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Study of Types and Doses of Fish Waste LOF on the Growth and Yield of Soybean Plants (*Glycine max* (L) Merrill)

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Abstract

Soybean is a promising crop that requires further development due to its significant market potential both locally and for export. Soybean cultivation is not widespread in South Sumatra, and production levels remain low. One strategy to enhance production is to utilize fish waste to create liquid organic fertilizer (LOF) by optimizing the type and dosage of fish waste used. This research aims to identify and determine the most suitable type and dosage of fish waste LOF for promoting the growth and yield of soybean plants. This study was conducted on a farmer's land on Jl Sukarela KM 7, Sukarami District, Palembang City. A field experiment method was employed, utilizing a split-plot design. The first factor (main plot) consisted of the type of fish waste LOF, which included a control group, LOF from marine fish waste, and LOF from river fish waste. The second factor (sub-plot) is yet to be detailed. The dosage of LOF fish waste was 10.0 ml/L, 200 ml/L, 300 ml/L, and 400 ml/L. The observed variables included plant height (cm), flowering age (days after planting), number of productive branches, number of pods per plant, number of filled pods, seed weight per plant (g), weight of 100 seeds (g), and seed weight per plot (g). The study results were obtained by tabulating the combinations of different types of liquid organic fertilizers derived from marine fish waste. The dosage of 300 ml/L yielded the highest soybean production, which was 451.00 g/plot, equivalent to 1.80 tons/ha.

Keywords: Dose, Growth, Liquid Organic Fertilizer, Fish Waste,Soybeans,

1. Introduction

Soybean (*Glycine max* (L.) Merrill) is a significant secondary crop with considerable economic value, as it serves as a raw material for traditional Indonesian foods such as tempeh, tofu, taucho, soy sauce, and other processed products. Soybeans are a commodity that requires attention due to the high domestic demand, while both the harvest area and production levels are in decline, leading to increased imports (Endriani et al., 2017).

The community's demand for soybeans is increasing, yet production remains insufficient. According to data from the Central Statistics Agency (2023), domestic soybean requirements are substantial, reaching 2.8 million tons annually. In contrast, national production in 2022 was only 301,518 tons, resulting in a deficit of approximately 2.5 million tons.

Soybean production in Indonesia for 2020-2021 was 290,784 tons and 212,863 tons, respectively, with productivity decreasing from 1.60 tons per hectare to 1.58 tons per hectare. This decline was accompanied by a reduction in the harvest area, which decreased from 182,072 hectares to 134,700 hectares. In contrast, soybean imports by Indonesia reached 724,746 kilograms in 2022. In South Sumatra, soybean production for the years 2021-2022 amounted to 402.17 tons and 39.31 tons, with productivity recorded at 15.81 quintals per hectare and 13.28 quintals per hectare (Central Statistics Agency of South Sumatra Province, 2023).

Low soybean production is due to some farmers not using soybean cultivation techniques that are still not optimal. Efforts to increase soybean production can be done by managing intensive plant cultivation techniques. One cultivation technique that can be done is organic fertilization (Turmanto et al., 2021).

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Fertilization must follow the fertilization recommendations because if it is excessive or insufficient, it will interfere with plant growth and development. Organic fertilizers usually improve the soil's physical, chemical and biological properties. However, the nutrient content in organic fertilizers is relatively lower than inorganic fertilizers.

One source of nutrients that can be given to plants is in liquid form. Liquid organic fertilizer is a liquid form that can come from a mixture of several types of nutrient sources that have been decomposed and are more easily absorbed by plants, so that they can have a greater effect on plant growth. Providing natural fertilizers that can be used to accelerate the soil fertilization process, one of which is liquid organic fertilizer from fish waste. According to Nugroho (2017), liquid organic fertilizer is waste from organic materials that can be used as fertilizer, liquid waste contains a lot of nutrients N, P and K. The use of organic liquid fertilizer can help improve the structure and nutrients. According to Sutriana et al. (2022), the advantages of liquid organic fertilizer are that it can quickly overcome nutrient deficiencies, has no problems with nutrient leaching, and can provide nutrients rapidly. It also functions to loosen the soil, improve drainage and aeration, increase water holding capacity, minimize erosion, increase cation exchange capacity, and enhance the weathering process of mineral sources for soil microorganisms.

One of the organic materials that can be used as organic fertilizer is fish waste, such as tails, fins, skin, bones, heads, and innards of fish, which can be used as the main ingredient in making liquid organic fertilizer (LOF) from fish waste. Fish waste is a liquid organic fertilizer that contains nutrients needed by plants for their growth and development, namely N (1.26%); P (4.37%); K (0.36%) and C-organic 15.42% (Waryanti et al., 2013).

Fish waste fertilizers, in addition to being a source of nutrients, can also induce Actinomycetes spp. and Rhizobacteria spp., which play a role in producing growth hormones around plant roots. The growth hormones in question are auxin, cytokinin, and gibberellin hormones.

Based on the research results of Rohima (2020), treating liquid organic fertilizer of fish waste with a dose of 300 ml/L increased the growth and yield of edamame soybean plants. Research by Nisa (2021) found that administering LOF of marine fish waste with a dose of 400 ml/L gave the best results on cucumber plants.

Research on providing types and doses of liquid organic fertilizer (LOF) from fish waste in soybean cultivation has not been widely conducted, especially in South Sumatra. Soybeans are a potential plant for development. Therefore, research is needed on the types and doses of LOF from fish waste in soybean cultivation.

2. Material and Methods

The research location was Jl. Sukarela KM 7, Sukarami District, Palembang City, with geographical coordinates of -2.9167° South Latitude and 104.7667° East Longitude. This area is located 8 to 12 meters above sea level—implementation from August to December 2024. The materials used in this study were Grobogan variety soybean seeds, marine fish waste, river fish waste, EM4, brown sugar, chicken manure, inorganic fertilizers (Urea, SP36, KCl), and pesticides. Split plot design, with 36 treatment combinations and repeated 3 times, obtained 36 experimental units. The first factor (main plot) type of LOF fish waste is Control; LOF marine fish waste and LOF river fish waste, while the second factor (subplot), the dose of LOF fish waste is 10.0 ml / L; 200 ml/L, 300 ml/L, and 400 ml/L.

Stages of research implementation: land preparation is made into 1 mx 2 m plots of 36 plots, planting distance of 20 cm x 40 cm, distance between plots of 50 cm and distance between replications of 1 m. Fertilization: application of types and doses of fish waste LOF according to treatment (Control; LOF marine fish waste and LOF river fish waste) with doses (100 ml/L; 200 ml/L; 300 ml/L, and 400 ml/L), given at intervals of every 10 days (5 times). Additional inorganic fertilizer (Urea, SP36, KCl) with a dose of ½ of the recommended dose, given 1 week after planting. Preparation of planting material for soybean seeds used is Grobogan variety soybeans, with the criteria of clean, non-wrinkled, and uniform seed size. Planting is done by digging a planting hole with a depth of 5 cm, and each planting hole is inserted 2 seeds. Maintenance includes: watering, thinning, weeding, pest and disease control and harvesting is carried out according to the harvest age of the Grobogan variety 85 days after planting with the characteristics of leaves that are yellowish and fall off, pods that are dry with a yellowish to brownish color, golden yellow seeds and the size of the pods and seeds are dense and not shriveled.

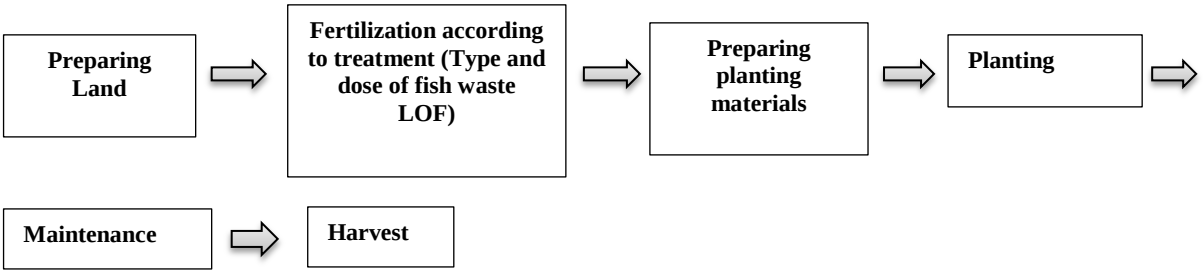

Figure 1. Research flow diagram

The data obtained were analyzed statistically based on the analysis of variance on each observation variable measured and further tested for real treatments using the Honestly Significant Difference Test (HSD) method at a level of 5%. Data processing was carried out using Microsoft Excel.

3. Results and Discussion

The analysis of variance results indicated that the use of liquid organic fertilizer made from fish waste had a significant impact on all the variables observed. The dosage of liquid organic fish waste fertilizer substantially impacted all variables observed, except for the number of productive branches, weight of 100 seeds, and seed weight per plant. The interaction treatment had no significant impact on any observed variables—Table 1.

Table 1. Results of Analysis of Diversity of Influence of Type and Dosage of Liquid Organic Fish Waste Fertilizer on Observed Variables

Observed Variables	Treatment			KK (%)
	L	D	I	
Plant height (cm)	**	*	tn	9.60
Flowering age (dap)	*	*	tn	16.62
Number of productive branches (branches)	*	tn	tn	25.49
Number of pods per plant (pods)	**	*	tn	17.76
Number of pods filled (pods)	**	**	tn	18.23
Seed weight per plant (g)	**	*	tn	12.90
Weight of 100 seeds (g)	*	tn	tn	18.16
Seed weight per plot (g)	**	tn	tn	4.71

Note: tn= No significant effect; *= Real Impact; **= Very real impact; L= Type of liquid organic fertilizer from fish waste; D= Dosage of liquid organic fertilizer from fish waste; I= Interaction; KK= Coefficient of Diversity

3.1. The effect of the type and dose of liquid organic fish waste fertilizer on the observed variables

The results of the analysis of variance showed that the treatment of liquid organic fertilizer types had a significant to very significant effect on all observed variables and the treatment of liquid organic fertilizer doses of fish waste had an important significant impact on plant height, flowering age, number of pods per plant, number of filled pods and seed weight per plant. The average type and dose of liquid organic fertilizer from fish waste on the observed variables can be seen in Table 2.

Table 2. Effect of type and dose of fish waste LOF on plant height, flowering age, number of productive branches, number of pods per plant, number of filled pods, seed weight per plant, weight of 100 seeds and seed weight per plot.

Treatment	Plant height (cm)	Flowering age (dap)	Number of productive branches (branches)	Number of pods per plant (pods)	Number of pods (pods)	Seed weight per plant (g)	Weight of 100 seeds (g)	Seed weight per plot (g)
---- Types of Fish Waste LOF -------								
Control	39.91 ±1.68 a	34.19 ±0.54 b	1.76 ±0.27 a	71.83 ±7.42 a	63.85 ±7.17 a	25.56 ±2.65 a	13.83 ±0.81 a	124.67 ±19.67 a
Sea	53.55 ±1.76 b	29.81 ±0.52 a	3.58 ±0.31 b	143.58 ±8.18 b	137.83 ±7.86 b	60.33 ±2.98 c	19.33 ±0.87 b	419.75 ±21.34 c
River	51.72 ±1.81 b	30.77 ±0.59 a	3.43 ±0.29 b	130.98 ±7.95 b	124.08 ±7.64 b	46.31 ±2.83 b	18.58 ±0.85 b	353.17 ±20.84 b
BNJ 0.05	4.84	1.55	0.78	21.36	20.63	7.63	2.32	56.61
------- Fish Waste LOF Dosage (ml/L) -------								
100	44.44 ±2.15 a	32.89 ±0.69 b	2.62 ±0.32 a	104.11 ±9.45 a	95.56 ±7.17 a	38.36 ±3.41 a	15.56 ±0.94 a	274.33 ±20.41 a
200	47.87 ±2.23 ab	32.22 ±0.67 b	2.74 ±0.33 a	107.72 ±9.53 a	99.47 ±7.34 a	42.2 ±3.52 ab	17.00 ±0.97 a	288.56 ±20.89a
300	52.55 ±2.31 b	29.83 ±0.63 a	3.43 ±0.36 a	131.03 ±10.12 b	126.81 ±8.24 b	50.64 ±3.75 b	18.44 ±1.03 a	299.11 ±21.67 a
400	48.83 ±2.26 ab	31.53 ±0.65 ab	2.90 ±0.34 a	119.00 ±9.87 ab	112.53 ±7.92 ab	45.00 ±3.63 ab	18.00 ±1.01 a	234.78 ±19.22 a
BNJ 0.05	6.19	1.98	tn	27.17	20.63	9.83	tn	tn

Description: Numbers followed by the same letter in the same column are not significantly different at the 5% BNJ level.

The results showed that treating marine fish waste LOF gave the best vegetative and generative growth compared to the control and river fish waste LOF. This is evidenced by the average plant height variable of 53.55 cm, average flowering age of 29.81 days after planting, average number of productive branches of 3.58 branches, average number of pods per plant of 143.58 pods, average number of pods containing 137.83 pods, average seed weight per plant of 60.33 g, weight of 100 seeds of 19.33 g and seed weight per plot of 419.75 g. This is thought to be due to differences in the amount of nutrient content that can be absorbed and utilized by plants where marine fish waste LOF based on the analysis results contains nutrients N (0.28%), P (0.064%), K (0.06%) compared to the content of river fish waste LOF nutrients N (0.21%), P (0.046%), K (0.04%). LOF from marine fish waste has a higher content of N, P, and K elements than LOF from river fish waste, and plants very much need the nutrients N, P, and K during the generative period, increasing their production. According to the use of marine fish waste, LOF has a higher content of N, P, and K elements to contribute nutrients for plant fertility. If the components of plant

growth are good, it will also cause the components in the growth phase to increase. Based on the research results, it was stated that the LOF content in fish waste significantly affects plant growth and production. Fish waste, such as tails, fins, skin, bones, heads, and innards, can be utilized based on the sufficient content in fish.

The control treatment (without fish waste LOF) gave the lowest vegetative and generative growth compared to the type of river fish waste LOF. This can be seen from the average plant height variable of 39.91 cm, average flowering age of 34.19 hst, average number of productive branches of 1.76 branches, average number of pods per plant of 71.83 pods, average number of filled pods of 63.85 pods, average seed weight per plant of 25.56 g, weight of 100 seeds of 13.83 g and seed weight per plot of 124.67 g. This is because the plants do not get enough supporting nutrients, only getting nutrients found in the soil. One of the things needed in plant growth and development is that the more complete the nutrients given, the more complete the plants' growth and yield responses. According to Novizan (2005), without adding fertilizer, plants will experience a lack of nutrients, so plant growth and production will be hampered.

The results showed that treating organic liquid fertilizer of fish waste with a dose of 300 ml/L provided the best vegetative and generative growth compared to other treatments. This can be seen in the average plant height variables of 52.55 cm, average flowering age of 29.83 days after planting, average number of productive branches of 3.43 branches, average number of pods per plant of 131.03 pods, average number of pods containing 126.81 pods, average seed weight per plant of 50.64 g, weight of 100 seeds of 18.44 g and seed weight per plot of 299.11 g. This means that providing liquid organic fertilizer with the right dose results in optimal root growth, so nutrient and water absorption are also optimal. The content of nutrients in organic materials, especially in liquid form, namely by providing liquid organic fertilizer, can be well absorbed by the roots so that plants can easily absorb nutrients, resulting in increased vegetative and generative growth of plants. Fish waste contains nutrients, including N, which can be added to the soil when applying LOF. In addition to N, fish waste LOF contains other nutrients such as phosphorus (P) and potassium (K), which are essential for plant growth. Based on the research of Murdaningsih and Rahayu (2021), the provision of fish waste LOF affects the amount of N plants absorb in the soil. The provision of fish waste LOF will increase the amount of N in the soil. N is essential for plant growth because it forms proteins, enzymes, and chlorophyll (green pigment in leaves). The main role of nitrogen (N) for plants is to stimulate overall growth, including leaves, stems, and branches. In addition, nitrogen also plays a role in forming green leaves, proteins, fats and various other organic compounds that are very useful in photosynthesis. According to Alex (2012) and Sultoniyah and Pratiwi (2019), the advantages of LOF are that it can provide nutrients and quickly overcome nutrient deficiencies. In addition, using LOF does not damage the soil, plants, or the environment, even though it is used continuously. During the growth and development of a plant, especially in the vegetative phase, the nutrient needed the most is nitrogen (N), such as during the growth of stems and leaves, requiring more nitrogen than other nutrients. In the generative phase (formation of flowers, fruit and seeds), the need for nitrogen may decrease, while nutrients such as phosphorus and potassium become more important.

3.2. The effect of the interaction between the type and dose of liquid organic fertilizer from fish waste on the observed variables

The results of the analysis of variance showed that the interaction of organic fertilizer type and liquid organic fertilizer dose had no significant effect on plant height, flowering age, number of productive branches, number of pods per plant, number of filled pods, seed weight per plant, weight of 100 seeds and seed weight per plot. The average interaction of type and dose of liquid organic fertilizer on the observed variables can be seen in Table 3.

The results of the analysis of variance showed that there was no interaction between the type and dose of fish waste LOF fertilizer. This interaction had no significant effect on all observed variables. This is suspected because the type of treatment with the dose of fish waste LOF did not affect other factors that play a role in the growth and production of soybean plants. According to Setiani (2014), each treatment does not affect the others; if one factor has a more substantial influence, its working nature is different and will produce a different relationship in influencing plant growth and production. Hanafiah (2010) added, if there is no interaction, it means that the influence of a factor is the same for all levels of other factors and is the same as its main influence. The position of the two factors is that they both support plant growth and production, but do not support each other if one factor covers the other.

A tabulated combination of marine fish waste LOF type with a dose of 300 ml/L fish waste LOF showed the highest results on the growth and production of soybean plants. This can be seen in the average plant height variable of 55.40 cm, average flowering age of 29.00 hst, average number of productive branches of 3.93 branches, average number of pods per plant of 167.50 pods, average number of pods containing 164.75 pods, average seed weight per plant of 75.50 g, average weight of 100 seeds of 20.22 g and average seed weight per plot of 451.00 g. This is because the type of marine fish waste LOF with a dose of 300 ml/L, can provide nutrients that plants need, stimulating growth and increasing plant production. According to Made et al. (2023), sufficient nutrients are available during plant growth and development because nutrients play an important role in photosynthesis running

more actively, which will directly impact plant growth and yield.

Table 3. Effect of interaction between type and dose of fish waste LOF on plant height, flowering age, number of productive branches, number of pods per plant, number of filled pods, seed weight per plant, weight of 100 seeds and seed weight per plot.

Treatment	Plant height (cm)	Flowering age (dap)	Number of productive branches (branches)	Number of pods per plant (pods)	Number of pods filled (pods)	Seed weight per plant (g)	Weight of 100 seeds (g)	Seed weight per plot (g)
Control + 100	33.06 ±3.14 a	36.33 ±0.95 a	1.25 ±0.36 a	67.16 ±10.75 a	57.66 ±10.12 a	24.08 ±4.12 a	11.00 ±1.14 a	103.67 ±25.38 a
Control + 200	39.03 ±3.25 a	34.66 ±0.93 a	1.53 ±0.38 a	68.66 ±10.82 a	59.75 ±10.22 a	25.16 ±4.18 a	14.00 ±1.25 a	110.33 ±25.72 a
Control + 300	46.86± 3.42 a	31.50 ±0.88 a	2.63 ±0.44 a	79.29 ±11.25 a	73.33 ±10.86 a	27.16 ±4.27 a	15.33 ±1.31 a	164.33 ±28.54 a
Control + 400	40.99 ±3.28 a	34.25 ±0.92 a	1.63 ±0.39 a	72.25 ±10.98 a	64.66 ±10.47 a	25.83 ±4.21 a	15.00 ±1.29 a	120.33 ±26.13 a
Sea + 100	52.30 ±3.56 a	30.58 ±0.87 a	3.33 ±0.48 a	130.08 ±13.56a	122.83 ±13.23 a	51.08 ±5.42 a	18.33 ±1.43 a	391.66 ±35.87 a
Sea + 200	53.15 ±3.58 a	30.00 ±0.86 a	3.36 ±0.48 a	130.50 ±13.58 a	122.92 ±13.24 a	53.83 ±5.54 a	18.66 ±1.44 a	413.33 ±36.45 a
Sea + 300	55.40 ±3.62 a	29.00 ±0.85 a	3.93 ±0.50 a	167.50 ±15.08 a	164.75 ±14.98 a	75.50 ±6.28 a	20.33 ±1.51 a	451.00 ±37.63 a
Sea + 400	53.66 ±3.59 a	29.83 ±0.86 a	3.70 ±0.49 a	146.25 ±14.26 a	140.83 ±14.06 a	60.91 ±5.58 a	20.00 ±1.49 a	423.00 ±36.74 a
River + 100	47.95 ±3.45 a	31.75 ±0.89 a	3.27 ±0.47 a	115.08 ±12.89 a	106.17 ±12.34 a	39.91 ±4.87 a	17.33 ±1.39 a	327.66 ±33.25 a
River + 200	51.43 ±3.54 a	31.66 ±0.89 a	3.33 ±0.48 a	124.00 ±13.28 a	115.75 ±12.85 a	47.83 ±5.22 a	18.33 ±1.43 a	342.00 ±33.78 a
River + 300	55.38 ±3.62 a	29.00 ±0.85 a	3.75 ±0.49 a	146.33 ±14.26 a	142.33 ±14.13 a	49.25 ±5.29 a	19.66 ±1.48 a	389.00 ±35.71 a
River + 400	52.13 ±3.56 a	31.41 ±0.88 a	3.36 ±0.48 a	138.50 ±13.95 a	132.08 ±13.68 a	48.25 ±5.24 a	19.00 ±1.46 a	354.00 ±34.25 a
	tn	tn	tn	tn	tn	tn	tn	tn

Description: Numbers followed by the same letter in the same column are not significantly different.

In the meantime, the combination of control treatment with no fish waste LOF at a dose of 100 ml/L produced the lowest growth and production results for soybean plants. The average plant height was 33.06 cm, the average flowering age was 36.33 days after planting, the average number of productive branches was 1.25 branches, the average number of pods per plant was 67.16 pods, the average number of pods containing 57.66 pods, the average seed weight per plant was 24.08 g, the average weight of 100 seeds was 11.00 g. The average seed weight per plot was 103.67 g. This was because, without specifying the type of LOF (control) with a dose of 100 ml/L, it could not meet the nutrient needs for soybean plants. Rosmarkam and Yuwono (2011) stated that one influencing factor on plants' growth rate and yield is the availability of nutrients that plants can obtain. Insufficient fertilization nutrients can hinder plants' growth and yield if they do not meet their needs.

4. Conclusion

After conducting field research and analyzing diversity, it can be inferred from tabulated results that the combination of liquid organic fertilizer (LOF) and marine fish waste at a dosage of 300 ml/L results in the highest soybean production, specifically 451.00 g/plot or approximately 1.80 tons/ha.

References

Alex, S. (2012). *Sukses mengolah sampah organik menjadi pupuk organik*. Pustaka Baru Press.

Ardian, Yoseva, S., Naibaho, A. P. S., & Pramana, A. (2023). Peningkatan pertumbuhan dan hasil tanaman kacang tanah (*Arachis hypogaea* L.) dengan pengolahan tanah dan pupuk organik cair limbah ikan. *Juatika (Jurnal Agronomi Tanaman Tropika)*, *5*(2), 453–467.

Badan Pusat Statistik Provinsi Sumatera Selatan. (2023). *Produksi palawija (ton), 2021-2023*. https://sumsel.bps.go.id/indicator/53/400/1/produksi-palawija.html

Endriani, Ghulamahdi, M., & Sulistyono, E. (2017). Pertumbuhan dan hasil kedelai di lahan rawa lebak dengan aplikasi pupuk hayati dan kimia. *Jurnal Agronomi Indonesia*, *45*(3), 263–270.

Hadisuwito, S. (2012). *Membuat pupuk organik cair*. Agro Media Pustaka.

Hanafiah, K. A. (2010). *Rancangan percobaan*. Rajawali Press.

López-Gómez, J. P., & Venus, J. (2021). Potential role of sequential solid-state and submerged-liquid fermentations in a circular economy. *Fermentation*, *7*(2). https://doi.org/10.3390/fermentation7020076

Made, U., Syamsiar, & Astuti, R. P. (2023). Pertumbuhan dan hasil tanaman kedelai (*Glycine max* L.) pada pemberian berbagai dosis pupuk guano dan konsentrasi LOF. *Jurnal Agrotekbis*, *11*(3), 674–684.

Murdaningsih, & Rahayu, P. S. (2021). Aplikasi pupuk organik cair limbah ikan pada tanaman mentimun (*Cucumis sativus* L.). *AGRICA: Journal of Sustainable Dryland Agriculture*, *14*(1), 1–10.

Nisa, C. (2021). *Pengaruh konsentrasi pupuk organik cair (LOF) limbah ikan laut terhadap pertumbuhan dan hasil tanaman mentimun (Cucumis sativus L.)* [Skripsi, Universitas Siliwangi].

Novizan. (2005). *Petunjuk pemupukan yang efektif*. Agro Media Pustaka.

Nugroho, P. (2017). *Panduan membuat pupuk kompos cair*. Pustaka Baru Press.

Ramadhani, E., Refnizuida, & Zihono, M. F. (2022). Aplikasi limbah pencucian ikan dan rumah tangga terhadap pertumbuhan dan produksi tanaman kacang panjang (*Vigna sinensis* L.). *Jurnal Triton*, *13*(2), 141–148.

Rohima. (2020). *Pengaruh pupuk organik cair limbah ikan terhadap pertumbuhan dan hasil kedelai edamame pada tanah aluvial* [Artikel ilmiah, Universitas Tanjungpura].

Rosmarkam, A., & Yuwono, N. W. (2011). *Ilmu kesuburan tanah*. Kanisius.

Setiani, W. (2014). Pengaruh jenis dan waktu pemberian bokashi terhadap pertumbuhan dan hasil tanaman jagung manis (*Zea mays* L. *saccharata* Sturt.) varietas super sweet. *Jurnal Agrifor*, *13*(2), 223–230.

Sultoniyah, S., & Pratiwi, A. (2019). Pengaruh pupuk organik cair limbah ikan nila (*Oreochromis niloticus*) terhadap pertumbuhan tanaman bayam hijau (*Amaranthus viridis* L.). *Symposium of Biology Education (Symbion)*. https://doi.org/10.26555/symbion.3513

Sutriana, S., Ulpah, S., & Baharuddin, R. (2022). Land productivity of the intercropping shallot (*Allium ascalonicum* L.) and chili pepper (*Capsicum frutescens* L.) with liquid organic fertilizer

and solid organic fertilizer. *Juatika (Jurnal Agronomi Tanaman Tropika)*, *4*(1), 37–47.

Turmanto, Sepriani, Y., & Rizal, K. (2021). Respon pertumbuhan tanaman kedelai (*Glycine max* L. *Merril*) dengan pemberian LOF limbah ikan dan solid. *Jurnal Agroplasma*, *8*(2), 36–45.

Waryanti, A., Sudarno, S., & Sutrisno, E. (2013). Studi pengaruh penambahan sabut kelapa pada pembuatan pupuk cair dari limbah air cucian ikan terhadap kualitas unsur hara makro (CNPK). *Jurnal Teknik Lingkungan*, *2*(4), 1–7.

Zahroh, S., Kusrinah, S. M., & Setyawati. (2018). Perbandingan variasi konsentrasi pupuk organik cair dari limbah ikan terhadap pertumbuhan tanaman cabai merah (*Capsicum annuum* L.). *Journal of Biology and Applied Biology*, *1*(1), 50–57.