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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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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.

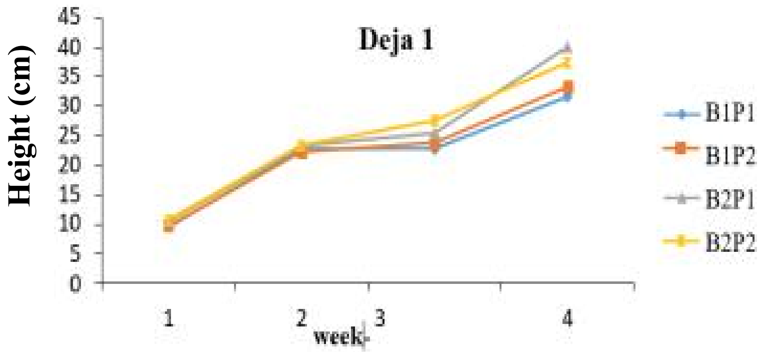

Figure 1: Deja 1 variety soybean growth height

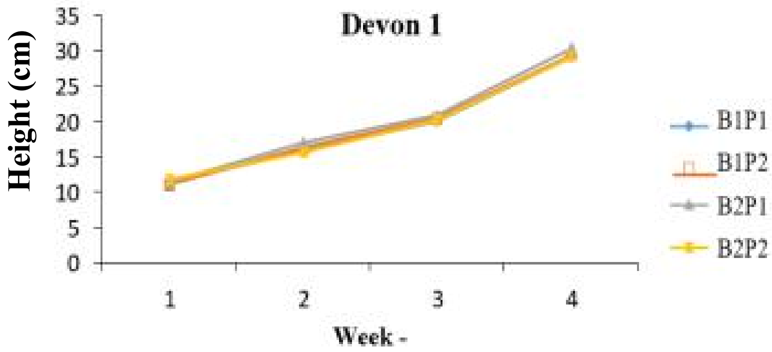

Figure 2: Devon 1 variety soybean growth height

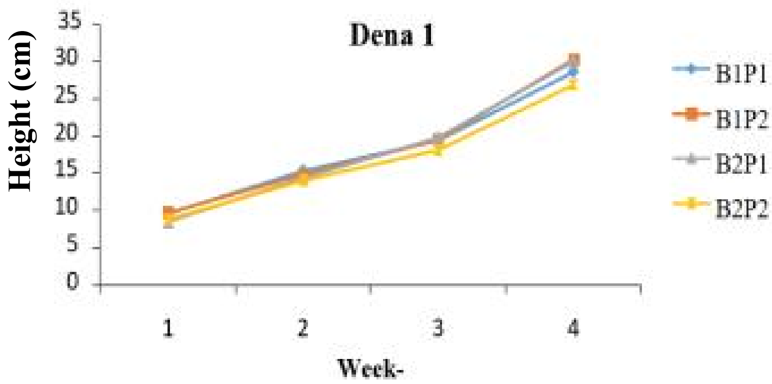

Figure 3: Dena 1 variety soybean growth height

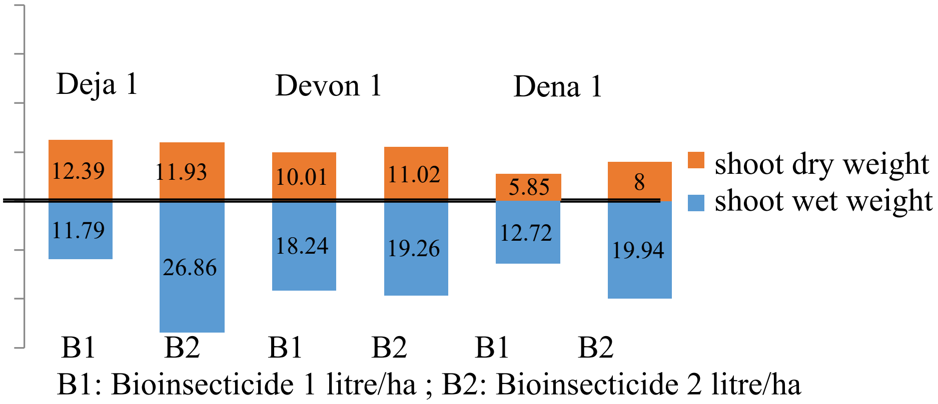

Figure 4. The effect of EKKU on soybean shoot weight

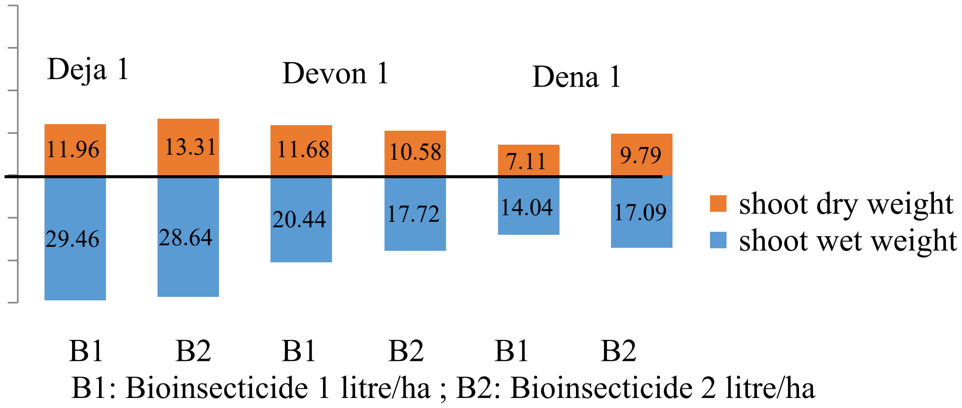

Figure 5. The effect of EKMTJ on soybean shoot weight

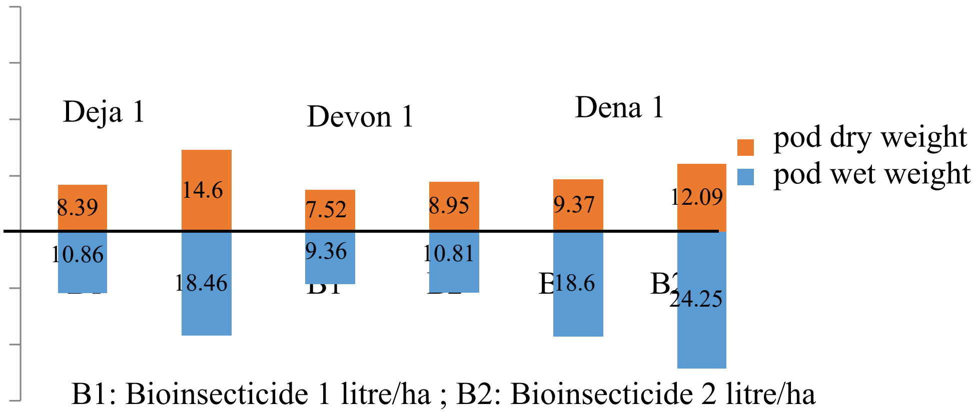

Figure 6. The effect of EKKU on soybean pod weight

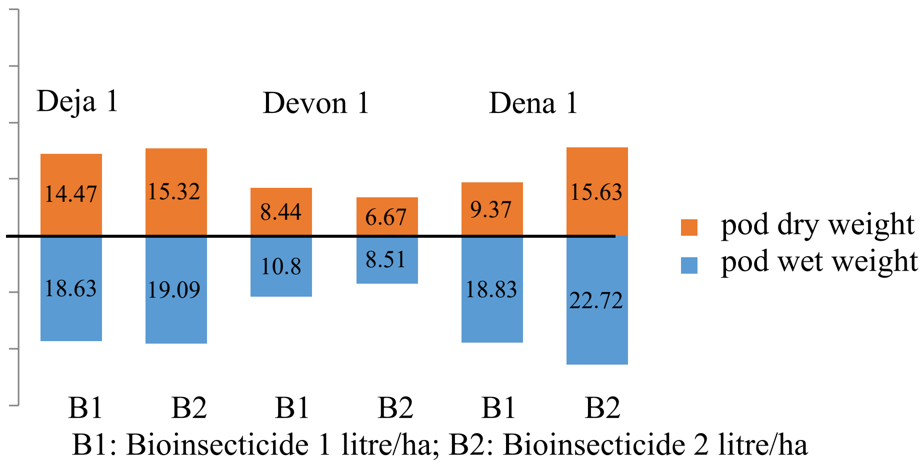

Figure 7. The effect of EKMTJ on soybean pod weight

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.

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REFERENCES

Abirami S, Gnanamuthu G, Nagarajan D. 2022. Bioconversion of shrimp shell waste into compost preparation and its plant growth study. *Indian Journal of Agricultural Research*. 56 (5): 588–593. DOI: 10.18805/IJARe.A-5214.

Carrasco J, Zied DC, Pardo JE, Preston GM, Pardo-Giménez A. 2018. Supplementation in mushroom crops and its impact on yield and quality. *AMB Express*. 8 (1): 1–9. DOI: 10.1186/s13568-018-0678-0.

Farouk S, Mosa AA, Taha AA, El-Gahmery AM. 2011. Protective effect of humic acid and chitosan on radish (Raphanus sativus, L. var. sativus) plants subjected to cadmium stress. *Journal of Stress Physiology & Biochemistry*. 7 (2): 99–116.

Fathipour Y, Sedaratian A. 2013. Integrated management of Helicoverpa armigera in soybean cropping systems. *Soybean-Pest Resistance. InTech, Rijeka, Croatia*. 231–280. DOI: 10.5772/54522.

Głowacka A, Jariene E, Flis-Olszewska E, Kiełtyka-Dadasiewicz A. 2023. The Effect of Nitrogen and Sulphur Application on Soybean Productivity Traits in Temperate Climates Conditions. *Agronomy*. 13 (3). DOI: 10.3390/agronomy13030780.

Hasan N, Suryani E, Hendrawan R. 2015. Analysis of Soybean Production And Demand to Develop Strategic Policy of Food Self Sufficiency : A System Dynamics Framework. *Procedia - Procedia Computer Science*. 72: 605–612. DOI: 10.1016/j.procs.2015.12.169.

Heidari G, Mohammadi K, Sohrabi Y. 2016. Responses of soil microbial biomass and enzyme activities to tillage and fertilization systems in soybean (*Glycine max* L.) production. *Frontiers in Plant Science*. 7: 17-30. DOI: 10.3389/fpls.2016.01730.

Hidangmayum A, Dwivedi P, Katiyar D, Hemantaranjan A. 2019. Application of chitosan on plant responses with special reference to abiotic stress. *Physiology and Molecular Biology of Plants*. 25 (2): 313–326. DOI: 10.1007/s12298-018-0633-1.

Itelima JU, Bang WJ, Onyimba IA, Sila MD, Egbere OJ. 2018. Bio-fertilizers as key player in enhancing soil fertility and crop productivity: A review. *Direct*

Research Journal of Agriculture and Food Science, 6 (3): 73–83. DOI: 10.26765/DRJAFS.2018.4815.

Kakar K, Xuan TD, Noori Z, Aryan S, Gulab G. 2020. Effects of organic and inorganic fertilizer application on growth, yield, and grain quality of rice. *Agriculture (Switzerland)*. 10 (11): 1–11. DOI: 10.3390/agriculture10110544.

Kartahadimaja J, Utomo SD, Yuliadi E, Salam AK, Warsono W. 2021. Agronomic characters, genetic and phenotypic diversity coefficients, and heritability of 12 genotypes of rice. *Biodiversitas Journal of Biological Diversity*. 22 (3): 1091–1097. DOI: 10.13057/biodiv/d220302.

Krasilnikov P, Taboada MA, Amanullah. 2022. Fertilizer Use, Soil Health and Agricultural Sustainability. *Agriculture (Switzerland)*. 12 (4): 16–20. DOI: 10.3390/agriculture12040462.

Krisnawati A, Nuryati N, Adie MM. 2021. Assessment of Soybean Resistance to Leaf-feeding Insect, Spodoptera litura. *Biosaintifika: Journal of Biology & Biology Education*. 13 (1): 92–98. DOI: 10.15294/biosaintifika.v13i1.24794.

Kumar J, Ramlal A, Mallick D, Mishra V. 2021. An overview of some biopesticides and their importance in plant protection for commercial acceptance. *Plants*. 10 (6): 1–15. DOI: 10.3390/plants10061185.

Niwińska B, Witaszek K, Niedbała G, Pilarski K. 2020. Seeds of n-GM soybean varieties cultivated in Poland and their processing products as high-protein feeds in cattle nutrition. *Agriculture*. 10 (5): 174. DOI: 10.3390/agriculture10050174.

Paula FS, Tatti E, Abram F, Wilson J, O'Flaherty V. 2017. Stabilisation of spent mushroom substrate for application as a plant growth-promoting organic amendment. *Journal of Environmental Management*. 196: 476–486. DOI: 10.1016/j.jenvman.2017.03.038.

Rouphael Y, Cardarelli M, Schwarz D, Franken P, Colla G. 2012. Effects of drought on nutrient uptake and assimilation in vegetable crops. *Plant Responses to Drought Stress: From Morphological to Molecular Features*. 171–195. DOI: 10.1007/978-3-642-32653-0_7.

Santo Pereira AE, Silva PM, Oliveira JL, Oliveira HC, Fraceto LF. 2017. Chitosan nanoparticles as carrier systems for the plant growth hormone gibberellic acid. *Colloids and Surfaces B: Biointerfaces*. 150: 141–152. DOI: 10.1016/j.colsurfb.2016.11.027.

Sayara T, Basheer-Salimia R, Hawamde F, Sánchez A. 2020. Recycling of organic wastes through composting: Process performance and compost application in agriculture. *Agronomy*. 10 (11): 1838. DOI: 10.3390/agronomy10111838.

Shaji H, Chandran V, Mathew L. 2021. Organic fertilizers as a route to controlled release of nutrients. In *Controlled release fertilizers for sustainable agriculture* (pp. 231–245). *Elsevier.* DOI: 10.1016/B978-0-12-819555-0.00013-3.

Singh M, Khan MMA, Naeem M. 2016. Effect of nitrogen on growth, nutrient assimilation, essential oil content, yield and quality attributes in Zingiber officinale Rosc. *Journal of the Saudi Society of Agricultural Sciences*. 15 (2): 171–178. DOI: 10.1016/j.jssas.2014.11.002.

Sridhar MKC, Hammed TB. 2014. Turning waste to wealth in Nigeria: An overview. *Journal of Human Ecology*. 46 (2): 195–203. DOI: 10.1080/09709274.2014.11906720.