variable canopy wet weight, while the administration of mushroom growing media compost extract (EKMTJ stands for *Ekstrak Kompos Media Tanam Jamur*) gave the best results for the variable canopy dry weight of the three soybean varieties.
3. The administration of mushroom growing media compost extract (EKMTJ stands for *Ekstrak Kompos Media Tanam Jamu*) combined with a bioinsecticide dose of 2 liters ha-1 gave the best results on the observed variables of the wet and dry weight of the three soybean varieties.

ACKNOWLEDGEMENTS

The authors thank the Faculty of Agriculture Universitas Sriwijaya for providing the experimental land (Agro Tecno Centre) for this research.

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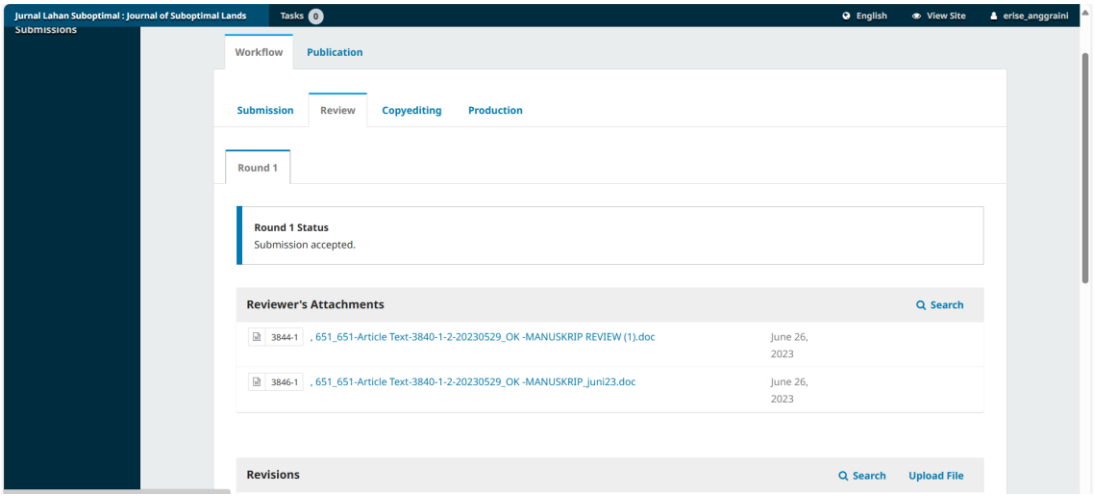
2. Review

Peer review round 1 (26 Juni 2023)



Jurnal Lahan Suboptimal : Journal of Suboptimal Lands
ISSN: 2252-6188 (Print), ISSN: 2302-3015 (Online, www.jlsuboptimal.unsri.ac.id)
Vol. xx, No.x: xx-xx April 20xx
DOI: 10.36706/JLSO.xx.x.20xx.xxx

THE APPLICATION OF COMPOST EXTRACT AND BIOPESTICIDE IN THREE DIFFERENT VARIETIES OF SOYBEAN (*Glycine max* L.)

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APLIKASI EKSTRAK KOMPOS DAN BIOPESTISIDA PADA TIGA VARIETAS BERBEDA TANAMAN KEDELAI (Glycine max L.)

ABSTRACT (Indonesian version)

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Keywords: Kedelai, Ekstrak Kompos, Biopestisida

ABSTRACT (English version)

Soybean plants have high protein and vegetable oil content. However, soil fertility, among other factors, has caused low production. This study aims to compare the effectiveness of EKKU (Shrimp Skin Compost Extract), and EKMTJ (Mushroom substrate media compost Extract) fertilizers combined with bioinsecticides with active ingredients from *Beauveria bassiana* on the growth and production of soybeans. This was a Factorial Randomized Design study with two factors. The first factor was compost extract, with P1: Shrimp skin compost extract (EKKU) and P2: Mushroom substrate media compost extract (EKMTJ). Furthermore, the second factor is a dosage of bioinsecticides with *Beauveria bassiana* active ingredients of 1 liter ha^{-1} (B1) and 2 liters ha^{-1} (B2). The results showed that administering shrimp shell compost extract (EKKU) combined with 2 liters of ha^{-1} bioinsecticide gave the best plant height and shoot weight results. Whereas the administration of mushroom substrate media compost extract (EKMTJ) showed the best results on plant pods' wet and dry weight and its canopy dry weight.

Keywords: *Soybean, Compost Extract, Biopesticide*

INTRODUCTION

Soybean (*Glycine max* L.) is a leguminous plant with high protein and vegetable oil content (Niwińska et al., 2020). It is also one of Indonesia's most important strategic food crops after rice and corn (Hasan et al., 2015). In Indonesia, soybeans are used in the

industrial sector, such as for material in producing soy sauce, processed soy milk, tempeh and tofu, and various other products (Krisnawati et al., 2021).

Various factors, such as the soybean varieties that are susceptible to changes in weather patterns and more robust pests, can cause low soybean production in Indonesia. Furthermore, changes in weather patterns can bring about the unpredictability of water availability. In addition, continuously developing and increasingly resistant diseases due to the constant use of chemicals are also an obstacle, for example, the armyworm (*Spodoptera litura*), leaf-rolling caterpillar (*Chrysodeixis chalsites*), the span caterpillar *Lamprosema indicate*, *Helicoverpa* spp., and the pod ladybug (*Riptortus linearis*) (Fathipour and Sedaratian, 2013).

The increase in soybean plant productivity can be committed in many ways. Some of the efforts that affect soybean production are fertilizing and controlling soybean pests (Fathipour and Sedaratian, 2013; Heidari et al., 2016). Fertilization increases the available nutrients in the soil (Schmitt et al., 2001). Meanwhile, the environmentally safe control of insect pest attacks can be done with bioinsecticides (Sarwar, 2015). The development of fertilization technology and disease control in organic farming has given various new findings. One of its products is the development of composting technology.

On the other hand, unused waste, such as shrimp shell waste and mushroom substrate media waste, is available in the community. However, over the years, most people still assume that waste is useless and not a utilizable resource. To overcome this problem, waste must be appropriately managed using the right technology. Nevertheless, direct waste disposal to the environment is the dominant choice of waste management (Sridhar and Hammed, 2014). The paradigm should be abandoned and replaced with a new one that views waste as a resource with economic value and can be utilized, for instance, to be made into compost (Sayara et al., 2020).

Production boost can also be accomplished by changing the fertilizer and employing better planting patterns. Applying widely used inorganic fertilizers will impact the soil quality in the planting area (Savci, 2012). The use of organic fertilizers can be one solution since not only can they provide nutrients for plants to grow, but they can also help improve soil quality and keep it healthy (Itelima et al., 2018; Shaji et al., 2021). One of the examples is the use of organic materials such as shrimp shell waste and mushroom substrate media that is no longer used. The significant expansion of mushroom cultivation is widely spread in South Sumatra.

In this study, the fertilizers used are EKKU which stands for *Ekstrak Kompos Kulit Udang*, or shrimp shell compost extract, and EKMTJ, which stands for *Ekstrak Kompos Media Tanam Jamur* or mushroom substrate media compost extract. At the same time, the bioinsecticide used is an insecticide with *Beauveria bassiana* active ingredient. Therefore, this study was conducted to obtain information on the effectiveness of EKKU and EKTMJ fertilization and bioinsecticide application with *Beauveria bassiana* active ingredient given to soybean plants.

The results of this study may provide alternative solutions for the reuse of shrimp shell waste and mushroom substrate media as organic fertilizer. Furthermore, combining compost extract and bioinsecticides can also increase soybean productivity and suppress insect pest attacks. Therefore, applying compost extracts and biopesticides on soybean plants is expected to reduce the use of chemical fertilizers and pesticides in soybean cultivation. Thus, this study was aimed to determine the effectiveness of EKKU (*Ekstrak Kompos Kulit Udang*) and EKMTJ (*Ekstrak Kompos Media Tanam Jamur*) fertilizers combined with Bioinsecticide with *Beauveria bassiana* active ingredient on the growth and production of soybean plants.

MATERIALS AND METHODS

This research was conducted at the Agro Techno Center (ATC) of the Faculty of Agriculture, Sriwijaya University, Indralaya Campus. The bioinsecticide with the brand "Bioverin" and the compost extract of

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shrimp shell with the brand "Biofitalik" used in this research were from the Department of crop protection, University of Sriwijaya. Furthermore, the compost extract of mushroom substrate media was conventionally made by this author, Erise Anggraini.

This is a factorial randomized block design study with the following treatments:
B1P1: Bioinsecticide dose of 1 liter ha-1 and shrimp shell compost extract
B1P2: Bioinsecticide dose 1 liter ha-1 and compost extract of mushroom substrate media.
B2P1: Bioinsecticide dose of 2 liters ha-1 and compost extract of shrimp shell.
B2P2: Bioinsecticide dose of 2 liters ha-1 and compost extract of mushroom substrate media.

Each treatment had four replications; therefore, 16 experimental units and ten plant samples were taken for each experimental unit, so the whole plants observed were 160. Each treatment was applied to 3 soybean varieties, i.e., Deja 1, Devon 1, and Dena 1.

Land preparation was carried out by clearing the land of weeds and wood residues. After the clearing, it was plowed using a hand tractor. Subsequently, it was plotted using a hoe into 16 plots of 2.5 m x 2.5 m. Before planting, it was fertilized with 50 kg of cow manure for eight plots and 100 kilograms for 16 plots. A direct seed planting system is used with the Deja 1, Devon 1, and Dena 1 varieties. The seeds were buried about 2-3 cm from the soil surface with a 30 cm x 20 cm distance between planting holes. In one hole, there were 2-3 seeds.

The compost extract was applied to the test plant by spraying it evenly on all leaves up to the neck of the stem. The application was carried out seven times with a concentration of 2% compost extract of shrimp shell and 5% compost extract of mushroom substrate media with an interval of 7 days after the first spraying. The first spraying was done when the soybean plants were two weeks old or after the plants had five leaves.

Bioinsecticide with *Beauveria bassiana* active ingredient was sprayed onto soybean plants aged three weeks after planting, with concentrations of 1 liter ha-1- and 2-liter ha-1, respectively. It was carried out at intervals of 7 days with seven sprays.

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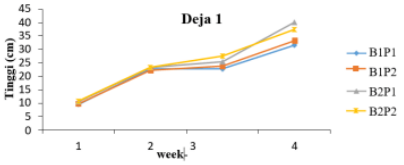
Plant maintenance was carried out by regularly watering every morning and evening and cleaning them from weeds growing in the planting area. The observations consisted of 1) plant height, 2) wet weight of plant crown and pods, and 3) dry weight of plant crown and pods. The data obtained from the measurement results were calculated on average. The resulting differences are presented in the form of bar charts and graphs.

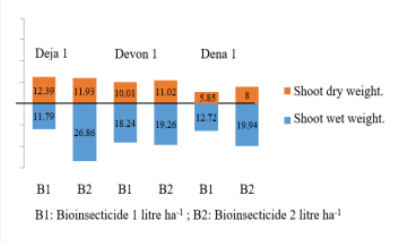
RESULTS

The statistical analysis showed that the growth height, shoot weight, and Pod weight between soybean varieties were not significantly different. Therefore, to calculate those, this study used descriptive analysis. The average plant height of soybean varieties Deja 1, Devon 1, and Dena 1 applied with shrimp shell compost extract and mushroom substrate media compost extract combined with bioinsecticide doses are presented in



Figures 1, 2, and 3:

Figure 1: Deja 1 variety soybean growth height.



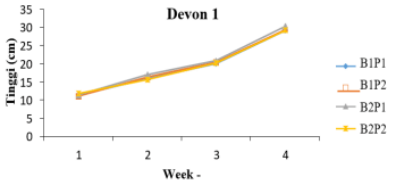
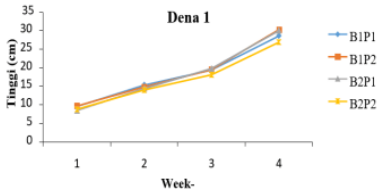


Figure 2: Devon 1 variety soybean growth height.

Figure 3: Dena 1 variety soybean growth height.

The average wet weight and dry weight of shoots and pods of soybean varieties Deja 1, Devon 1, and Dena 1



applied with shrimp shell compost extract and mushroom substrate media compost extract combined with bioinsecticides are presented in Figures 4, 5, 6, and 7:

Figure 4: The effect of EKKU on soybean shoot weight.

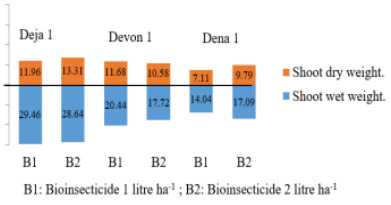


Figure 5: The effect of EKMTJ on soybean shoot weight

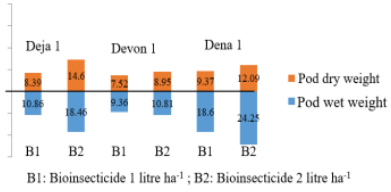
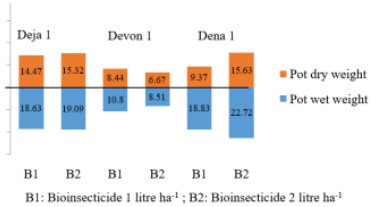


Figure 6: The effect of EKKU on soybean pod weight.

Figure 7: The effect of EKMTJ on soybean pod weight



DISCUSSION

Based on the results of the average data as presented in Figures 1 to 7, it can be concluded that each variety has different growth and production. Differences in development and production between varieties of the observed variables are thought to be caused by differences in the characteristics or superiority of each variety according to its genotype. The differences in genetic variations and environmental factors are one of the causes of the diversity of plant appearances (Kartahadimaja et al., 2021). Genetics in a plant will be expressed by various plant traits, including the form and function of plants that result in different growth and production.

The growth of soybean plants described in Figures 1, 2, and 3 of the average plant height indicates that the treatment combination B2P1 resulted in the highest plant height compared to other treatment combinations in each variety. From the combination of these treatments, it was found that giving shrimp shell compost extract affected plant height. This is because shrimp shell waste contains macro and micronutrients needed by plants (Abirami et al., 2022). In addition, the chitosan content in shrimp shells can stimulate plant growth by increasing the

response to gibberellins and auxin hormones (Santo Pereira et al., 2017).

The treatments of B1 and B2 were the dose levels used for bioinsecticides. It is known that the bioinsecticide used contains the fungus *Beauveria bassiana* with shrimp shell compost extract as carrier material. As a result, in addition to being an ingredient for pest control, bioinsecticide can also provide additional nutrients for plants. The increase in plant height corresponded with the increase in the dose used. This is good for plant cultivation since soybeans' height will affect their production ability. Nutrients, water, and sunlight absorbed by plants during the growth process will be translocated as dry matter, then, at the end of the vegetative phase, photosynthetic products will accumulate in the plant organs (Rouphael et al., 2012).

A plant's wet and dry weight indicates whether the growth is satisfactory. A plant's dry weight suggests the presence of photosynthates in the plant (Bota et al., 2004). Based on the average results in Figures 4 and 5, the variable wet weight of the plant crown with the application of EKKU with 2 liters of bioinsecticide ha^{-1} had the best results. However, the best results were obtained on the canopy dry weight variable by administering EKMTJ with 2 liters of bioinsecticide ha^{-1}.

These results presumably result from the B2P1 treatment using the EKKU, which contains chitosan. It can facilitate plant root systems in absorbing water in the soil (Farouk et al., 2011). Furthermore, chitosan also contains nutrients, especially Ca. In the B2P2 treatment using the EKMTJ application, EKMTJ has several nutrients plants need, especially nitrogen (Uzun, 2004). The application of organic material in the form of mushroom-substrate media waste can support plant growth-promoting organic amendment (Paula et al., 2017).

In Figures 6 and 7 displaying the results of the average wet and dry weight of plant pods, the administration of EKMTJ with 2 liters ha-1 of bioinsecticide had the best results. This results from the EKMTJ containing nutrients, especially nitrogen which is one of the macronutrients plants need. Nitrogen in plants helps prepare amino acids, proteins, coenzymes, and chlorophyll to increase the dry weight of seeds (Gendy et al., 2013).

CONCLUSION

Based on the results and discussion, it can be concluded that the administration of:

1. Shrimp shell compost extract (EKKU) combined with 2 liters ha-1 bioinsecticide gave the best results on the height of the three soybean plant varieties.
2. Shrimp shell compost extract (EKKU) gave the best results for the canopy wet weight. In contrast, the administration of mushroom substrate media compost extract (EKMTJ) showed the best results for the canopy dry weight of the three varieties.
3. Mushroom substrate media compost extract (EKMTJ) combined with 2 liters ha-1 bioinsecticide gave the best results on the wet and dry weight of the three varieties.

ACKNOWLEDGEMENTS

The authors acknowledge the Faculty of Agriculture Universitas Sriwijaya for providing this research's experimental land (Agro Tecno Centre).

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Jurnal Lahan Suboptimal : Journal of Suboptimal Lands
ISSN: 2252-6188 (Print), ISSN: 2302-3015 (Online, www.jlsuboptimal.unsri.ac.id)
Vol. xx, No.x: xx-xx April 20xx
DOI: 10.36706/JLSO.xx.x.20xx.xxx

THE APPLICATION OF COMPOST EXTRACT AND BIOPESTICIDE IN THREE DIFFERENT VARIETIES OF SOYBEAN (*Glycine max* L.)

APLIKASI EKSTRAK KOMPOS DAN BIOPESTISIDA PADA TIGA VARIETAS BERBEDA TANAMAN KEDELAI (Glycine max L.)

ABSTRACT (Indonesian version)

Kedelai merupakan salah satu tanaman yang memiliki kandungan protein dan minyak nabati yang cukup tinggi. Rendahnya produksi kedelai disebabkan oleh beberapa faktor salah satunya adalah kesuburan tanah. Penelitian ini bertujuan mengetahui perbandingan efektivitas antara pemberian pupuk EKKU (Ekstrak Kompos Kulit Udang) dan EKMTJ (Ekstrak Kompos Media Tanam Jamur) yang dikombinasikan dengan bioinsektisida berbahan aktif *Beauveria bassiana* terhadap pertumbuhan dan produksi kedelai. Metode yang digunakan dalam penelitian ini adalah Rancangan Acak Kelompok Faktorial yang terdiri dari dua faktor yaitu: Faktor 1 adalah ekstrak kompos: P_1: Esktrak kompos kulit udang (EKKU) dan P_2: Ekstrak kompos media tanam jamur (EKMTJ). Faktor 2 adalah dosis bioinsektisida berbahan aktif *Beauveria bassiana*: Taraf dosis B_1: 1 liter ha^{-1} dan B_2: 2-liter ha^{-1}. Hasil penelitian menunjukkan bahwa pemberian ekstrak kompos kulit udang (EKKU) yang dikombinasikan dengan bioinsektisida dosis 2-liter ha^{-1} memberikan hasil terbaik terhadap variabel tinggi tanaman dan berat basah tajuk. Sedangkan pemberian ekstrak kompos media tanam jamur (EKMTJ) memberikan hasil terbaik pada variabel berat basah dan kering polong tanaman serta berat kering tajuk tanaman.

Keywords: Kedelai, Ekstrak Kompos, Biopestisida

ABSTRACT (English version)

Soybean plants have high protein and vegetable oil content. However, soil fertility, among other factors, has caused low production. This study aims to compare the effectiveness of EKKU (Shrimp Skin Compost Extract), and EKMTJ (Mushroom substrate media compost Extract) fertilizers combined with bioinsecticides with active ingredients from *Beauveria bassiana* on the growth and production of soybeans. This was a Factorial Randomized Design study with two factors. The first factor was compost extract, with P1: Shrimp skin compost extract (EKKU) and P2: Mushroom substrate media compost extract (EKMTJ). Furthermore, the second factor is a dosage of bioinsecticides with *Beauveria bassiana* active ingredients of 1 liter ha^{-1} (B1) and 2 liters ha^{-1} (B2). The results showed that administering shrimp shell compost extract (EKKU) combined with 2 liters of ha^{-1} bioinsecticide gave the best plant height and shoot weight results. Whereas the administration of mushroom substrate media compost extract (EKMTJ) showed the best results on plant pods' wet and dry weight and its canopy dry weight.

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INTRODUCTION

Soybean (*Glycine max* L.) is a leguminous plant with high protein and vegetable oil content (Niwińska et al., 2020). It is also one of Indonesia's most important strategic food crops after rice and corn (Hasan et al., 2015). In Indonesia, soybeans are used in the

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MATERIALS AND METHODS

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Commented [h7]: The compost extract was applied to the test plant by spraying it evenly on all the leaves up to the neck of the stem. The application was repeated seven times at a concentration of 2% shrimp shell compost extract and 5% fungus substrate medium with an interval of 7 days after the first application (Niwińska et al., 2020). It is also one of the most important strategic food crops in Indonesia after rice and corn (Hasan et al., 2015). In Indonesia, soybean is used in the application of better cultivation patterns. The application of widely used inorganic fertilizers will effect the soil quality in the planting area (Savci, 2012).

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Commented [h4]: Various factors, such as soybean varieties that are more susceptible to changes in weather patterns and more resistant to pests, can lead to low soybean production in Indonesia. Changes in weather patterns can also make water availability unpredictable. In addition, continuously developing and increasingly resistant diseases due to the constant use of chemicals are also an obstacle, such as the armyworm (Spodoptera litura), the leaf-rolling caterpillar (Chrysodeixis chalsites), the span caterpillar Lamprosema indicate, Helicoverpa spp. and the pod ladybug (Riptortus linearis) (Fathipour and Sedaratian, 2013).

Commented [h9]: The fertilizers used in this study are EKKU (Ekstrak Kompost Kulit Udang) and EKMTJ (Ekstrak Kompost Tanam Jamur). At the same time, the bioinsecticide used is an insecticide with the active ingredient of Beauveria bassiana. Therefore, this study was conducted to obtain information on the effectivity of EKKU and EKTMJ fertilisation and bioinsecticide application with Beauveria bassiana active ingredient to soybean plants.

Commented [h5]: The productivity of soybean plants can be increased in many ways. Some of the efforts that affect soybean production are the application of fertilizer and the control of soybean pests (Fathipour and Sedaratian, 2013; Heidari et al., 2016). The application of fertilizer increases the available nutrients in the soil (Schmitt et al., 2001). On the other hand, bio-insecticides can be used to control insect pests in an environmentally sustainable method (Sarwar, 2015). The development of the technology of fertilization and disease control in organic farming has led to various new insights. One of these products is the technology of composting

Commented [h10]: The results of this study may provide alternative solutions for the reuse of shrimp shell waste and mushroom substrate media as organic fertilizers. Furthermore, the combinations of compost extracts and bio-insecticides can also increase soybean productivity and suppress insect pests. Therefore, the application of compost extracts and bio-insecticides to soybean plants is expected to reduce the use of chemical fertilizers and pesticides in soybean cultivation. Therefore, this study aimed to determine the effectiveness of EKKU (Ekstrak Kompos Kulit Udang) and EKMTJ (Ekstrak Kompos Media Tanam Jamur) fertilizers combined with Beauveria bassiana bioinsecticide on soybean growth and productivity.

Commented [h6]: On the other hand, unused waste, such as shrimp shell waste and mushroom substrate media waste, is available in the community. However, over the years, most people still assume that waste is useless and not a valuable resource. To overcome this problem, waste must be properly managed using the right technology. Despite this, direct disposal of waste into the environment is the dominant waste management option (Sridhar and Hammed, 2014). This paradigm should be abandoned and replaced by a new one that considers waste as a resource with economic value that can be utilised, for example, to produce compost (Sayara et al., 2020).

shrimp shell with the brand “Biofitalik” used in this research were from the Department of crop protection, University of Sriwijaya. Furthermore, the compost extract of mushroom substrate media was conventionally made by this author, Erise Anggraini.

This is a factorial randomized block design study with the following treatments:
B1P1: Bioinsecticide dose of 1 liter ha-1 and shrimp shell compost extract
B1P2: Bioinsecticide dose 1 liter ha-1 and compost extract of mushroom substrate media.
B2P1: Bioinsecticide dose of 2 liters ha-1 and compost extract of shrimp shell.
B2P2: Bioinsecticide dose of 2 liters ha-1 and compost extract of mushroom substrate media.

Each treatment had four replications; therefore, 16 experimental units and ten plant samples were taken for each experimental unit, so the whole plants observed were 160. Each treatment was applied to 3 soybean varieties, i.e., Deja 1, Devon 1, and Dena 1.

Land preparation was carried out by clearing the land of weeds and wood residues. After the clearing, it was plowed using a hand tractor. Subsequently, it was plotted using a hoe into 16 plots of 2.5 m x 2.5 m. Before planting, it was fertilized with 50 kg of cow manure for eight plots and 100 kilograms for 16 plots. A direct seed planting system is used with the Deja 1, Devon 1, and Dena 1 varieties. The seeds were buried about 2-3 cm from the soil surface with a 30 cm x 20 cm distance between planting holes. In one hole, there were 2-3 seeds.

The compost extract was applied to the test plant by spraying it evenly on all leaves up to the neck of the stem. The application was carried out seven times with a concentration of 2% compost extract of shrimp shell and 5% compost extract of mushroom substrate media with an interval of 7 days after the first spraying. The first spraying was done when the soybean plants were two weeks old or after the plants had five leaves.

Bioinsecticide with *Beauveria bassiana* active ingredient was sprayed onto soybean plants aged three weeks after planting, with concentrations of 1 liter ha-1- and 2-liter ha-1, respectively. It was carried out at intervals of 7 days with seven sprays.

Plant maintenance was carried out by regularly watering every morning and evening and cleaning them from weeds growing in the planting area. The observations consisted of 1) plant height, 2) wet weight of plant crown and pods, and 3) dry weight of plant crown and pods. The data obtained from the measurement results were calculated on average. The resulting differences are presented in the form of bar charts and graphs.

RESULTS

The statistical analysis showed that the growth height, shoot weight, and Pod weight between soybean varieties were not significantly different. Therefore, to calculate those, this study used descriptive analysis. The average plant height of soybean varieties Deja 1, Devon 1, and Dena 1 applied with shrimp shell compost extract and mushroom substrate media compost extract combined with bioinsecticide doses are presented in Figures 1, 2, and 3:

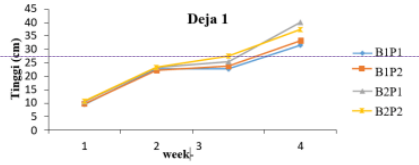


Figure 1: Deja 1 variety soybean growth height.

Commented [h16]: This research was conducted at the Agro Techno Centre (ATC) of the Faculty of Agriculture, Sriwijaya University, Indralaya Campus. The bio-insecticide branded "Bioverin" and the compost extract were sprayed. The first spraying was done when the soybean plants were two weeks old or when the plants had five leaves.

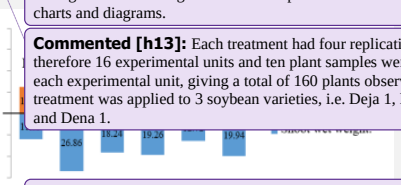
Commented [h11]: Production increase can also be achieved by changing the fertilizers and shrimp shells with the brand "Biofitalik" used in this research were from the Department of Plant Protection, University of Sriwijaya. Furthermore, the compost extract of mushroom substrate media was conventionally made by this author, Erise Anggraini.

Commented [h17]: A bioinsecticide containing Beauveria bassiana was sprayed on soybean plants three weeks after planting at concentrations of 1 litre ha-1 and 2 litres ha-1. Seven sprays were made at 7-day intervals.

Commented [h12]: This is a factorial randomized block design study with the following treatments
B1P1: bioinsecticide dose 1 litre ha-1 and shrimp shell compost extract
B1P2: bioinsecticide dose of 1 litre ha-1 and mushroom compost extract
B2P1: Bioinsecticide dose of 2 litres ha-1 and compost extract of shrimp shells.
B2P2: Bioinsecticide dose of 2 litres ha-1 and compost extract of mushroom substrate media.

Commented [h18]: The plants were maintained by regular watering every morning and evening. Weeds were removed from the planting area. The observations consisted of 1) plant height, 2) wet weight of the plant crown and pods, and 3) dry weight of the plant crown and pods. The data obtained from the observations were averaged. The resulting differences are presented in the form of bar charts and diagrams.

Commented [h13]: Each treatment had four replications; therefore 16 experimental units and ten plant samples were taken for each experimental unit, giving a total of 160 plants observed. Each treatment was applied to 3 soybean varieties, i.e. Deja 1, Devon 1 and Dena 1.



Commented [h14]: The land was prepared by clearing it of weeds and wood waste. After clearing, the land was tillaged with a hand tractor. The land was then plotted with a harrow into 16 plots of 2.5 m x 2.5 m. Before planting, the land was fertilized with 50 kg of cow manure for eight plots and 100 kg for 16 plots. The varieties Deja 1, Devon 1 and Dena 1 were planted using a direct seed system. Seeds were sowed about 2-3 cm below the soil surface with a 30 cm x 20 cm between holes. There were 2-3 seeds per hole.

Commented [h19]: The statistical analysis showed that the height of growth, the weight of the shoots and the weight of the pods were not significantly different between the soybean varieties. Therefore, descriptive analysis was used to calculate these in this study. The average plant height of soybean varieties Deja 1, Devon 1 and Dena 1 treated with shrimp shell compost extract and fungal substrate media compost extract combined with bioinsecticide doses are shown in Figures 1, 2 and 3:

Commented [h15]: The compost extract was applied to the test plant by spraying it evenly on all the leaves up to the neck of the stem. The application was repeated seven times at a concentration of 2% shrimp shell compost extract and 5% mushroom compost extract with an interval of 7 days after the first application.

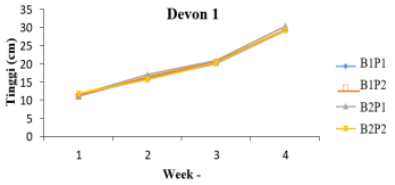
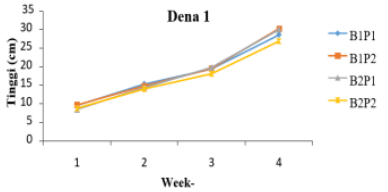


Figure 2: Devon 1 variety soybean growth height.

Figure 3: Dena 1 variety soybean growth height.

The average wet weight and dry weight of shoots and pods of soybean varieties Deja 1, Devon 1, and Dena 1



applied with shrimp shell compost extract and mushroom substrate media compost extract combined with bioinsecticides are presented in Figures 4, 5, 6, and 7:

Figure 4: The effect of EKKU on soybean shoot weight.

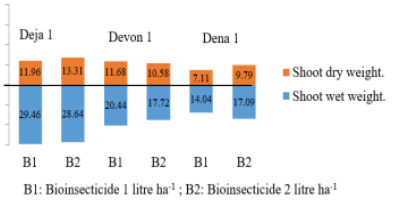


Figure 5: The effect of EKMTJ on soybean shoot weight

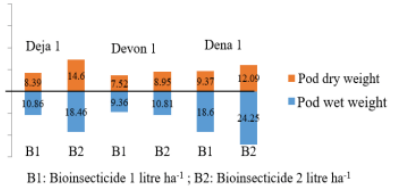
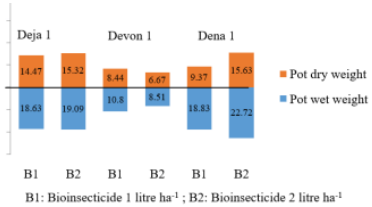


Figure 6: The effect of EKKU on soybean pod weight.

Figure 7: The effect of EKMTJ on soybean pod weight



DISCUSSION

Based on the results of the average data as presented in Figures 1 to 7, it can be concluded that each variety has different growth and production. Differences in development and production between varieties of the observed variables are thought to be caused by differences in the characteristics or superiority of each variety according to its genotype. The differences in genetic variations and environmental factors are one of the causes of the diversity of plant appearances (Kartahadimaja et al., 2021). Genetics in a plant will be expressed by various plant traits, including the form and function of plants that result in different growth and production.

The growth of soybean plants described in Figures 1, 2, and 3 of the average plant height indicates that the treatment combination B2P1 resulted in the highest plant height compared to other treatment combinations in each variety. From the combination of these treatments, it was found that giving shrimp shell compost extract affected plant height. This is because shrimp shell waste contains macro and micronutrients needed by plants (Abirami et al., 2022). In addition, the chitosan content in shrimp shells can stimulate plant growth by increasing the

Commented [h20]: The average wet and dry weights of sprouts and pods of soybean varieties Deja 1, Devon 1 and Dena 1 treated with shrimp shell compost extract and fungal substrate compost extract in combination with bioinsecticides are shown in Figures 4, 5, 6 and 7:

Commented [h21]: Based on the results of the average data presented in Figures 1 to 7, it can be concluded that each variety has different growth and production. Differences in development and production between varieties of the observed variables are thought to be caused by differences in the characteristics or superiority of each variety according to its genotype. The differences in genetic variants and environmental factors are one of the causes of the diversity of plant phenotypes (Kartahadimaja et al., 2021). Genetics in a plant will be expressed by various plant traits, including the form and function of plants that will result in different growth and production.

Commented [h22]:

Commented [h23R22]: The growth of soybean plants described in Figures 1, 2 and 3 of average plant height indicates that the B2P1 treatment combination resulted in the highest plant height compared to other treatment combinations in each variety. From the combination of these treatments, it was found that the application of shrimp shell extract had an effect on plant height. This is because shrimp shell waste contains macro- and micronutrients needed by plants (Abirami et al., 2022). In addition, the chitosan content in shrimp shells can stimulate plant growth by increasing the response to gibberellin and auxin hormones (Santo Pereira et al., 2017).

response to gibberellins and auxin hormones (Santo Pereira et al., 2017).

The treatments of B1 and B2 were the dose levels used for bioinsecticides. It is known that the bioinsecticide used contains the fungus *Beauveria bassiana* with shrimp shell compost extract as carrier material. As a result, in addition to being an ingredient for pest control, bioinsecticide can also provide additional nutrients for plants. The increase in plant height corresponded with the increase in the dose used. This is good for plant cultivation since soybeans' height will affect their production ability. Nutrients, water, and sunlight absorbed by plants during the growth process will be translocated as dry matter, then, at the end of the vegetative phase, photosynthetic products will accumulate in the plant organs (Rouphael et al., 2012).

A plant's wet and dry weight indicates whether the growth is satisfactory. A plant's dry weight suggests the presence of photosynthates in the plant (Bota et al., 2004). Based on the average results in Figures 4 and 5, the variable wet weight of the plant crown with the application of EKKU with 2 liters of bioinsecticide ha^{-1} had the best results. However, the best results were obtained on the canopy dry weight variable by administering EKMTJ with 2 liters of bioinsecticide ha^{-1}.

These results presumably result from the B2P1 treatment using the EKKU, which contains chitosan. It can facilitate plant root systems in absorbing water in the soil (Farouk et al., 2011). Furthermore, chitosan also contains nutrients, especially Ca. In the B2P2 treatment using the EKMTJ application, EKMTJ has several nutrients plants need, especially nitrogen (Uzun, 2004). The application of organic material in the form of mushroom-substrate media waste can support plant growth-promoting organic amendment (Paula et al., 2017).

In Figures 6 and 7 displaying the results of the average wet and dry weight of plant pods, the administration of EKMTJ with 2 liters ha-1 of bioinsecticide had the best results. This results from the EKMTJ containing nutrients, especially nitrogen which is one of the macronutrients plants need. Nitrogen in plants helps prepare amino acids, proteins, coenzymes, and chlorophyll to increase the dry weight of seeds (Gendy et al., 2013).

CONCLUSION

Based on the results and discussion, it can be concluded that the administration of:

1. Shrimp shell compost extract (EKKU) combined with 2 liters ha-1 bioinsecticide gave the best results on the height of the three soybean plant varieties.
2. Shrimp shell compost extract (EKKU) gave the best results for the canopy wet weight. In contrast, the administration of mushroom substrate media compost extract (EKMTJ) showed the best results for the canopy dry weight of the three varieties.
3. Mushroom substrate media compost extract (EKMTJ) combined with 2 liters ha-1 bioinsecticide gave the best results on the wet and dry weight of the three varieties.

ACKNOWLEDGEMENTS

The authors acknowledge the Faculty of Agriculture Universitas Sriwijaya for providing this research's experimental land (Agro Tecno Centre).

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Bota, J., Stasyk, O., Flexas, J., Medrano, H., 2004. Effect of water stress on partitioning of 14C-labelled photosynthates in Vitis vinifera. Functional Plant Biology 31, 697–708.

Commented [h28]: In Figures 6 and 7, which show the results of the average wet and dry weight of the plant pods, the application of EKMTJ with 2 litres ha-1 of bioinsecticide gave the best results. This is a result of the presence of nutrients in EKMTJ, particularly nitrogen, which is one of the macronutrients that plants need. Nitrogen in plants helps to prepare amino acids, proteins, coenzymes and chlorophyll to increase the dry weight of seeds (Gendy et al., 2013).

Commented [h24]: The treatments B1 and B2 were the doses of bio-insecticide used. It is known that the bioinsecticide used contains the fungus Beauveria bassiana with shrimp shell compost extract as carrier material. As a result, the bioinsecticide not only acts as a pest control agent, but also provides additional nutrients to the plants. The increase in plant height corresponded to the increase in dose applied. This is good for growing plants because the height of the soya bean has an effect on its ability to produce. Nutrients, water and sunlight absorbed by plants during growth are translocated as dry matter, and at the end of the vegetative phase, photosynthetic products accumulate in plant organs (Rouphael et al., 2012).

Commented [h29]: Based on the results and discussion, it can be concluded that the administration of
1. Shrimp shell compost extract (EKKU) combined with 2 litres ha-1 bioinsecticide gave the best results on the height of the three soybean varieties.
2. Shrimp shell compost extract (EKKU) gave the best results for canopy wet weight. In contrast, the application of the fungal substrate media compost extract (EKMTJ) gave the best results for the canopy dry weight of the three varieties.
3. Mushroom substrate media compost extract (EKMTJ) in combination with 2 litres ha-1 bioinsecticide gave the best results for wet and dry weight of the three cultivars.

Commented [h25]: The wet and dry weight of a plant indicates whether growth is satisfactory. The dry weight of a plant indicates the presence of photosynthates in the plant (Bota et al., 2004). Based on the average results in Figures 4 and 5, the variable wet weight of the plant crown with the application of EKKU with 2 litres of bioinsecticide ha-1 had the best results. However, the best results were obtained on the variable canopy dry weight with the application of EKMTJ at 2 litres of bioinsecticide ha-1.

Commented [h26]: These results are probably due to the B2P1 treatment with EKKU, which contains chitosan. This can help plant root systems to absorb water from the soil (Farouk et al., 2011).

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Jurnal Lahan Suboptimal : Journal of Suboptimal Lands
ISSN: 2252-6188 (Print), ISSN: 2302-3015 (Online, www.jlsuboptimal.unsri.ac.id)
Vol. 12, No.2: 219-226 Oktober 2023
DOI: 10.36706/JLSO.12.2.2023.651

The Application of Compost Extract and Biopesticide in Three Different Varieties of Soybean (*Glycine max* L.)

Aplikasi Ekstrak Kompos dan Biopestisida pada Tiga Varietas Berbeda Tanaman Kedelai (*Glycine max* L.)

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(Received: 29 May 2023, Accepted: 21 September 2023)

Citation: Anggraini E, Gofar N, Pradana TR, Patria WT, Sinurat D. 2023. The application of compost extract and biopesticide in three different varieties of soybean (*Glycine max* L.). *Jurnal Lahan Suboptimal : Journal of Suboptimal Lands.* 12 (2): 219-226. DOI: 10.36706/JLSO.12.2.2023.651.

ABSTRAK

Kedelai merupakan salah satu tanaman yang memiliki kandungan protein dan minyak nabati yang cukup tinggi. Rendahnya produksi kedelai disebabkan oleh beberapa faktor salah satunya adalah kesuburan tanah. Penelitian ini bertujuan mengetahui perbandingan efektivitas antara pemberian pupuk EKKU (Ekstrak Kompos Kulit Udang) dan EKMTJ (Ekstrak Kompos Media Tanam Jamur) yang dikombinasikan dengan bioinsektisida berbahan aktif *Beauveria bassiana* terhadap pertumbuhan dan produksi kedelai. Metode yang digunakan dalam penelitian ini adalah Rancangan Acak Kelompok Faktorial yang terdiri dari dua faktor yaitu: Faktor 1 adalah ekstrak kompos: P1: Esktrak kompos kulit udang (EKKU) dan P2: Ekstrak kompos media tanam jamur (EKMTJ). Faktor 2 adalah dosis bioinsektisida berbahan aktif *B. bassiana*: Taraf dosis B1: 1 liter/ha dan B2: 2-liter/ ha. Hasil penelitian menunjukkan bahwa pemberian ekstrak kompos kulit udang (EKKU) yang dikombinasikan dengan bioinsektisida dosis 2-liter/ha memberikan hasil terbaik terhadap variabel tinggi tanaman dan berat basah tajuk. Sedangkan pemberian ekstrak kompos media tanam jamur (EKMTJ) memberikan hasil terbaik pada variabel berat basah dan kering polong tanaman serta berat kering tajuk tanaman.

Kata kunci: kedelai, ekstrak kompos, biopestisida

ABSTRACT

Soybeans are high in protein and vegetable oil. However, soil fertility, among other factors, has resulted in low production. This study aimed to compare the effects of shrimp shells compost extract (EKKU) and Mushroom Substrate Media Compost Extract (EKMTJ) fertilizers in combination with bio-insecticides with active ingredients from *Beauveria bassiana* on the growth and production of soybean. This was a factorial randomised design study with two factors. The first factor was compost extract, with P1: EKKU and P2:

EKMTJ. Furthermore, the second factor is a dosage of bioinsecticides with *B. bassiana* active ingredients of 1 litre/ha (B1) and 2 litres/ha (B2). The results showed that the application of shrimp shell compost extract (EKKU) combined with 2 litres/ha bioinsecticide gave the best results in plant height and shoot weight. On the other hand, the application of mushroom substrate medium compost extract (EKMTJ) gave the best results for wet and dry weight of plant pods and canopy dry weight.

Keywords: soybean, compost extract, biopesticide

INTRODUCTION

Soybean (*Glycine max* L.) is a leguminous plant with high protein and vegetable oil content (Niwińska et al., 2020). It is also one of Indonesia's most important strategic food crops after rice and corn (Hasan et al., 2015). In Indonesia, soybeans are used in the industrial sector, such as for material in producing soy sauce, processed soy milk, tempeh and tofu, and various other products (Krisnawati et al., 2021).

Various factors, such as soybean varieties that are more susceptible to changes in weather patterns and more resistant to pests, can lead to low soybean production in Indonesia. Furthermore, changes in weather patterns can bring about the unpredictability of water availability. In addition, continuously developing and increasingly resistant diseases due to the constant use of chemicals are also an obstacle, for example, the armyworm (*Spodoptera litura*), leaf-rolling caterpillar (*Chrysodeixis chalsites*), the span caterpillar *Lamprosema indicate*, *Helicoverpa* spp., and the pod ladybug (*Riptortus linearis*) (Fathipour & Sedaratian, 2013).

The productivity of soybean plants can be increased in many ways. Some of the efforts that affect soybean production are the application of fertilizer and the control of soybean pests (Fathipour & Sedaratian, 2013; Heidari et al., 2016). The application of fertilizer increases the available nutrients in the soil (Krasilnikov et al., 2022). On the other hand, bio-insecticides can be used to control insect pests in an environmentally sustainable method (Kumar et al., 2021). The development of fertilization technology and disease control in organic farming has given various new findings. One of these products is the development of composting technology.

On the other hand, unused waste, such as shrimp shell waste and mushroom substrate media waste, is available in the community. However, over the years, most people still assume that waste is useless and not a valuable resource. To overcome this problem, waste must be properly managed using the right technology. Despite this, direct disposal of waste into the environment is the dominant waste management option (Sridhar & Hammed, 2014). This paradigm should be abandoned and replaced by a new one that considers waste as a resource with economic value that can be utilised, for example, to produce compost (Sayara et al., 2020).

Production boost can also be accomplished by changing the fertilizer and employing better planting patterns. Applying widely used inorganic fertilizers will impact the soil quality in the planting area (Kakar et al., 2020). The use of organic fertilizers can be one solution since not only can they provide nutrients for plants to grow, but they can also help improve soil quality and keep it healthy (Itelima et al., 2018; Shaji et al., 2021). These include the use of organic materials such as shrimp shells and unused mushroom substrate media. In South Sumatra, mushroom cultivation has expanded significantly.

The fertilizers used in this study are EKKU (Ekstrak Kompost Kulit Udang or shrimp shells compost extract) and EKMTJ (Ekstrak Kompost Tanam Jamur or mushroom substrate medium compost extract). At the same time, the bioinsecticide used is an insecticide with the active ingredient of *Beauveria bassiana*.

Therefore, this study was conducted to obtain information on the effectivity of EKKU and EKTMJ fertilisation and bioinsecticide application with Beauveria bassiana active ingredient to soybean plants. The results of this study may provide alternative solutions for the reuse of shrimp shell waste and mushroom substrate media as organic fertilizers.

Furthermore, the combinations of compost extracts and bio-insecticides can also increase soybean productivity and suppress insect pests. Therefore, the application of compost extracts and bio-insecticides to soybean plants is expected to reduce the use of chemical fertilizers and pesticides in soybean cultivation. Therefore, this study aimed to determine the effectiveness of EKKU and EKMTJ fertilizers combined with *B. bassiana* bioinsecticide on soybean growth and productivity.

MATERIALS AND METHODS

Research Area

This research was conducted at the Agro Techno Center (ATC) of the Faculty of Agriculture, Sriwijaya University, Indralaya Campus.

Research Procedures

The bioinsecticide with the brand "Bioverin" and the compost extract of shrimp shell with the brand "Biofitalik" used in this research were from the Department of crop protection, University of Sriwijaya. Furthermore, the compost extract of mushroom substrate media was conventionally made by this author, Erise Anggraini. The soybean plants were planted in soil with a total area of 500 m^2.

This is a factorial randomized block design study with the following treatments:
B1P1: bioinsecticide dose 1 litre/ha and shrimp shell compost extract
B1P2: bioinsecticide dose of 1 litre/ha and mushroom compost extract
B2P1: Bioinsecticide dose of 2 litres/ha and compost extract of shrimp shells.
B2P2: Bioinsecticide dose of 2 litres/ha and compost extract of mushroom substrate media. Each treatment had four replications; therefore, 16 experimental units and ten plant samples were taken for each experimental unit, so the whole plants observed were 160. Each treatment was applied to 3 soybean varieties, i.e., Deja 1, Devon 1, and Dena 1.

The land preparation was carried out by clearing the land of weeds and wood residues. After the clearing, it was plowed using a hand tractor. Subsequently, it was plotted using a hoe into 16 plots of 2.5 m x 2.5 m. Before planting, it was fertilized with 50 kg of cow manure for eight plots and 100 kilograms for 16 plots. A direct seed planting system was used with the Deja 1, Devon 1, and Dena 1 varieties. The seeds were buried about 2-3 cm from the soil surface with a 30 cm x 20 cm distance between planting holes. In one hole, there were 2-3 seeds. The compost extract was applied to the test plant by spraying it evenly on all the leaves up to the neck of the stem. The application was repeated seven times at a concentration of 2% shrimp shell compost extract and 5% mushroom compost extract with an interval of 7 days after the first application. The first spraying was done when the soybean plants were two weeks old or after the plants had five leaves.

A bioinsecticide containing *B. bassiana* was sprayed on soybean plants three weeks after planting at concentrations of 1 litre/ha and 2 litres/ha. Seven sprays were made at 7-day intervals. The plants were maintained by regular watering every morning and evening. Weeds were removed from the planting area.

Data Analysis

The observations consisted of 1) plant height, 2) wet weight of the plant shoots and pods, and 3) dry weight of the plant shoots and pods. The data obtained from the observations were averaged. The resulting differences were presented in the form of bar charts and diagrams.

RESULTS

The Plant Height

The statistical analysis showed that the height of growth, the weight of the shoots and the weight of the pods were not significantly different between the soybean varieties. Therefore, descriptive analysis was used to calculate these in this study. The average plant height of soybean varieties Deja 1, Devon 1 and Dena 1 treated with shrimp shell compost extract and mushroom substrate media compost extract combined with bioinsecticide doses were showed in Figures 1, 2 and 3.

The Average Wet and Dry Weights of Sprouts And Pods of Soybean

The average wet and dry weights of sprouts and pods of soybean varieties Deja 1, Devon 1 and Dena 1 treated with shrimp shell compost extract and mushroom substrate compost extract in combination with bioinsecticides were showed in Figures 4, 5, 6 and 7.

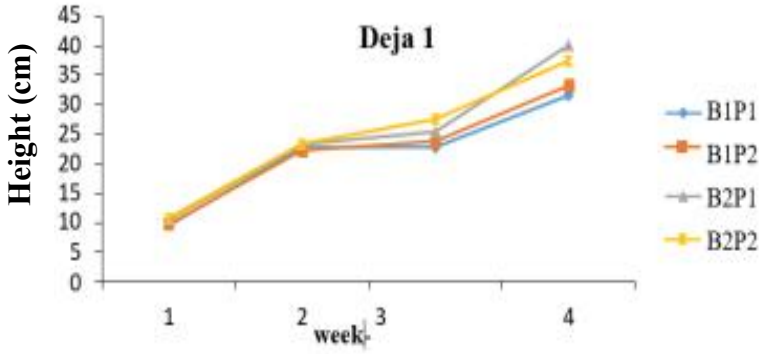

Figure 1: Deja 1 variety soybean growth height

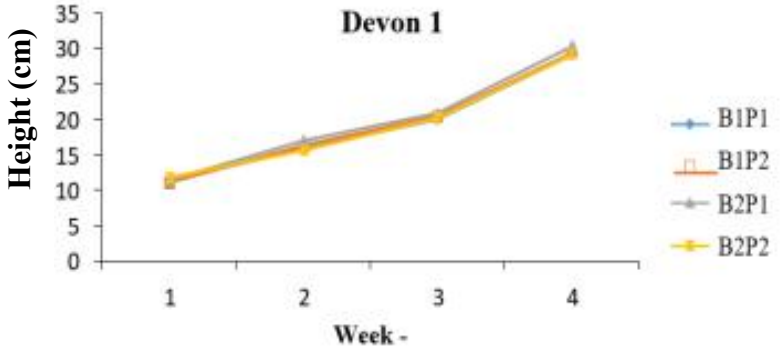

Figure 2: Devon 1 variety soybean growth height

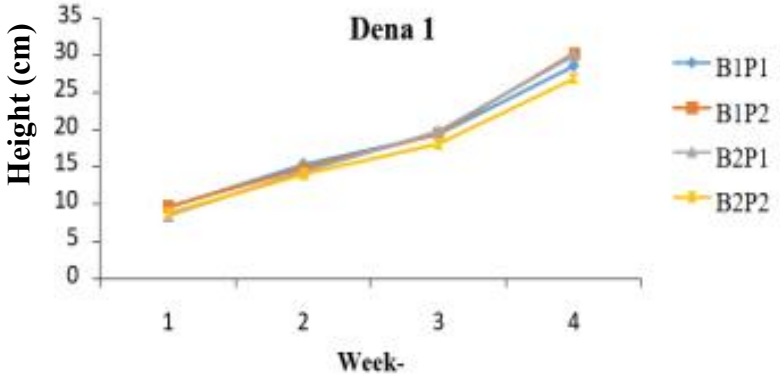

Figure 3: Dena 1 variety soybean growth height

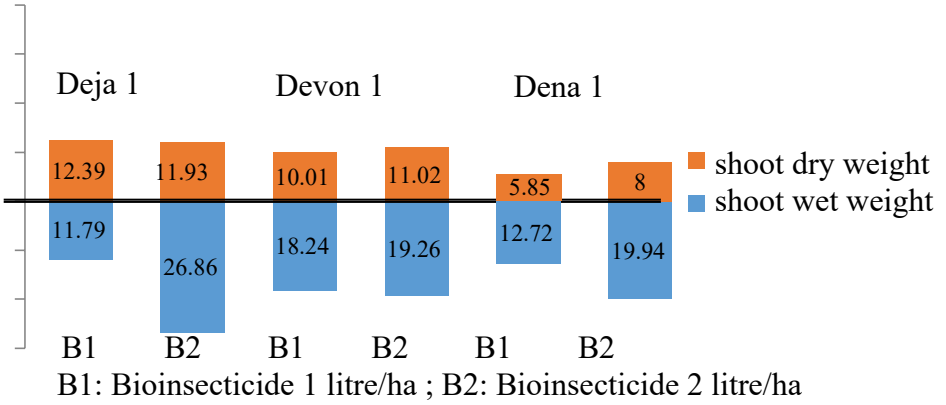

Figure 4. The effect of EKKU on soybean shoot weight

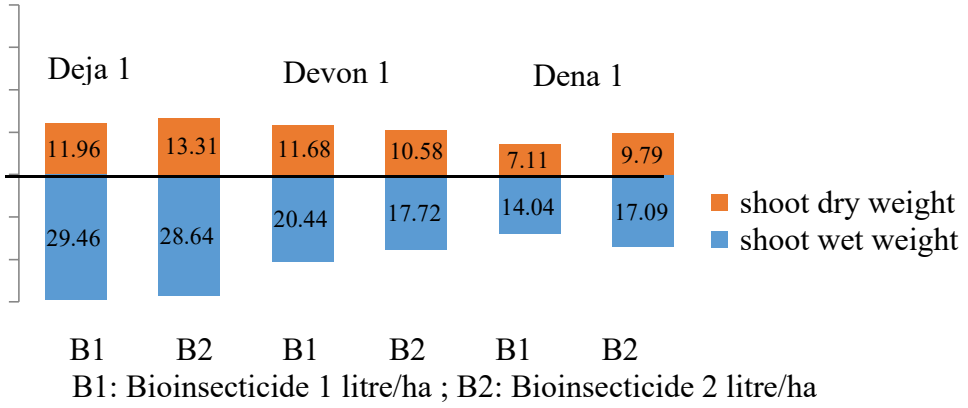

Figure 5. The effect of EKMTJ on soybean shoot weight

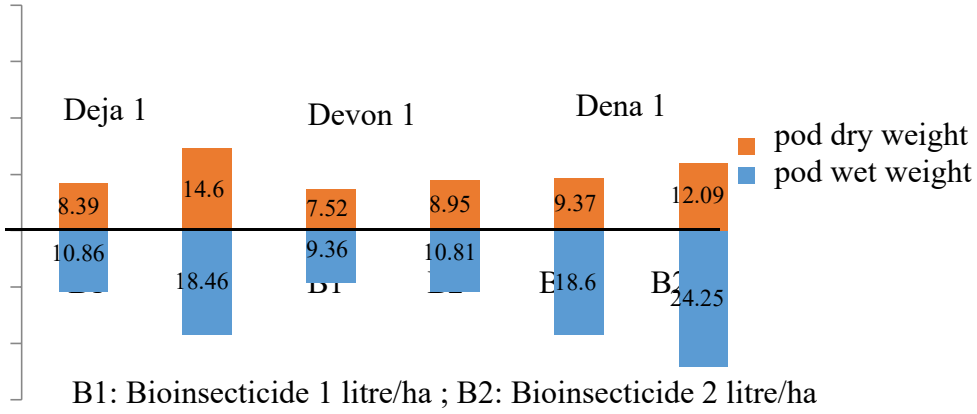

Figure 6. The effect of EKKU on soybean pod weight

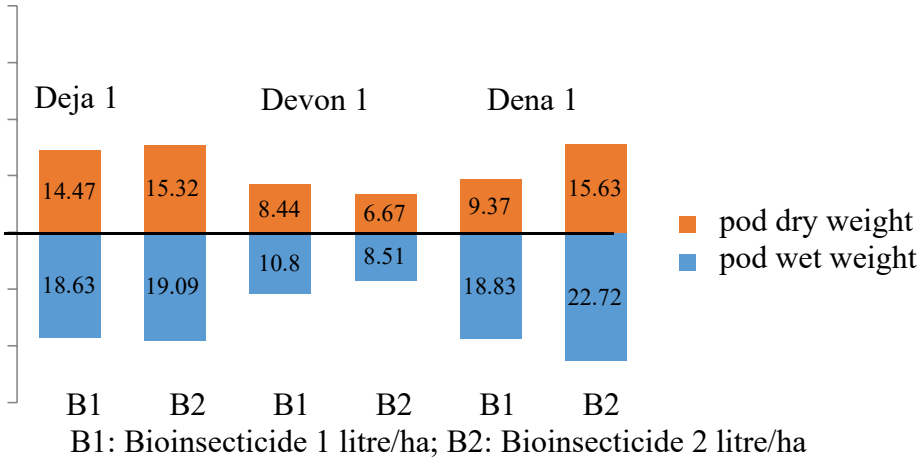

Figure 7. The effect of EKMTJ on soybean pod weight

DISCUSSION

Based on the results of the average data as presented in Figures 1 to 7, it can be concluded that each variety has different growth and production. Differences in development and production between varieties of the observed variables are thought to be caused by differences in the characteristics or superiority of each variety according to its genotype. The differences in genetic variations and environmental factors are one of the causes of the diversity of plant appearances (Kartahadimaja et al., 2021). Genetics in a plant will be expressed by various plant traits, including the form and function of plants that result in different growth and production.

The growth of soybean plants described in Figures 1, 2, and 3 of the average plant height indicates that the B2P1 treatment combination resulted in the highest plant height compared to other treatment combinations in each variety. From the combination of these treatments, it was found that giving shrimp shell compost extract affected plant height. This is because shrimp shell waste contains macro and micronutrients needed by plants (Abirami et al., 2022). In addition, the chitosan content in shrimp shells can stimulate plant growth by increasing the response to gibberellins and auxin hormones (Santo Pereira et al., 2017).

The treatments of B1 and B2 were the dose levels used for bioinsecticides. It is known that the bioinsecticide used contains *B. bassiana* with shrimp shell compost extract as carrier material. As a result, in addition to being an ingredient for pest control, bioinsecticide can also provide additional nutrients for plants. The increase in plant height corresponded with the increase in the dose used. This is good for plant cultivation since soybeans' height will affect their production ability. Nutrients, water, and sunlight absorbed by plants during the growth process will be translocated as dry matter, then, at the end of the vegetative phase, photosynthetic products will accumulate in the plant organs (Rouphael et al., 2012).

Based on the average results in Figures 4 and 5, the variable wet weight of the shoot of soybean with the application of EKKU with 2 litres of bioinsecticide/ha had the best results. However, the best results were obtained on the canopy dry weight variable by administering EKMTJ with 2 litres of bioinsecticide/ha. These results presumably result from the B2P1 treatment using the EKKU, which contains chitosan. Application of chitosan can improve root growth and overall plant development (Hidangmayum et al., 2019). In the B2P2 treatment using the EKMTJ application, EKMTJ has several nutrients plants need, especially nitrogen (Carrasco et al., 2018).

The application of organic material in the form of mushroom-substrate media waste can support plant growth-promoting organic amendment (Paula et al., 2017). In Figures 6 and 7 displaying the results of the average wet and dry weight of plant pods, the administration of EKMTJ with 2 litres/ha of bioinsecticide had the best results. This results from the EKMTJ containing nutrients, especially nitrogen which is one of the macronutrients plants need. Nitrogen in plants helps prepare amino acids, proteins, coenzymes, and chlorophyll to increase the dry weight of seeds (Głowacka et al., 2023; Singh et al., 2016).

CONCLUSION

Based on the results and discussion, it can be concluded that the administration of shrimp shell compost extract (EKKU) combined with 2 litres/ha bioinsecticide gave the best results on the height of the three soybean plant varieties. Shrimp shell compost extract (EKKU) gave the best results for the canopy wet weight. In contrast, the administration of mushroom substrate media compost extract (EKMTJ) showed the best results for the canopy dry weight of the three varieties. Mushroom substrate media compost extract (EKMTJ) combined with 2 litres/ha bioinsecticide gave the best results on the wet and dry weight of the three varieties.

ACKNOWLEDGEMENTS

The authors acknowledge the Faculty of Agriculture Universitas Sriwijaya for providing this research's experimental land (Agro Techno Centre).

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