The Effect of Different Rate of Black Soldier Fly Frass (BSFL) and Paddy Husk on Growth and Flowering Performance on Okra (*Abelmoschus esculentus*)

IQMAL RUSYAIDI BIN USOP

F18A0042

UNIVERSITI MALAYSIA KELANTAN

2022

The Effect of Different Rate of Black Soldier Fly Frass (BSFL) and Paddy Husk on Growth and Flowering Performance on Okra (*Abelmoschus esculentus*)

Iqmal Rusyaidi Bin Usop

F18A0042

A report submitted in fulfilment of the requirements for the degree of Bachelor of Applied Science (Agrotechnology) with Honours

Faculty of Agro Based Industry

UNIVERSITI MALAYSIA KELANTAN

2022

DECLARATION

I hereby declare that the work embodied in here is the result of my own research except for the excerpt as cited in the references.

____

Signature

Student's Name :

Matric No :

Date :

Verified by:

Supervisor Signature

Supervisor Name : Encik Mohd bin Mahmud @ Mansor

Stamp :

Date :

ACKNOWLEDGEMENT

It is a great pleasure to address people who helped me throughout this project to enhance my knowledge and practical skills. It was very challenging journey to carry out the research and it has been a great platform for me to improve myself in many aspects of my life. I would like to thank University Malaysia Kelantan, Jeli, for allowing me to come back from home to campus to do my research peacefully in the era of pandemic Covid-19.

Secondly, I would like to appreciate my beloved parents for being great support to complete my research. My supervisor, Encik Mohd bin Mahmud @ Mansor also showed me excellent guidance in submitting this thesis.

Finally, I sincerely thank to all those who directly or indirectly helped me for this Final Year Project.

The Effect of Different Rate of Black Soldier Fly Frass (BSFL) and Paddy Husk on Growth and Flowering Performance on Okra (*Abelmoschus esculentus*)

ABSTRACT

This research study has been carried out to compare the effect of Black Soldier Fly Larvae (BSFL) fertilizer and commercial NPK fertilizer on the growth of Okra. There were many options to choose the composition, but I choose to buy the ready-made one at the online shop due to transportation problems. The research was done using completely randomized design method to test some parameters like the height of the plant, number of leaves, and days of flowering. Each parameter is recorded every week until the dateline of the fieldwork ended. The analysis of the data was conducted using SPSS Anova. The result showed that there was a significant effect between commercial fertilizer and organic BSFL fertilizer treatment with paddy husk.

Keywords: BSFL, okra, NPK, Paddy Husk

Kesan Kadar Berbeza Black Soldier Fly Frass (BSFL) dan Sekam Padi terhadap Prestasi Pertumbuhan dan Pembungaan pada Okra (Abelmoschus esculentus)

ABSTRAK

Kajian penyelidikan ini telah dijalankan untuk membandingkan kesan baja Black Soldier Fly Larva (BSFL) dan baja NPK komersial terhadap pertumbuhan Okra. Terdapat banyak pilihan untuk memilih gubahan, tetapi saya memilih untuk membeli yang siap di kedai dalam talian kerana masalah pengangkutan. Penyelidikan dilakukan menggunakan kaedah reka bentuk rawak sepenuhnya untuk menguji beberapa parameter seperti ketinggian tumbuhan, bilangan daun, dan hari berbunga. Setiap parameter direkodkan setiap minggu sehingga garis tarikh kerja lapangan tamat. Analisis data dijalankan menggunakan SPSS Anova. Hasil kajian menunjukkan terdapat kesan yang signifikan antara baja komersial dan rawatan baja BSFL organik dengan sekam padi.

Kata kunci: BSFL, bendi, NPK, Sekam Padi

LIST OF ABREVIATIONS

cm	centimetre
g	Gram
T	treatment
R	replication
ATP	Agro Technopark
UMK	Universiti Malaysia Kelantan
ANOVA	Analysis of Variance
BSFL	Black Soldier Fly
NPK	Commercial fertilizer
Kg	Kilogram

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENT

CHAPTER 1

INTRODUCTION

1.0 RESEARCH BACKGROUND

Organic waste may be converted into insect biomass, which can be utilized as an animal feed ingredient, using insects as a possible alternative approach for organic waste management (Liu, Z., Minor, M., Morel, P. C., & Najar-Rodriguez, A. J. ,2018). Organic waste may be converted into insect biomass, which can be utilized as an animal feed ingredient, using insects as a possible alternative approach for organic waste management. Insects are not only tasty, but they are also a fantastic source of protein, healthy fats, and a few trace elements when prepared correctly. Since their environmental effect is lesser than that of other animal foods, they are frequently hailed as food rescuers in times of food scarcity. The feed-to-protein conversion rate of insects is lower than that of cattle or pigs and even poultry, according to some sources (Huis, 2013).

It is also possible to reduce the environmental impact of vertebrate meats by using insects as feed. It is possible to increase the protein content of larger food animals by feeding them insects that have been raised on human-inedible wastes, which may be fed back to the insects. It uses less space and resources than cultivating fields of wheat or other feeds, which could otherwise be used to produce food for people and is therefore more ecologically friendly. However, there is currently a shortage of insects to pick from when it comes to industrializing edible insects. Only a few of the thousands of species that are consumed across the world can be farmed at this time, which has serious ramifications for both supply and conservation. House crickets and mealworms, which are extensively sold and consumed in the West, are not always the most sustainable or the most desirable organoleptic qualities, such as taste and texture, of the species available (Huis2013). Most customers will not want insects since they are harder to raise or harvest, which means they are more expensive. Flavor is also an important factor in food consumption, and it should not be overlooked. If insects were raised on edible organic waste instead of inedible ones, this would have a significant positive impact on both the environment and the lives of people non the poor world. As an additional benefit, the recycling of the waste itself provides a cost-effective and environmentally friendly alternative to managing organic wastes like manure and leachates (Huis2013).

The crop used for this research is *Abelmoschus esculentus* (okra). To produce healthy okra, it needs adequate nutrients. Black Soldier Fly (BSFL) frass has become one new solution to replace the standard chemical fertilizer. Consumers are nowadays more concerned about chemical usage in farming. Using these organic insects, harmful microorganisms found in organic waste such as Escherichia, Salmonella, or other enterobacterial colonies are reduced or eliminated after being digested by the larvae of black soldier flies (Kim et al., 2021).

1.1 PROBLEM STATEMENT

Nutrient deficiency is today's most pressing issue when it comes to planting. Surprisingly, the general public's knowledge of organic products is increasing year after year. (Lyu,2020). Thus according to information available on the website of the World Economic Forum, By 2030, it is estimated that global food waste would have increased by over 2.1 billion tonnes, So food waste disposal is a societal issue that requires immediate action (Klammsteiner, 2020). Consumer understanding of dietary aspects and the need of living a healthy lifestyle is becoming an increasingly critical issue (Lyu,2020). Customers have responded to this knowledge by changing their eating habits, favouring high-quality and healthy food sources such as organic vegetables and fruits, as a result of their increased awareness. In addition, consumers are becoming more aware of the negative consequences of agricultural goods that have been polluted or generated by the excessive use of pesticides and chemical or synthetic fertilisers, particularly in the United States (Proshchalykina, 2019). Organic agricultural goods that are free of fertilisers and pesticides are growing popularity and increasing demand among organic enthusiasts and local customers in this regard (Chrysochou, 2019).

Because of the nutritious richness of BSFL frass, it may be the answer to organic fertiliser needs in the future (Choi, 2019). BSFL grass does neither transmit or resist illness, according to a recent study. Consequently, adding grass to the soil on a regular basis can help prevent fungal diseases from pathogens such as Rhizoctonia, Fusarium, and Pythium from developing (Hassanzadeh, 2020). After the study is completed, it will be concluded that frass can increase plant development while not increasing the transmission of plant-pathogenic illnesses from a compost waste diet. Not only will frass increase soil fertility and guard against diseases, but it will also do so without damaging the environment and is readily accessible on the market at a reasonable price. Frass is available on the market at an inexpensive price (Hassanzadeh, 2020).

1.2 HYPOTHESIS

Ho: Okra grown using BSFL fertilizer has a better plant growth and days of flowering.

H_1: Okra grown using BSFL fertilizer had no change in the plant growth, and days of flowering.

1.3 OBJECTIVE

i. To analyze the effect of BSFL frass fertilizer treatment and commercial NPK fertilizer on the growth of Okra.
ii. To compare the days of the flowering number between each treatment.

1.4 SIGNIFICANCE OF STUDY

From this research, we can utilize the abundance of BSFL extract to something beneficial for the future. This study will improve the practices of organic and natural fertilizers. Organic farming can also control weeds and pests through biological, physical, and cultural methods. Through this method, weeds and pests can be controlled effectively without harming farmers and their users compared to pesticides. For example, pesticides such as lemongrass can repel pests and not harm the environment. Thus, organic crops can help control weeds and pests through biological, physical, and cultural methods.

Turns out these insects can help sustainably address the global issue of world hunger. It will prevent pollution and chemical waste to provide better sustainable farming. This study also will improve the policy of reducing the cost to use commercial fertilizer. Efforts to recycle organic waste using BSFL into high-quality alternative protein ingredients in animal feeds and organic fertilizers have gained momentum worldwide (Beesigamukama,2021). In addition, organic crops will also help recycle agricultural waste, kitchen waste yard waste and livestock manure biologically. This is because this recycling process involves the process of organisms that do not give a negative impact to crops or society. For example, cattle manure can be used as compost for crops. With this recycling, cow dung is not thrown away just like that. In fact, this compost fertilizer does not contain any chemical elements that can be harmful to the health of consumers. Therefore, this recycling will make quality organic crops and can avoid wastage. (Beesigamukama,2021). As a result of the study, it can be established that BSFL frass does not transmit disease and provides a defence against diseases such as Rhizoctonia, Fusarium, and Pythium if it is added to the soil on a constant basis. To see if disease might be transmitted, researchers in Part I found no R. *solani or F. oxysporum* growth, indicating that any pathogens found in *R. solani or F. oxysporum* diets were digested by larvae and transformed to less harmful compounds (Choi, 2019).

CHAPTER 2

LITERATURE REVIEW

2.1 Black Soldier Fly Larvae (BSFL)

Black Soldier Fly Larvae (BSFL) has successfully converted organic waste into high-quality fat and protein (Klammsteiner, 2020). Black soldier fly larvae have a high nutrient content of up to 42% protein and 32% fat suitable as an alternative food for livestock, especially chickens while the waste produced can be used as organic fertilizer for crops. The technology of using insects to produce animal feed has already received a lot of attention at home and abroad, especially to reduce energy costs and the use of chemicals in the process of organic waste management and reduce the import of raw materials for animal feed globally. This study anticipates that harmful microorganisms found in organic wastes such as Escherichia sp., Salmonella sp. or other enterobacterial colonies are reduced or eliminated after digestion by the larvae of black soldier flies (Beesigamukama, 2021).

The high moisture content and warm temperature are among the best condition for insects to grow (Yanakittkul, 2020). There are many reasons why Black soldier fly is being widely researched as a sustainable protein source food in the poultry and other animal husbandry industry. Black soldier fly can be grown and harvested in some climates, they eat mostly organic matter and are generally a non -pest species. In a study conducted in East Africa showed that by incorporating BSFL larvae into food for their poultry farms, they were able to reduce food prices and reduce the environmental costs incurred in the poultry production process. The study involved scientists from the Kenya Agriculture and Livestock Research Organization investigating whether BSFL could replace soybean meal or fish as a source of protein in commercial foods (Choi,2019).

As a result of the study the results obtained a cost -benefit ratio of 16% and a better return of 25% were recorded when chickens were fed the highest concentration of protein from BSFL compared to the conventional diet, which was also 19% more expensive. Kenya is now looking for sustainable and affordable food for commercial poultry farms as now Kenya does not grow enough soybeans for their protein source and must import them. In addition, the demand for fishmeal has led to too much fishing in Lake Victoria, a problem that is also occurring globally. Kenya is not the only country having trouble finding sustainable and affordable protein as their pet food. This is a problem facing breeders around the world (Choi, 2019). However, their biggest advantage over traditional livestock feeding methods and from other insects is their ability to convert organic waste into valuable foodstuffs, thereby generating profit value and shutting down the nutrient cycle as they reduce pollution and costs. The nutrient cycle is the movement and exchange of organic and inorganic matter back into material production (Klammsteiner,2020).

One study was conducted by looking at the development of chickens, which were fed black soldier fly larvae reared in a horse breeding waste area. The purpose of this study was to evaluate the growth performance of local chickens fed Black Soldier Fly larvae. The chickens were fed larvae that they had frozen and then thawed-Black Soldier

Fly larvae were then included in the chicken's diet for 30 to 80 days. By introducing only 8% of Fly Black Soldier larvae, studies show that the growth of their chickens improved during their breeding period. Moreover, the participation of BSF larvae had no negative influence on the other parameters measured. The results also show that feeding BSF larvae is very suitable for the traditional system of chicken production, which is commonly used in Malaysia and other Southeast Asian countries (Hassanzadeh,2019).

These ongoing studies are just the beginning. Protein sources from insects are expected to have a huge impact on the food industry not just in the poultry division, and for sure Black soldier fly will lead it (Bessa,2020). These flies differ from house flies in several respects. This difference also makes these flies more environmentally friendly where they are able to prevent the transmission of diseases carried by house flies. The life cycle of this fly begins with the egg stage where a female BSF is able to lay between 900 to 1200 eggs. Next, these eggs will hatch after 4 days of BSF parent laying eggs. The ideal place for BSF to lay eggs is on drywalls/areas and underneath there is a food source (Thomas,2020).

Frass additionally consists of nitrifying microorganism and nitrogen-fixing microorganism, which partakes withinside the nitrogen cycle and help in the plants uptake of nitrogen (Choi,2019). Frass also consists of safer chemicals for human publicity, while artificial fertilizers frequently are composed of harmful substances including cadmium, uranium, and arsenic, all of which can be cancer-causing agents as well as triggers for developmental problems in kids (Sharma & Singhvi, 2017). If BSFL frass possesses defensive properties for plants, it could be a viable alternative to chemical fertilizers for plant growth (Choi, 2019). Dairy cow dung can be blended with other materials to increase larval yields and reduce waste because of the high crude fiber content of pure dairy manure that flies cannot fully digest. BSFL can be grown on this mixed manure.

Slaughterhouse blood and offal can also be used to raise BSFL, repurposing human food waste once again.

Accordingly, it is clear that BSFL may be used to feed a wide range of vertebrates and can be utilized as a substrate for a variety of vertebrate wastes, with no negative impacts on human consumption of BSFL-fed meats. Food conglomerates' promises to reduce waste, coupled with the volatile prices of fish meal and other feed, are expected to lead to ~~a~~ greater use of insect feeds in advanced economies like the United States, where consumers are becoming more environmentally conscious while regulators are becoming more environmentally aware (Feed, 2017).

Combined with their nitrogen-rich frass, BSFL can be used as fertilizer (Green, T.R., Popa, R., 2012). No other insect comes close to closing so many material flow loops and creating nearly self-sustaining food production cycles as BSFL, effectively making BSFL rearing on wastes a self-financing form of pollution reduction (Wang & Shelomi, 2017). Although it is not yet known what are the best ratios of insects to substrate and what conditions will provide the optimal mix of larval production and waste recycling. BSFL thus show strong promise as part of a sustainable system with hydroponics or composting and aquaculture or poultry farming (Nyakeri et al., 2017).

2.2 OKRA

The Malvaceae family member okra (*Abelmoschus esculentus* L.) is also known as Lady's finger, bhindi, okura, quimgombo, bamia, gombo, and lai long ma in the many countries where it is cultivated. According to history, Okra was first grown in Egypt in the 12th century and spread throughout the Middle East and North Africa after that. In addition to being a popular garden and farm crop, okra is an annual plant that survives in tropical and subtropical parts of the world. One of the world's most popular food crops, it is grown in abundance across the globe. Many recipes for soup and sauce thickening include okra extract, which is extracted from the green, immature pods of the vegetable (Choi,2019).

Okra's bioactive components and related bioactivities have led to its recent usage as a nutraceutical and medicinal supplement in addition to its nutritional benefits. okra's nutritive value and the potential pharmacological uses of its bioactive components are discussed, as are the qualities that might be useful in developing and formulating nutraceuticals and functional foods. Okra-based nutraceuticals and their use are also examined in this review, as is the nutraceutical potential for Abelmoschus esculentus for different therapeutic purposes (Applications2021). Okra is more likely to be a nutrient-dense supplement than a primary food source. Surajbala Exports Private Limited in New Delhi, India, and Hunan QiyiXinye culture media, both in Hunan, China, use okra seeds to produce oil. Several food kinds contain varying degrees of lipid content, such as triacylglycerols, polar lipids, free fatty acids, or diacylglycerols, which is one essential part of a meal's nutritional value. Fatty acids are the most important of these components in influencing the stability and nutritional value of food. Saturated and unsaturated fatty acids combine to form triacylglycerols, which differ somewhat in the number of related acyl group repeats, the number of double bonds, and the locations of the double bonds. Furthermore, these lipids are built to serve as energy storage (Applications,2021).

Okra is also a good source of minerals that are necessary for cellular homeostasis. 84, 90, and 1.20 mg of calcium, phosphorus, and iron, respectively, have been found in the edible plant portions. Vitamins A, C, and B complexes are also present in rather high amounts (185 g, 0.08 mg, and 0.04 mg, respectively). To this purpose, the specific toxicity of plant compounds against malignant cells has drawn the attention of several researchers throughout the world. The blossoms of okra are also said to have a higher concentration of flavonoids and phenols than other parts of the plant, including the pods, peel, leaves and seeds. According to a recent study, flavonoids isolated from the flowers of okra plants exhibited a considerable anticancer impact on colorectal cancer cells, both in-vitro and in vivo, acting as powerful antioxidants while also inhibiting tumour cell proliferation. Colorectal tumour cells were unable to perform mitochondrial activities due to the antiproliferative action of flavonoids in Okra flowers, which led to apoptosis and inhibited autophagy (Applications,2021).

2.3 PADDY HUSK

The supply of paddy husk from rice processing facilities continues to be abundant, owing to the rise in global rice consumption. When rice is processed in Malaysia, paddy husk is burned as fuel, and the ash that is produced is utilised as fertiliser on the fields. This method, on the other hand, is not environmentally beneficial because it has the potential to degrade air quality. Paddy husks co-composted with chicken dung to make organic amendment might eliminate the need for this procedure in the future. In the context of waste treatment, co-composting can be regarded as a technology that is relevant for the land application of chicken manure and rice husk. Co-composting is one of the most promising waste disposal processes for the development of environmentally friendly treatment options (Wang, 2004).

~~A~~ Low carbon to nitrogen (C/N) ratio source such as chicken dung co-composted with a high C/N ratio source such as paddy husk, according to (Brady and Weil, 2010), provides adequate C for N immobilisation by microorganisms. This strategy can reduce NO3 leaching from chicken manure while still providing enough nitrogen to accelerate the breakdown rate of the rice husk, which is beneficial for the environment. Co-composting of rice husk and chicken manure can result in an excellent soil amendment that has several benefits for agricultural systems when utilised as a soil amendment. However, nitrogen loss during co-composting can be significant, and this loss may result in air pollution as well as a reduction in the nutritional content of the finished compost.

CHAPTER 3

MATERIALS AND METHODS

3.1. MATERIAL

Organic soil in commercial packaging was used to ensure it was suitable for the crop and used as a growing medium for all Abelmoschus esculentus (okra) seeds. The BSFL fertilizer (Biovae brand) was ordered from the online shop due to the difficulty in obtaining materials. Paddy husk which has been burned, also ordered from an online shop (no brand) was used as one of the treatments, along with fertilizer.

3.2 APPARATUS

21 unit of white polybags 16”×16”, seedling tray with 104 holes (2 unit), disposable glove (1 box), small sprayer (1 unit), measuring tape (1 unit), weight measuring machine (1 unit), compost scoop (1 unit), permanent marker (2 unit).

3.3 METHOD

3.3.1 PREPARATION OF SEED

Before planting in polybags, the seed was sown at the student hostel in a seed tray on 9 Nov 2021. It takes around 2 weeks to get a mature plant before transferring into polybags. The plants were taken from the seedling tray that is ready to for planting transferred into polybags with 2kg gardening soil. The bags were arranged using the experimental design to see the changes between the plant in commercial fertilizer and the plant in BSFL frass. The polybags placed at ATP nursery give the best exposure to sunlight.

NPK with ratio 15:15:15+2Sulphur and BSFL frass with the composition of Nitrogen (N): 4%, Phosphorus (P): 3%, Potassium (K): 1%, Magnesium (Mg): 0.5% and 74% of organic matter, and 100% organic burned paddy husk combined with cocopeat ratio of 30:70 used in the treatment.

3.3.2 PREPARATION OF THE FIELD SITE

The nursery site was inspected and observed. A black net successfully covered the roof to limit the overshade of sunlight. The water sprinkler system at Agro Technopark was automatically watered two times a day. It was made sure that the place was hygienic and safe to experiment. Treatments were carried out with three replicates arranged using a completely randomized design (CRD), as shown below.

T1R1	T3R2	N1
T5R3	T4R1	T1R3
T2R1	T5R2	C2
T4R2	T1R2	T3R3
T5R3	T3R1	T2R3
T2R2	C1	T4R3
N2	C3	N3

Table 3.3.2: Completely Randomized Design (CRD)

C-Control, N-NPK, T-treatment, R-replicates

TREATMENT	BSFL FRASS (g)	PADDY HUSK (g)	Gardening soil (kg)
T1	20	80	3
T2	30	70	3
T3	50	50	3
T4	70	30	3
T5	80	20	3
NPK (+ve control)	50 (NPK)	50 (NPK)	3
CONTROL (-ve control)	0	0	3

Parameters: Height, Number of Leaves and Days of Flowering. *The treatment was divided equally until week 4

Table 3.3.3: Treatment composition

3.3.3 DATA ANALYSIS

Each treatment was conducted with three replicates arranged in Completely Randomized Design (CRD). All the data and parameters on the studies were analyzed in one-way analysis of variance (ANOVA), and differences between means for significance under a significance level of $p<0.05$ were calculated. Computer software Statistical Package for Social Science (SPSS) version 26 was used for statistical analysis. Turkey HSD range test was used to compare the means of all treatments at significance at $P<0.05$.

CHAPTER 4

RESULT AND DISSCUSSION

4.1 PLANT HEIGHT

In this research, plant height plays a significantly vital role in showing differentiation between the effect of each treatment and controlled plant. The plant height data was recorded 4 week due to lack of experiment timing. T4R1 has the highest data recorded in 4 weeks of collecting data. C1 and C2 do not show much difference in controlled plants. They have deficient data. For the NPK treatment, N2 and N3 show a significant height difference. The mean value of plant height using treatment 3 shows an increasing trend in height compared to other treatments.

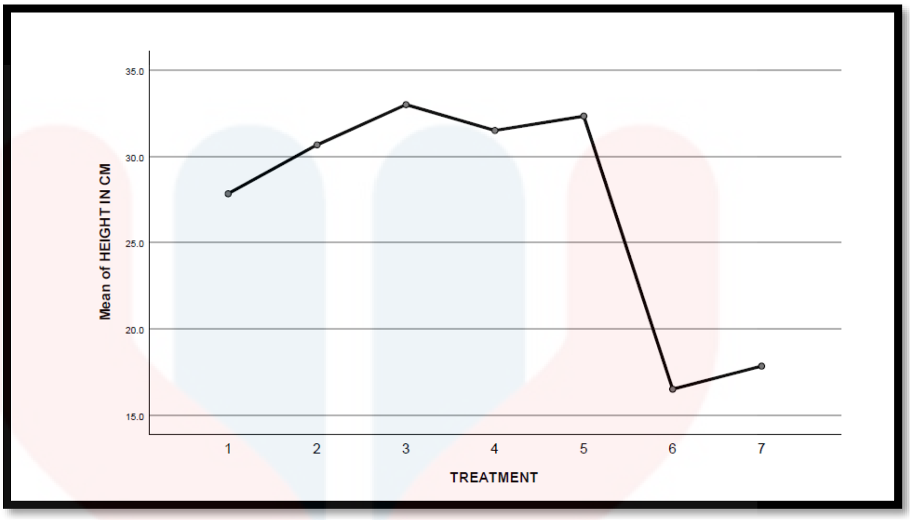


Figure 4.1: The mean of Plant Height and Treatments from SPSS Anova.

4.2 NUMBER OF LEAVES

The number of leaves is also affected by the treatments compared to controlled plants. T4R1 again shows the greatest number of leaves in the treatment group. Meanwhile, C2 shows the smallest number of leaves. Treatment 4 also shows the higher mean number of leaves.

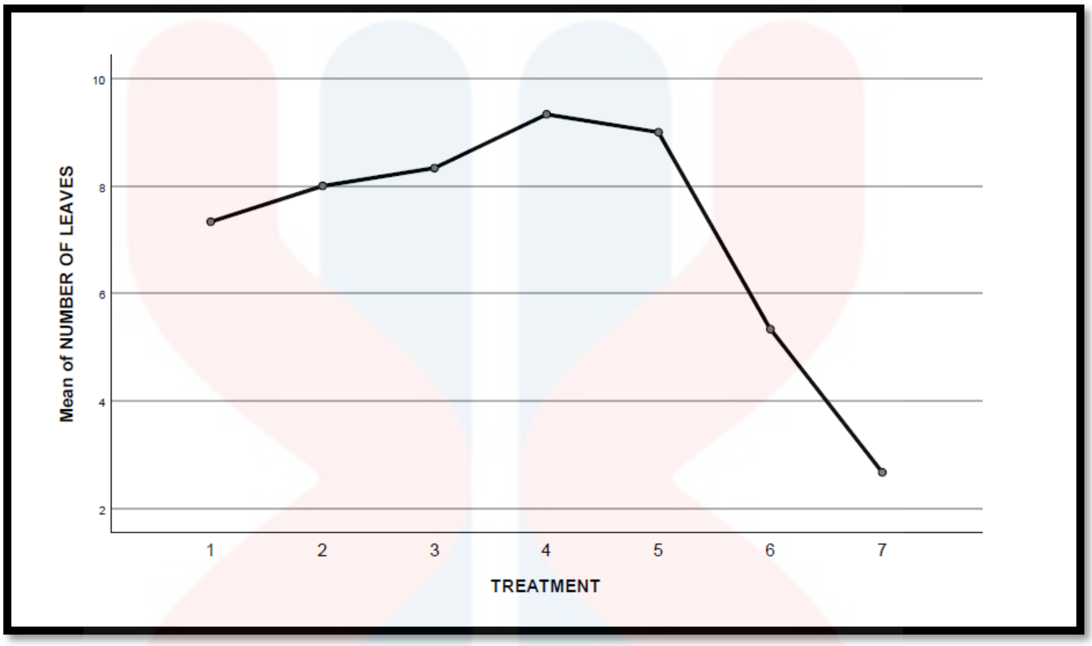


Figure 4.2: The mean Number of Leaves and Treatment from SPSS Anova.

4.3 DAYS OF FLOWERING

However, in different scenarios here at the days of flowering data, the T1R1 shows the early treatment that has shown flowering. Many other treatments have not the number days of flowering. The data also exceed the week 4 because the crop was Okra.

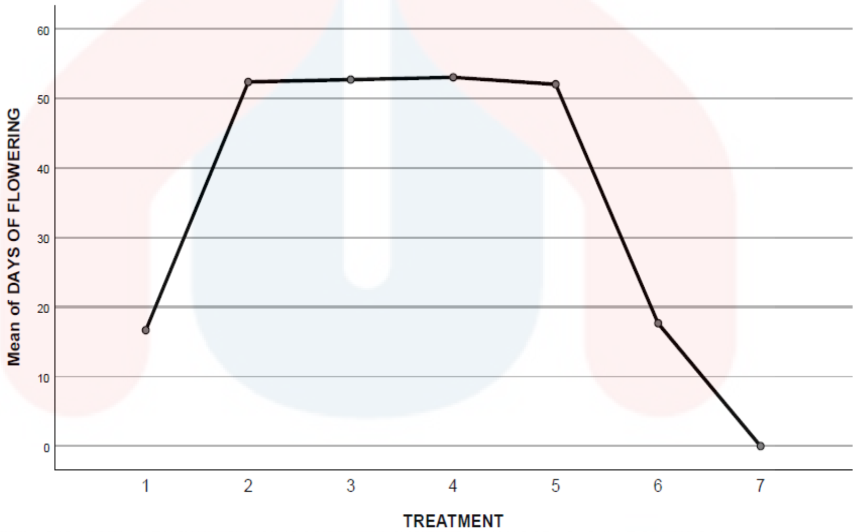


Figure 4.3 : The Mean days of flowering and Treatments from SPSS Anova.

4.4: DISCUSSION

The research was conducted during Covid-19 Pandemic. There was so many problem to complete the research. One of the challenging problems was making sure the timing of the planting was not delayed. The shipping of the products was also affected by the Covid-19 Pandemic. NPK fertilizer used also did not give good results on okra flowers. Due to that, the pollination process takes a long time (up to the 50th day). From the first day the seeds were sown, I admitted that many incidents occurred that caused the seedlings to take a long time to grow. Among them is the lack of water and sunlight.

The experiment was arranged in a completely randomized design to ensure that all plants get nutrients and light at random. I should use NPK 20:10:10 because it contributes more to the growth of okra flowers.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

In this study, the objectives have been significantly achieved by identifying the height, number of leaves and days of flowering. From the result obtained, the treatment of BSFL and burned paddy husk was produced better outcomes than the commercial fertilizer. Furthermore, the plant also looks healthier and shows excellent resistance in the monsoon month. This research will implement the organic fertilizer practices among the farmers.

5.2 Recommendation

Further research should be done in organic fertilizer to identify the best timing of the fertilization. Besides, the commercial fertilizer includes many chemical ingredients that may have been affect the environmental.

REFERENCES

Beesigamukama, D., Mochoge, B., Korir, N. K., Fiaboe, K. K., Nakimbugwe, D., Khamis, F. M., ... & Tanga, C. M. (2021). Low-cost technology for recycling agro-industrial waste into nutrient-rich organic fertilizer using black soldier fly. *Waste Management*, *119*, 183-194.

Yanakittkul, P., & Aungvaravong, C. (2020). A model of farmers intentions towards organic farming: A case study on rice farming in Thailand. *Heliyon*, *6*(1), e03039.

Klammsteiner T, Turan V, Juárez MFD, Oberegger S, Insam H. Suitability of black soldier fly frass as soil amendment and implication for organic waste hygienization. *Agronomy*. 2020;10(10 October). doi:10.3390/agronomy10101578

Song S, Ee AWL, Tan JKN, et al. Upcycling food waste using black soldier fly larvae: Effects of further composting on frass quality, fertilising effect and its global warming potential. *J Clean Prod*. 2021;288. doi:10.1016/j.jclepro.2020.125664

Choi S, Hassanzadeh N. BSFL Frass: A Novel Biofertilizer for Improving Plant Health While Minimizing Environmental Impact. *Candian Sci fair J*. 2019;2(2).

Bessa LW, Pieterse E, Marais J, Hoffman LC. Why for feed and not for human consumption? The black soldier fly larvae. *Compr Rev Food Sci Food Saf*. 2020;19(5). doi:10.1111/1541-4337.12609

Kim CH, Ryu J, Lee J, et al. Use of black soldier fly larvae for food waste treatment and energy production in asian countries*: A review*. *Processes*. 2021;9(1). doi:10.3390/pr9010161

Lyu F, Choi J. The forecasting sales volume and satisfaction of organic products through text mining on web customer reviews. *Sustain*. 2020;12(11). doi:10.3390/su12114383

Proshchalykina A, Kyryliuk Y, Kyryliuk I. Prerequisites for the development and prospects of organic agricultural products market. *Entrep Sustain Issues*. 2019;6(3). doi:10.9770/jesi.2019.6.3(18)

Chrysochou P, Festila A. A content analysis of organic product package designs. *J Consum Mark*. 2019;36(4). doi:10.1108/JCM-06-2018-2720

Sharma SK, Chawla S, Sastry MD, et al. Understanding the reasons for variations in luminescence sensitivity of natural quartz using spectroscopic and chemical studies. *Proc Indian Natl Sci Acad*. 2017;83(3). doi:10.16943/ptinsa/2017/49024

Huis A Van. Potential of Insects as Food and Feed in Assuring Food Security. Published online 2013. doi:10.1146/annurev-ento-120811-153704

Popa, R., & Green, T. R. (2012). Using black soldier fly larvae for processing organic leachates. *Journal of Economic Entomology*, *105*(2). https://doi.org/10.1603/EC11192

Applications H. Okra (Abelmoschus Esculentus) as a Potential Dietary Medicine with Nutraceutical Importance for Sustainable. Published online 2021:1-21.

Feed A, Food H. Review of Black Soldier Fly (Hermetia illucens) as Animal Feed and Human Food. Published online 2017. doi:10.3390/foods6100091

Latifah, O., Ahmed, O. H., Susilawati, K., & Majid, N. M. (2015). Compost maturity and nitrogen availability by co-composting of paddy husk and chicken manure amended with clinoptilolite zeolite. <i>Waste Management and Research</i>, <i>33</i>(4). https://doi.org/10.1177/0734242X15576771</div>

Liu, Z., Minor, M., Morel, P. C., & Najar-Rodriguez, A. J. (2018). Bioconversion of three organic wastes by black soldier fly (Diptera: Stratiomyidae) larvae. *Environmental Entomology*, *47*(6), 1609-1617.

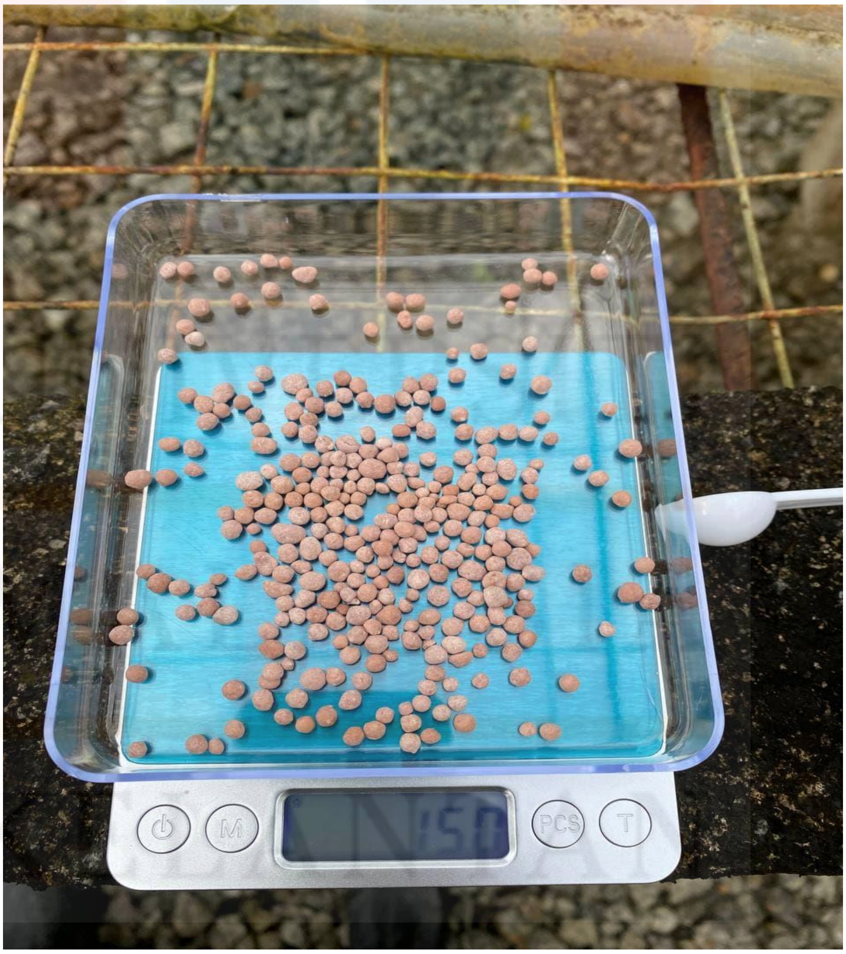
Green, T. R., & Popa, R. (2012). Enhanced Ammonia Content in Compost Leachate Processed by Black Soldier Fly Larvae. *Applied Biochemistry and Biotechnology*, *166*(6), 1381–1387. https://doi.org/10.1007/s12010-011-9530-6

Wang, Y.-S., & Shelomi, M. (2017). Review of Black Soldier Fly (Hermetia illucens) as animal feed and human food. *Foods*, *6*(10), 91. https://doi.org/10.3390/foods6100091

Nyakeri, E. M., Ogola, H. J., Ayieko, M. A., & Amimo, F. A. (2017). An open system for farming black soldier fly larvae as a source of proteins for smallscale poultry and fish production. *Journal of Insects as Food and Feed*, *3*(1), 51–56. https://doi.org/10.3920/jiff2016.0030

APPENDICES


Biovae
FEEDING THE FUTURE SUSTAINABLY
Black Soldier Fly | Larvae | Meal | Frass
BIOVAEFRASS
ORGANIC FERTILIZER
Nitrogen (N) > 3%
Phosphorus (P_2O_5) > 2%
Potassium (K_2O) > 1%
Magnesium (MgO) > 0.5%
Total Organic Matter > 70%
BIOVAEMY
BIOVAE.COM.MY



```
GET DATA
  /TYPE=XLSX
  /FILE='C:\Users\Acer\Desktop\New Microsoft Excel Worksheet.xlsx'
  /SHEET=name 'Sheet1'
  /CELLRANGE=FULL
  /READNAMES=ON
  /DATATYPEMIN PERCENTAGE=95.0
  /HIDDEN IGNORE=YES.
EXECUTE.
DATASET NAME DataSet1 WINDOW=FRONT.
ONEWAY Height BY V1
  /STATISTICS DESCRIPTIVES
  /PLOT MEANS
  /MISSING ANALYSIS
  /POSTHOC=TUKEY BTUKEY DUNCAN LSD ALPHA(0.05).
```

Oneway

[DataSet1]

Descriptives

HEIGHT IN CM

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
1	3	27.833	2.2546	1.3017	22.233	33.434
2	3	30.667	1.5275	.8819	26.872	34.461
3	3	33.000	2.5981	1.5000	26.546	39.454
4	3	31.500	10.3320	5.9652	5.834	57.166
5	3	32.333	1.1547	.6667	29.465	35.202
6	3	16.500	16.0234	9.2511	-23.304	56.304
7	3	17.833	2.7538	1.5899	10.993	24.674
Total	21	27.095	9.0893	1.9834	22.958	31.233

Page 1

Descriptives

HEIGHT IN CM

	Minimum	Maximum
1	25.5	30.0
2	29.0	32.0
3	31.5	36.0
4	20.5	41.0
5	31.0	33.0
6	.0	32.0
7	16.0	21.0
Total	.0	41.0

ANOVA

HEIGHT IN CM

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	879.143	6	146.524	2.653	.062
Within Groups	773.167	14	55.226		
Total	1652.310	20			

Post Hoc Tests

Homogeneous Subsets

HEIGHT IN CM

	TREATMENT	N	Subset for alpha = 0.05 1	2	3
Tukey HSD[a]	6	3	16.500		
	7	3	17.833		
	1	3	27.833		
	2	3	30.667		
	4	3	31.500		
	5	3	32.333		
	3	3	33.000		
	Sig.		.164		
Tukey B[a]	6	3	16.500		
	7	3	17.833		
	1	3	27.833		
	2	3	30.667		
	4	3	31.500		
	5	3	32.333		
	3	3	33.000		
Duncan[a]	6	3	16.500		
	7	3	17.833	17.833	
	1	3	27.833	27.833	27.833
	2	3		30.667	30.667
	4	3		31.500	31.500
	5	3			32.333
	3	3			33.000
	Sig.		.097	.055	.452

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 3.000.

F18a0042

ORIGINALITY REPORT

18%	4%	3%	12%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universiti Malaysia Kelantan Student Paper	12%
2	www.ncbi.nlm.nih.gov Internet Source	2%
3	Omar Latifah, Osumanu Haruna Ahmed, Kassim Susilawati, Nik Muhamad Majid. "Compost maturity and nitrogen availability by co-composting of paddy husk and chicken manure amended with clinoptilolite zeolite", Waste Management & Research: The Journal for a Sustainable Circular Economy, 2015	1%