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Article

Optimization of Growth and Yield in Bird's Eye Chili (Capsicum frutescens L.) through Sustainable Organic Fertilization Using Banana Stem Compost and Tofu Industry Liquid Waste

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Abstract. The objective of this experiment was to investigate the interaction between the application of banana stem compost and tofu industry liquid waste on the growth and yield of Bird's Eye Chili (Capsicum frutescens L.). The experiment followed a factorial completely randomized design (CRD) with two factors: the first factor being the application of banana stem compost with four levels: 0 g/polybag, 100 g/polybag, 200 g/polybag, and 300 g/polybag; the second factor being the dosage of tofu industry liquid waste with three levels: 0 ml/L water, 50 ml/L water, and 100 ml/L water. Based on the research findings, it can be concluded that the application of 300 g/polybag of banana stem compost and 100 ml/L of tofu industry liquid waste resulted in increased fruit weight in Bird's Eye Chili, with a yield of 107.87 g.

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1. Introduction

The Bird's Eye Chili (Capsicum frutescens L.) is one of the potential horticultural crops to be developed. Bird's Eye Chili is widely used as a culinary ingredient and is rich in essential nutrients for human health [1-2]. Besides its spicy taste, Bird's Eye Chili contains various nutritional components such as fat, protein, carbohydrates, calcium, phosphorus, iron, vitamin A, B1, B2, C, as well as alkaloid compounds like capsaicin, oleoresin, flavonoids, and essential oils [3-4].

Bird's Eye Chili (Capsicum frutescens L.) is an important horticultural crop, particularly valued as a flavor enhancer in culinary practices. The demand for Bird's Eye Chili is high, estimated at around 4 kg per capita per year. According to the agricultural census, in 2017, the production of Bird's Eye Chili reached 18,144.98 tons/ha from a harvested area of 139,199 ha. However, in 2018, the production declined to 12,545.57 tons/ha from a harvested area of 145,169 ha. The price increase of Bird's Eye Chili has contributed to the overall food inflation in Indonesia [5-6].

To ensure the availability and improve the quality of Bird's Eye Chili plants, the application of fertilizers is crucial. Fertilizers are essential factors in agricultural production. The proper use of fertilizers in terms of quantity, price, quality, placement, and timing significantly affects the quality and quantity of agricultural products. One potential organic fertilizer is compost derived from banana stems. Currently, banana stems are often considered waste and accumulate without proper utilization. However, banana stems possess the potential to be used as organic compost material [7-9].

In addition to the application of banana stem compost, the use of tofu industry liquid waste (LCIT) has been shown to enhance the growth and production of various plants, including Bird's Eye Chili, white mustard, cocoa, and water spinach [10-12]. Organic matter in the liquid waste contains essential elements such as carbon (C), hydrogen (H), oxygen (O), nitrogen (N), phosphorus (P), and sulfur (S), which can provide beneficial nutrients for plant growth [13-14]. The aim of this research is to investigate the interaction between the application of banana stem compost and tofu industry liquid waste on the growth and yield of Bird's Eye Chili (Capsicum frutescens L.).

2. Methods

The experiment utilized a factorial completely randomized design (CRD) with two factors: The first factor was the application of banana stem compost, consisting of four levels: 0 g/polybag (A0), 100 g/polybag (A1), 200 g/polybag (A2), and 300 g/polybag (A3). The second factor was the dosage of tofu industry liquid waste, with three levels: 0 ml/L water (L0), 50 ml/L water (L1), and 100 ml/L water (L2). Each treatment was replicated three times. The data were analyzed using analysis of variance (ANOVA) at a significance level of 5% and 1%. If the calculated F-value exceeded the critical F-value at 5% or 1% significance level, Duncan's Multiple Range Test (DMRT) was conducted at a significance level of 5% to determine significant differences among treatment means.

Data on the growth and yield of Bird's Eye Chili (Capsicum frutescens L.) were collected through periodic field observations during the plant growth period [15]. Parameters such as plant height, leaf area, number of branches, flowering intensity, and fruit yield were observed. Plant height was measured using a ruler or height measuring device, while leaf area was measured using a leaf area meter or through manual measurement using a leaf area formula. The number of branches was visually counted by observing the main branches and side branches on each plant. Flowering intensity was assessed by counting the number of flowers on each plant. Fruit yield was determined by harvesting ripe fruits from each plant and weighing them using a scale.

The collected data were analyzed using analysis of variance (ANOVA) to test the significance of the treatment factors on the growth and yield of Bird's Eye Chili [16]. If significant differences were found among treatments, post-hoc tests such as Duncan's Multiple Range Test (DMRT) were conducted to determine significant differences between individual treatments [17]. Descriptive statistics such as means, standard deviations, and percentage calculations of growth or yield increase from different treatments were also performed.

The results of the data analysis were used to interpret the effects of the application of banana stem compost and tofu industry liquid waste on the growth and yield of Bird's Eye Chili. Comparisons between different treatments were analyzed to determine the most effective treatment. The significant results of the treatments were explained by examining the differences observed in the growth and yield parameters of the plants. Data interpretation also involved explaining the mechanisms by which banana stem compost and tofu industry liquid waste influence plant growth, such as improving nutrient availability, enhancing soil structure, or controlling pests and diseases. Additionally, data interpretation may involve comparisons with previous research or relevant theories to support or reinforce the findings of the current study.

3. Result and Discussions

3.1. Plant Hight

Table 1 shows a significant effect of banana stem compost application on the height of Bird's Eye Chili plants. The application of 200 g/polybag of banana stem compost resulted in a plant height of 40.24 cm. Increasing the dosage of banana stem compost to 200 g/polybag effectively promoted the growth of Bird's Eye Chili plants. This is likely due to the optimal nutrient content in the compost, which provides essential macro and micronutrients required for plant growth, particularly in terms of height. It is consistent with previous studies indicating that compost typically contains nitrogen (N) levels ranging from 0.10% to 0.51% [18-19].

On the other hand, Table 1 reveals that the application of tofu industry liquid waste (LCIT) did not have a significant impact on plant height. In fact, when given a dosage of 100 ml/L water, the height of Bird's Eye Chili plants decreased to 37.60 cm. This could be attributed to various factors, including the genetic traits of the plants and external factors that hinder the efficient uptake of nutrients present in the LCIT by the Bird's Eye Chili plants.

Table 1. Height of cayenne pepper plants aged 35 HST with banana weevil compost and LCIT

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L air)			Average
	0	50	100	
	.....cm.....			
0	37.53	41.00	36.00	38.17 b
100	36.28	38.82	37.77	37.62 b
200	42.35	40.65	37.73	40.24 a
300	42.48	45.50	38.90	42.29 a
Average	39.66	41.49	37.60	
KK	9.21%			

Numbers in a column followed by lowercase letters are not significantly different according to DNMRT 5%.

3.2 Number of Main Branches

Table 2 illustrates that the application of banana weevil compost significantly influences the number of main branches in cayenne pepper plants. Providing a dose of 200 g/polybag of banana weevil compost resulted in a count of 4.00 main branches. An additional dose of banana weevil compost at 200 g/polybag can enhance the number of main branches in cayenne pepper plants. This effect may be attributed to the macro nutrients present in the banana weevil compost, such as phosphorus (P), which plays a crucial role in the growth and development of new shoots. It's worth noting that banana

weevil compost contains important elements needed by plants, like nitrogen (N), phosphorus (P), and potassium (K) [20-21]. Plants grown in a medium supplemented with compost tend to grow better, due to the relatively high macro-nutrient content in banana compost. This offers the potential to provide potassium in the form of organic matter in the soil medium for cultivation [22-23].

Table 2. Number of main branches of plants by adding banana weevil compost and tofu industrial wastewater

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L air)			Average
	0	50	100	
	……branches……			
0	2.33	3.00	4.00	3.11 b
100	3.33	4.00	3.67	3.66 b
200	3.83	3.17	5.00	4.00 a
300	5.66	5.17	5.50	5.44 a
Average	3.79	3.83	4.54	
KK	24.20%			

Numbers in a column followed by lowercase letters are not significantly different according to DNMRT 5%.

Table 2 also indicates that the administration of LCIT has not been effective in increasing the number of main branches. Upon administering a dose of 100 ml/L of water, the number of main branches in the cayenne pepper plant increased to 4.54 branches. This outcome might be due to the genetic factors of the plant and external influences, leading to the suboptimal absorption of the elements contained in LCIT by the cayenne pepper.

3.3 Flowering Age

Table 3 demonstrates that the application of banana weevil compost has not been able to accelerate the flowering period of cayenne pepper plants. With a dose of 300 g/polybag, the flowering period is observed at 34.39 days after sowing (DAS). This might be due to the cayenne pepper plants not optimally utilizing the elements contained in the banana weevil compost.

Table 3. Age of flowering plants by applying banana weevil compost and tofu industrial liquid waste

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L water)			Average
	0	50	100	
	……HST……			
0	34.67	34.00	35.00	34.55
100	34.66	34.00	34.17	34.27
200	34.50	34.17	34.00	34.22
300	34.83	34.17	34.17	34.39
Average	34.66 B	34.08 A	34.33 B	
KK	1.09%			

Inline numbers followed by capital letters are not significantly different according to DNMRT 5%.

However, Table 3 also reveals that the addition of tofu industrial wastewater significantly impacts the flowering period of cayenne pepper plants. Administering a dose of 50 ml/L of water resulted in an earlier flowering period. This is likely because the industrial wastewater contains nutrients and organic content of nitrogen (N), phosphorus (P), and potassium (K), which play a role in enhancing plant growth, including accelerating the onset of flowering [24-25].

In summary, the data demonstrates the multifaceted impacts of banana weevil compost and tofu industrial wastewater on the growth and development of cayenne pepper plants. While the banana weevil compost significantly influenced factors like plant height and the number of main branches, it did not affect the flowering period of the plants. On the other hand, the application of tofu industrial wastewater did show a significant impact on the flowering period, hinting at the presence of nutrients that aid in accelerating this specific stage of development. The results underscore the importance of understanding the specific benefits of different types of organic matter and waste products on plant growth, providing valuable insights for improving agricultural practices.

3.4 First Harvest Age

Table 4 indicates that the application of banana weevil compost has not successfully accelerated the harvesting period of cayenne pepper plants. With a dose of 300 g/polybag, the harvesting period is observed at 64.16 days after sowing (DAS). This might be due to the cayenne pepper plants not fully utilizing the elements contained in the banana weevil compost.

However, Table 4 also shows that the application of tofu industrial wastewater significantly impacts the age at first harvest of cayenne pepper plants. Administering a dose of 100 ml/L of water resulted in an earlier harvest period. This outcome is likely due to the nutrient content contained in the wastewater.

Table 4. Age of the first harvest of plants by applying banana weevil compost and tofu industry liquid waste

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L water)			Average
	0	50	100	
	……..HST……			
0	64.83	65.00	65.00	64.76
100	64.33	64.67	64.00	64.33
200	64.50	64.17	64.00	64.22
300	64.50	64.00	64.00	64.16
Average	65.54 B	64.46 A	64.25 A	
KK	0.69%			

Numbers inline followed by capital letters are not significantly different according to DNMRT 5%.

Tofu wastewater is rich in organic matter, with the protein content reaching 40-60%, carbohydrates making up 25-50%, and fat constituting about 10%. Banana weevil compost is also an organic material that contains several macro and micro nutrients, including N, P, and K, and it contains carbohydrates which can stimulate the growth of microorganisms in the soil. In addition, the age of the first harvest is related to the flowering period. If the flowering period is faster, the harvest period will likewise be expedited [26-27].

3.5 Fruit Circle

Table 5 shows that applying banana weevil compost has a significant effect on the fruit circumference of the cayenne pepper plant. Applying banana weevil compost with an additional dose of 200 g/polybag of banana weevil compost has been able to increase the fruit circumference of cayenne pepper plants. This is presumably because banana weevil compost can contribute nutrients and improve soil structure. Banana stem compost used as an additional treatment can improve soil structure, this makes the basis that the compost used has a high level of maturity. Apart from that, the content of element K is supplied by the banana cob compost. Element K functions to stimulate new roots to grow, as well as absorb water and strengthen plant stems [28-29].

Table 5. Circumference of fruit plants by applying banana weevil compost and tofu industrial liquid waste

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L water)			Average
	0	50	100	
	……cm……			
0	1.52	2.00	1.00	1.50 b
100	1.67	1.77	1.41	1.61 b
200	1.86	1.72	1.84	1.80 a
300	1.93	2.12	2.27	2.10 a
Average	1.74	1.90	1.63	
KK	18.98%			

Numbers in a column followed by lowercase letters are not significantly different according to DNMRT 5%.

Table 5 also shows that the administration of LCIT has not been able to increase fruit circumference. By administering a dose of 100 ml/L of water, the fruit circumference of the cayenne pepper plant decreased by 1.63 cm, based on the numbers by administering LCIT it increased the number of branches besides that this was due to genetic factors of a plant and external factors so that cayenne pepper had not maximally absorbed the elements contained in LCIT.

3.6 Fruit Length

Table 6 demonstrates that the application of banana stem compost significantly influenced the fruit length of Bird's Eye Chili plants. Increasing the dosage of banana stem compost, specifically at 200 g/polybag, resulted in an improvement in the fruit length of the plants. This can be attributed to the ability of banana stem compost to provide essential nutrients for the plants, thereby enhancing fruit development. Additionally, the use of banana stem compost as a treatment can also contribute to soil improvement and nutrient availability [30-31].

Table 6. Length of plant fruit by applying banana weevil compost and tofu industrial liquid waste

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L water)			Average
	0	50	100	
	……cm……			
0	1.93	2.00	2.00	1.97 b
100	2.19	2.05	2.08	2.10 b
200	2.06	1.99	2.33	2,82 a
300	2.28	2.56	2.26	3.30 a
Average	2.11	2.15	2.16	
KK	9.24%			

Numbers in a column followed by lowercase letters are not significantly different according to DNMRT 5%.

However, Table 6 indicates that the application of tofu industry liquid waste (LCIT) did not have a significant effect on fruit length. With a dosage of 100 ml/L of water, the fruit circumference of Bird's Eye Chili plants was 12.16 cm. This may be due to various factors, including genetic factors and external limitations that affect the plants' ability to absorb nutrients from the LCIT.

3.7 Number of Fruit

Table 7 illustrates that the application of 300 g/polybag of banana weevil compost and 100 ml/L water LCIT resulted in a total of 140.15 fruits. The application of different doses of banana weevil compost and varying doses of LCIT led to significant differences in the number of fruits obtained. The highest yield of fruits was observed with the treatment of 300 g/polybag of banana weevil compost and the administration of 100 ml/L water LCIT dose, totaling 140.15 fruit

Table 7. Number of fruit plants with banana weevil compost and tofu industrial liquid waste

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L water)		
	0	50	100
	……..buah……		
0	83.97 Bab	88.00 Abb	97.00 Aab
100	73.21 Cb	93.09 Ab	80.49 Bb
200	90.81 Aa	91.17 Ab	80.79 Bb
300	124.26 Ba	125.63 Ba	140.15 Aa
KK	2.49%		

An inline number followed by the same capital letter and a column followed by the same lowercase letter were not significantly different according to DNMRT 5%.

This outcome is likely due to the fact that the administration of banana weevil compost and tofu industrial liquid waste could enhance the fruit yield of cayenne pepper plants. This occurs by supplying the plants with necessary nutrients, such as phosphorus (P), which stimulates root growth and development, acts as a primary ingredient of adenosine triphosphate (ATP) and adenosine diphosphate (ADP), aids in assimilation and respiration, accelerates the process of flowering and

fertilization, as well as the ripening of seeds and fruit. The provision of tofu industrial liquid waste increases the fruit count, as previously demonstrated in a study on the effects of cow urine liquid organic fertilizer and tofu liquid waste on the growth of cocoa (Theobroma cacao) seedlings. The study found that the application of 40 ml/kg of soil cow urine and 80 ml/kg of soil tofu liquid waste had the most significant effect on stem diameter, plant fresh weight, and plant dry weight of cocoa seedlings [32-33].

3.8 Fruit Weight

Table 8 shows that the application of 300 g/polybag banana weevil compost and 100 ml/L water LCIT resulted in a fruit weight of 107.87 g.

Table 8. Plant fruit weight by applying banana weevil compost and tofu industrial liquid waste

Banana Weevil Compost (g/polybag)	Industrial Liquid Waste tofu (ml/L air)		
	0	50	100
	……..gram……..		
0	55.98 Bb	60.00 Abc	64.00 Ab
100	48.81 Bc	60.48 Ac	53.66 Abc
200	65.32 ABb	71.31 Ab	63.98 Bb
300	97.88 Ba	97.76 Ba	107.87 Aa
KK	5.26%		

An inline number followed by the same capital letter and a column followed by the same lowercase letter were not significantly different according to DNMRT 5%.

The administration of varying doses of banana weevil compost and LCIT with significant interaction differences impacted the fruit weight. The treatment involving 300 g/polybag of banana weevil compost and 107.87 g of LCIT per 100 ml/L water yielded the highest fruit weight. This is likely due to the fact that banana weevil compost is rich in elements such as carbon (C), nitrogen (N), phosphorus (P), and potassium (K). These macro elements can be limiting factors for plant growth.

For instance, potassium (K) plays a vital role in the growth and enhancement of sugar content in sweet corn plants. Tofu liquid waste is known to contain several macro and micro elements essential for plants. These include macro elements such as nitrogen, phosphorus, and sulfur, as well as micro elements like iron (Fe), chloride (Cl), manganese (Mn), copper (Cu), and zinc (Zn). According to established research, the nitrogen element contributes to the formation of green leaves, which is crucial for the photosynthesis process, and aids in the formation of proteins, fats, and various other organic compounds. The phosphorus element assists in the formation of certain proteins, aids in assimilation and respiration, and expedites the processes of flowering, seed ripening, and fruit development [34-35].

4. Conclusion

The interaction between the application of banana stem compost and tofu industry liquid waste had a significant impact on the growth and yield of Bird's Eye Chili (Capsicum frutescens L.). Specifically, the combined treatment of 300 g/polybag of banana stem compost and 100 ml/L of tofu industry liquid waste resulted in a higher number of fruits (140.15 fruits) and a heavier fruit weight (107.87 grams). Furthermore, the application of banana stem compost alone showed notable effects on the growth and yield of Bird's Eye Chili. Using a dosage of 200 g/polybag of banana stem compost, the plant height reached 40.24 cm, and the number of main branches was 4.00 branches.

Similarly, the application of tofu industry liquid waste had an influence on the growth and yield of Bird's Eye Chili. With a dosage of 50 ml/L of tofu industry liquid waste, the flowering age was observed to be 34.04 days after sowing, while a dosage of 100 ml/L resulted in the first harvest occurring at 64.25 days after sowing. These findings demonstrate the combined and individual contributions of banana stem compost and tofu industry liquid waste in enhancing the growth and yield of Bird's Eye Chili. The optimal dosage of both organic fertilizers played a significant role in improving various aspects of the plant's development, including fruit quantity, fruit weight, plant height, number of branches, flowering age, and first harvest age

References

[1] Vaishnavi, B. A., Bhoomika, H. R., & Shetty, G. R. (2018). Genetic parameters study for growth, yield and quality traits in Bird's eye chilli (Capsicum frutescens L.). *Int. J. Curr. Microbiol. App. Sci*, *7*(5), 1813-1817.

[2] Dutta, S. K., Singh, S. B., Saha, S., Akoijam, R. S., Boopathi, T., Banerjee, A., ... & Roy, S. (2017). Diversity in bird's eye chilli (Capsicum frutescens L.) landraces of north-east India in terms of antioxidant activities. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, *87*, 1317-1326.

[3] Kroff, J., Hume, D. J., Pienaar, P., Tucker, R., Lambert, E. V., & Rae, D. E. (2017). The metabolic effects of a commercially available chicken peri-peri (African bird's eye chilli) meal in overweight individuals. *British Journal of Nutrition*, *117*(5), 635-644.

[4] Yang, H. J., Lee, Y. S., & Choi, I. S. (2018). Comparison of physicochemical properties and antioxidant activities of fermented soybean-based red pepper paste, Gochujang, prepared with five different red pepper (Capsicum annuum L.) varieties. *Journal of food science and technology*, *55*, 792-801.

[5] Sembiring, A., Basuki, R. S., Rosliani, R., & Rahayu, S. T. (2021). Farmers' challenges on chili farming in the acid dry land: A case study from Pasir Madang-Bogor Regency, Indonesia. In *E3S Web of Conferences* (Vol. 316, p. 03010). EDP Sciences.

[6] Muflikh, Y. N., Smith, C., Brown, C., & Aziz, A. A. (2021). Analysing price volatility in agricultural value chains using systems thinking: a case study of the indonesian chilli value chain. *Agricultural Systems*, *192*, 103179.

[7] Rehman, A., Chandio, A. A., Hussain, I., & Jingdong, L. (2019). Fertilizer consumption, water availability and credit distribution: Major factors affecting agricultural productivity in Pakistan. *Journal of the Saudi Society of Agricultural Sciences*, *18*(3), 269-274.

[8] Itelima, J. U., Bang, W. J., Onyimba, I. A., Sila, M. D., & Egbere, O. J. (2018). Bio-fertilizers as key player in enhancing soil fertility and crop productivity: A review.

[9] Prabakaran, G., Vaithiyanathan, D., & Ganesan, M. (2018). Fuzzy decision support system for improving the crop productivity and efficient use of fertilizers. *Computers and electronics in agriculture*, *150*, 88-97.

[10] Khatua, C., Sengupta, S., Balla, V. K., Kundu, B., Chakraborti, A., & Tripathi, S. (2018). Dynamics of organic matter decomposition during vermicomposting of banana stem waste using Eisenia fetida. *Waste Management*, *79*, 287-295.

[11] Faisal, M., Gani, A., Mulana, F., & Daimon, H. (2016). Treatment and utilization of industrial tofu waste in Indonesia. *Asian Journal of Chemistry*, *28*(3).

[12] Widayat, W., Philia, J., & Wibisono, J. (2019). Liquid waste processing of tofu industry for biomass production as raw material biodiesel production. In *IOP Conference Series: Earth and Environmental Science* (Vol. 248, No. 1, p. 012064). IOP Publishing.

[13] Chen, P., Xie, Q., Addy, M., Zhou, W., Liu, Y., Wang, Y., ... & Ruan, R. (2016). Utilization of municipal solid and liquid wastes for bioenergy and bioproducts production. *Bioresource technology*, *215*, 163-172.
[14] Lewandowski, D. A. (2017). *Design of thermal oxidation systems for volatile organic compounds*. CRC Press.
[15] Batool, T., Ali, S., Seleiman, M. F., Naveed, N. H., Ali, A., Ahmed, K., ... & Mubushar, M. (2020). Plant growth promoting rhizobacteria alleviates drought stress in potato in response to suppressive oxidative stress and antioxidant enzymes activities. *Scientific Reports*, *10*(1), 16975.
[16] Lakens, D., & Caldwell, A. R. (2021). Simulation-based power analysis for factorial analysis of variance designs. *Advances in Methods and Practices in Psychological Science*, *4*(1), 2515245920951503.
[17] Sriagtula, R., Karti, P. D. M. H., & Abdullah, L. (2016). Growth, Biomass and Nutrient Production of Brown Midrib Sorghum Mutant Lines at Different Harvest Times. *Pakistan journal of Nutrition*, *15*(6), 524-531.
[18] Hananto, T., Banuwa, I. S., Niswati, A., & Yuwono, S. B. (2021). Study on the suspension extract of agro-industrial plant waste and the compost type on the change of soil chemical properties and the yields of shallot (Allium ascalonicum L.). In *International Seminar on Promoting Local Resources for Sustainable Agriculture and Development (ISPLRSAD 2020)* (pp. 225-233). Atlantis Press.
[19] Riyanto, D. (2021). The utilization of agricultural and livestock waste and the effect on new rice varieties yield on rainfed rice land of Ponjong-Gunungkidul. In *BIO Web of Conferences* (Vol. 33, p. 05004). EDP Sciences.
[20] Spaccini, R., Cozzolino, V., Di Meo, V., Savy, D., Drosos, M., & Piccolo, A. (2019). Bioactivity of humic substances and water extracts from compost made by ligno-cellulose wastes from biorefinery. *Science of the Total Environment*, *646*, 792-800.
[21] Briukhanov, A., Subbotin, I., Uvarov, R., & Vasilev, E. (2017). Method of designing of manure utilization technology. *Agronomy research*, *15*(3), 658-663.
[22] Heiskanen, J., Ruhanen, H., & Hagner, M. (2019). Effects of Compost, Biochar and Ash Mixed in Till Soil Cover of Mine Tailings on Plant Growth and Bioaccumulation of Elements: A Bioassay in a Greenhouse. *Biochar and Ash Mixed in Till Soil Cover of Mine Tailings on Plant Growth and Bioaccumulation of Elements: A Bioassay in a Greenhouse*.
[23] Spanoghe, J., Grunert, O., Wambacq, E., Sakarika, M., Papini, G., Alloul, A., ... & Vlaeminck, S. E. (2020). Storage, fertilization and cost properties highlight the potential of dried microbial biomass as organic fertilizer. *Microbial Biotechnology*, *13*(5), 1377-1389.
[24] Eich-Greatorex, S., Vivekanand, V., Estevez, M. M., Schnürer, A., Børresen, T., & Sogn, T. A. (2018). Biogas digestates based on lignin-rich feedstock–potential as fertilizer and soil amendment. *Archives of Agronomy and Soil Science*, *64*(3), 347-359.
[25] Di Costanzo, N., Cesaro, A., Di Capua, F., & Esposito, G. (2021). Exploiting the nutrient potential of anaerobically digested sewage sludge: a review. *Energies*, *14*(23), 8149.
[26] Putro, P. G. L., & Hadiyanto, H. (2021). Water quality parameters of tofu wastewater: a review. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1156, No. 1, p. 012018). IOP Publishing.
[27] Seroja, R., Effendi, H., & Hariyadi, S. (2018). Tofu wastewater treatment using vetiver grass (Vetiveria zizanioides) and zeliac. *Applied water science*, *8*, 1-6.
[28] Khatua, C., Sengupta, S., Balla, V. K., Kundu, B., Chakraborti, A., & Tripathi, S. (2018). Dynamics of organic matter decomposition during vermicomposting of banana stem waste using Eisenia fetida. *Waste Management*, *79*, 287-295.

[29] Alzate Acevedo, S., Díaz Carrillo, Á. J., Flórez-López, E., & Grande-Tovar, C. D. (2021). Recovery of banana waste-loss from production and processing: a contribution to a circular economy. *Molecules*, *26*(17), 5282.

[30] Hartatik, W., & Setyorini, D. (2021). Application of organic and biofertilizers to increase soil biota diversity and vegetable production. In *IOP Conference Series: Earth and Environmental Science* (Vol. 648, No. 1, p. 012148). IOP Publishing.

[31] Alzate Acevedo, S., Díaz Carrillo, Á. J., Flórez-López, E., & Grande-Tovar, C. D. (2021). Recovery of banana waste-loss from production and processing: a contribution to a circular economy. *Molecules*, *26*(17), 5282.

[32] Kumar, H., Bhardwaj, K., Sharma, R., Nepovimova, E., Kuča, K., Dhanjal, D. S., ... & Kumar, D. (2020). Fruit and vegetable peels: Utilization of high value horticultural waste in novel industrial applications. *Molecules*, *25*(12), 2812.

[33] Amalia, S. N., Prihastanti, E., & Hastuti, E. D. (2019, May). Effect of the combination of tofu liquid waste and plant media of sago waste on the growth of cayenne (Capsicum frustescens L.). In *Journal of Physics: Conference Series* (Vol. 1217, No. 1, p. 012157). IOP Publishing.

[34] Kuryata, V. G., & Kravets, O. O. (2018). Features of morphogenesis, accumulation and redistribution of assimilate and nitrogen containing compounds in tomatoes under retardants treatment. *Ukrainian journal of ecology*, *8*(1), 356-362.

[35] Malhotra, H., Vandana, Sharma, S., & Pandey, R. (2018). Phosphorus nutrition: plant growth in response to deficiency and excess. *Plant nutrients and abiotic stress tolerance*, 171-190.