



Performance of Sweet Corn and Increasing Soil Total Nitrogen after the Application of Vegetable Waste-Based Liquid Organic Fertilizer in Coastal Entisols

Zainal Mukhtar^{a*}, Dicky P. Sinaga^{b++}, Heru Widiyono^a,
Herry Gusmara^a and Bambang G. Mucitro^a

^a Department of Soil Science, The University of Bengkulu, 38121, Indonesia.

^b The University of Bengkulu, 38121, Indonesia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i213968

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/107424>

Original Research Article

Received: 02/08/2023

Accepted: 08/10/2023

Published: 16/10/2023

ABSTRACT

Coastal Entisols generally have coarse-textured, low organic matter and total soil nitrogen (N), and low water holding capacity. The liquid organic fertilizer is expected to increase soil organic matter in soil. The study's objective was to determine the total soil organic carbon (TSOC) and TSN on coastal Entisols and the performance of sweet corn under the application of liquid organic fertilizer (LOF) produced from vegetable waste. The study used a completely randomized design (CRD) with the treatments rates of LOF from vegetable waste consisting of 0, 100, 200, 300, 400, 500, and 600

⁺⁺ Student at Soil Science Study Program;

*Corresponding author: E-mail: muktamar@unib.ac.id, muktamar1959@yahoo.com;

ml l⁻¹ with three replicates. The results indicated that applied LOF linearly increased TSOC and TSN. The addition of LOF at the rate of 600 ml l⁻¹ improved TSOC and TSN by as much as 19.5% and 24.70%, respectively, compared to the control. The growth of sweet corn was insignificantly dependent on the LOF, except plant height. The optimum concentration of LOF was approximately 250 ml l⁻¹ to reach the highest yield, indicated by unhusked ear diameter (5.57 mm), unhusked ear weight (319.75 g plant⁻¹), and husked ear weight (215.12 g plant⁻¹). The study is significant for the productivity improvement of coastal Entisols.

Keywords: Coastal entisols; liquid organic fertilizer; soil nitrogen; sweet corn; soil organic carbon.

1. INTRODUCTION

Indonesia comprises thousands of islands with 106.000 km long coastlines. The coastal area has the potential for the expansion of agricultural land. Moreover, Bengkulu Province has a coastline of approximately 525 km. Most of the coastal area in this province has not been intensively used as a productive agricultural area. Entisols are an order of soil commonly found in coastal areas. The main constraints of this soil are low water holding capacity, loose structure, high water infiltration and evaporation, and low soil fertility indicated by low organic matter content and high salinity [1]. A study by [2] suggested that Entisols in the coastal area contain low organic matter and low fertility. According to Saki [3] Entisols from Bandar Pinang have low total soil nitrogen (0.07-0.16%)

Low N content in Entisols might have been due to coarse texture, causing its leaching and low soil organic matter [4]. Denitrification, volatilization, harvest loss, and erosion also lead to the N loss from the soil. This nutrient is very mobile in the soil; therefore, adding organic matter is an approach to overcome the constraints of the soil. The application of organic matter to soil increases organic-C, nitrate, total N, available-P, exchangeable K, microbial biomass carbon (MBC), and soil pH [5,6,7,8]. A previous study also suggested that applying liquid organic fertilizer (LOF) improves soil chemical properties, including N, P, and K [9]. Liquid organic fertilizer is superior to solid one since the nutrients are more readily available and easily absorbed by plants. Organic sources for LOF are abundant, such as household waste, industry, agricultural production, livestock, etc [10,11,12,13]. Converting household waste into LOF is strategic to prevent environmental pollution.

The quality of LOF highly depends on its source. Liquid organic fertilizer from household waste contains organic-C 7.85% and N 0.33% [14].

Another study revealed that LOF from urban organic waste has organic matter 17.98-22.15%, N 0.03-0.08%, P 0.04-0.095%, K 0.31-0.825%, organic-C 0.79-1.22%, Mg 2.26-4.12 ppm, Ca 2.26-11.80 ppm, Cu 0.52-0.86 ppm, Zn 2.83-3.83 ppm, Fe 2.83-3.81 ppm, and humic acid 3.85-7% [15].

Liquid organic fertilizer is commonly used to improve plant performance. The application of LOF significantly increases the productivity of sweet corn [16], lettuce [17], and cucumber [18]. Applying LOF from animal wastes also increases the absorption of P, and K by plants [19]. Our objective was to examine total soil nitrogen under the application of household waste-based liquid organic fertilizer and determine the growth and yield of sweet corn response on the LOF in coastal Entisols.

2. MATERIALS AND METHODS

2.1 Soil Collection and Experimental Design

A study was carried out in the Greenhouse, the Faculty of Agriculture, the University of Bengkulu from July to September 2021. The experiment used coastal Entisols from Beringin Raya Village, Muara Bangkahulu SubDistrict, the City of Bengkulu at an altitude of approximately 5 m above sea level. Composite soil samples were collected from 5 representative spots at 0-20 cm depth. The soil was air-dried, ground, and sieved with a 5 mm screen. A portion of the soil sample was screened with a 0.5 mm sieve and analyzed for total soil organic carbon (TSOC) using the Walky and Black Method and total soil nitrogen (TSN) using the Kjeldahl Method. The soil contained 2.71% TSOC and 1.3% TSN. The experiment used a completely randomized design (CRD) with seven treatments of LOF concentrations (0, 100, 200, 300, 400, 500, and 600 ml/ l⁻¹). The treatments were replicated three times.

2.2 Liquid Organic Fertilizer Preparation

The LOF was produced from vegetable wastes collected from urban markets, mainly cabbage wastes. Other wastes with small amount included broccoli, mustard, lettuce, etc. The vegetable waste was cut into approximately 2-4 cm pieces to ensure it quickly decomposed. The organic substrate (675 kg) was placed in a 250-l plastic bio-decomposer with selected tiny holes around the decomposer for airflow. A faucet was inserted at the basal of the decomposer for dispensing the LOF. The decomposer was mixed with 1 l EM4 and water to achieve 225 ml of total volume. The mixture was incubated for five weeks and stirred every week. After the incubation, the LOF was ready for application, indicated by odorless and brown. The original LOF was considered 100% (concentrated). The LOF contained 5.74% N, 0.29% P, 0.48% K, 3.19% organic-C, and a pH of 5.1.

2.3 Experimental Procedure

Growing media was prepared by weighing 10 kg of air-dried soil incorporated with basal fertilization, consisting of half of the recommended rate (75 kg urea ha⁻¹, 37.5 kg SP36 ha⁻¹, and 25 kg KCl ha⁻¹), and put into the polybag. The polybags were randomly allocated in a 50 cm wooden rack. Two seeds of sweet corn (var. Paragon) were inserted into the Furadan-treated hole at the center of the polybag. Thinning was carried out a week after planting by leaving the healthier plant.

Each polybag received 1 liter of LOF in 6 applications at a volume of 100, 200, 200, 200, 200, and 100 ml at weeks 2, 3, 4, 5, 6, and 7, respectively. The water for plant was applied every day in the afternoon. Pest control used 500 g l⁻¹ Profenofos active ingredient at a rate of 1 ml l⁻¹ while weed was manually controlled. The growth variables were observed at tasseling and the yield components were measured after harvesting. The plant was harvested 63 days after planting, indicated by yellowish ear, brownish ear hair, and fully filled seed. A representative soil sample was collected from each polybag, air-dried, sieved with a 0.5 mm screen, and analyzed for pH, TSOC, and TSN.

2.4 Statistical Analysis

Data was subjected to analysis of variance (ANOVA) at a confidence level of 95% using

SAS University Edition, and treatment means were separated using polynomial orthogonal.

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

Analysis of variance showed that applying LOF with different rates significantly affected TSN, TSOC, plant height, husked ear weight, unhusked ear weight, and husked ear diameter, as seen in Table 1. However, the LOF did not affect soil pH, leaf number, shoot fresh weight, shoot dry weight, and husked ear length.

3.2 The Effect of LOF on Soil pH, TSOC, and TSN

The study showed no significant effect of LOF on soil pH, as presented in Fig. 1. This result differs from that reported by [9], where LOF significantly increased soil pH. The difference might be related to the lower concentration of LOF than in the previous study. The highest concentration of LOF in this study was 600 ml l⁻¹, while the previous one was 100% (1000 ml l⁻¹), indicating a trend of rising soil pH in this study.

Liquid organic fertilizer linearly increased TSOC with a regression equation of $y = 0,0007x + 2,0481$ and R² of 0.39 (Fig. 2). The addition of LOF will directly increase carbon in the soil, as indicated by the concentration of C in the LOF is 3.19%. An increase in 1 ml l⁻¹ of LOF raises TSOC by 7 ppm. The application of the highest concentration (600 ml l⁻¹) provides an increase of 2.4% TSOC compared to the control. This result is in line with that reported by [20], where the application of 50% from the original LOF on sandy soil had an organic C of 1.56%.

The application of LOF also linearly enhances TSN following the equation of $y = 0,00009x + 0,2186$ with R² of 0.50, as shown in Fig. 3. TSN increases by 0.9 ppm with a rising 1 ml l⁻¹ LOF concentration. An addition of 600 ml l⁻¹ exhibited a TSN of 0.27%. Nitrogen from LOF will eventually be available for plant growth, and the residual will accumulate in the soil. The nitrogen content of LOF is 5.74%, which directly contributes to TSN. The increase in TSN is closely associated with the TSOC, where the increase in TSOC followed that in TSN. Carbon in organic matter will play as a primary energy source of microorganisms, leading to faster decomposition of organic matter and releasing protein and amino acids as well as simpler N

inorganic forms such as N-NO₃ [21]. The result of a study by [9] discovered a similar result, where applying LOF at the rate of 100 mg l⁻¹ on Inceptisols provides 0.27% TSN.

Table 1. Analysis of variance on variables observed in the study

Variable	F-calc	F-table 5%	Coefficient of variance (%)
pH	2.19 ^{ns}	2.85	2.32
TSOC	5.85*	2.85	7.41
TSN	8.76*	2,85	6.53
Plant height	14.75*	2.85	5.39
Leaf number	1.13 ^{ns}	2.85	6.80
Shoot fresh weight	2.31 ^{ns}	2.85	24.15
Shoot dry weight	2.71 ^{ns}	2.85	23.37
Husked ear weight	17.38*	2.85	18.54
Unhusked ear weight	5.65*	2.85	12.35
Husked ear length	2.08 ^{ns}	2.85	7.93
Husked ear diameter	12,17*	2.85	13.01

Note: * = significantly different, ^{ns} = insignificantly different

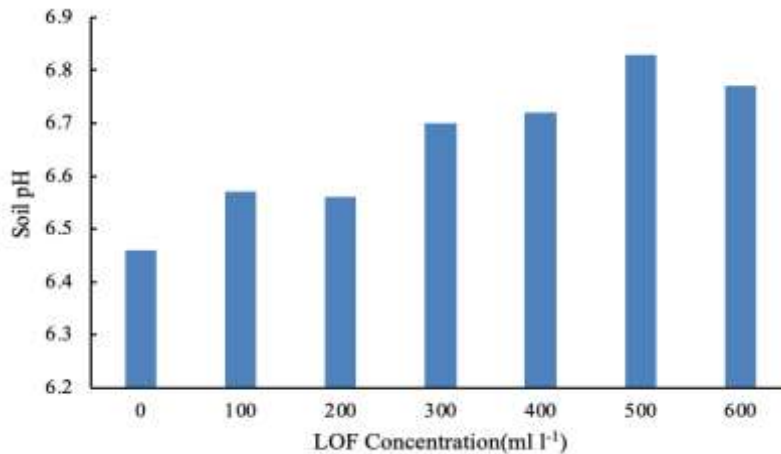


Fig. 1. The effect of LOF on soil pH

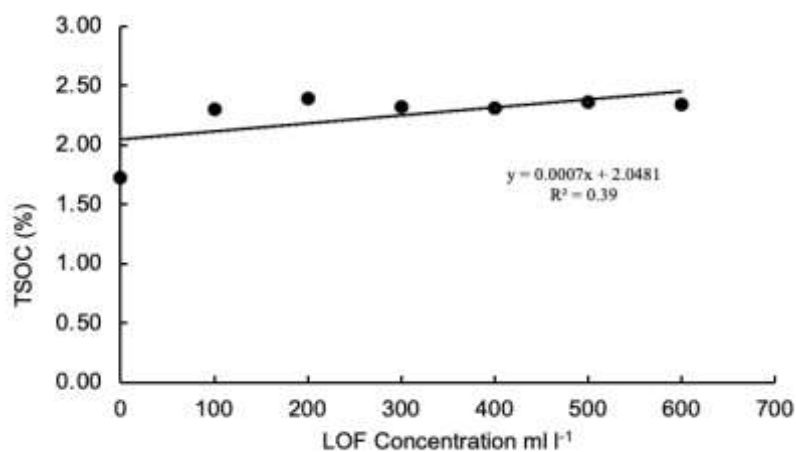


Fig. 2. The effect of LOF on total soil organic carbon (TSOC)

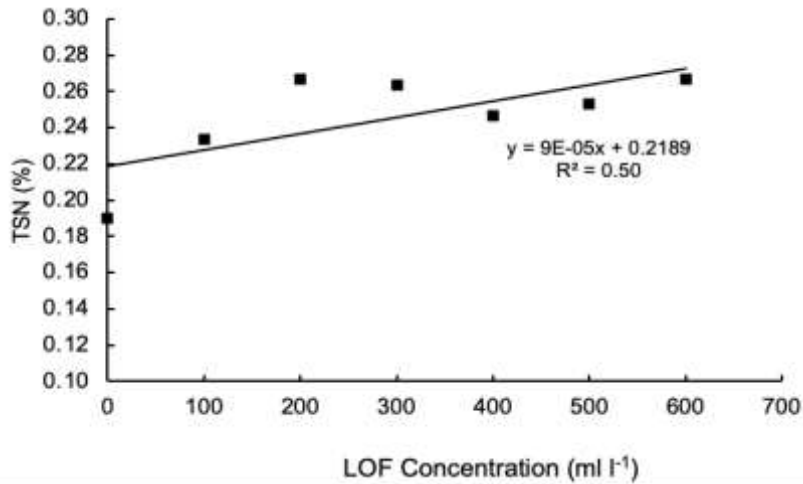


Fig. 3. Total soil nitrogen (TSN) under different concentrations of LOF

3.3 The Influence of LOF on Sweet Corn Growth

The study revealed that LOF affected the plant height of sweet corn. The relationship between LOF concentration and plant height follows the quadratic equation $y = -0.0003x^2 + 0.1015x + 173.2$ with R^2 of 0.60 (Fig. 4). The optimum concentration of LOF is 169.2 ml l^{-1} with the plant height of 181.2 cm, indicating that the plant continues to increase up to the concentration of 169.2 ml l^{-1} , then decreasing afterward. A similar trend was discovered by [22], where applying LOF from mustard at a concentration of 3 ml l^{-1} reached the tallest corn while a higher concentration of $4\text{-}5 \text{ ml l}^{-1}$ lowers the height of the corn. However, this result differs from that reported by [23], where applying LOF from pineapple waste does not affect sweet corn height and leaf area.

Unlike plant height, the application of LOF did not affect the number of leaves, shoot fresh weight, and shoot dry weight, even though there is an increased trend of those variables (Table 2). This result indicates that the application of LOF has not affected the growth of sweet corn. The insignificant effect might be attributed to the application method of the LOF. In our study, the LOF was applied sequentially at 2, 3, 4, 5, and 7 weeks after planting. This result indicates that in the early stage of sweet corn growth, mainly at weeks 3-4, P and K from LOF are insufficient for plant growth. A similar result was suggested by [24], where the number of sweet corn leaves is not different among concentrations of LOF from vegetable waste. Applying LOF up to 100 ppm,

[25] did not find a significant effect on shoot fresh weight.

3.4 The Effect of LOF on the Yield of Sweet Corn

The application of LOF did not influence the husked ear length, as seen in Fig. 5. even though the concentration of 100 and 200 ml l^{-1} exhibited higher than others. On the other hand, unhusked ear diameter and ear weight significantly differed under different concentrations of LOF.

The polynomial analysis shows that the effect of LOF on ear diameter and weight of sweet corn follows quadratic equations. The equation on unhusked ear diameter is $y = -0,00003x^2 + 0,0145x + 3,8171$, dan $R^2 = 0,71$ (Fig. 6). unhusked ear weight is $y = -0,0021x^2 + 1,0385x + 191,36$ dan $R^2 = 0,71$ (Fig. 7). while husked ear weight is $y = -0,0013x^2 + 0,6257x + 139,83$ dan $R^2 = 0,71$ (Fig. 8).

In general, the LOF has no significant effect on the growth of sweet corn except for plant height. This result indicates that nutrient availability mainly P and K from LOF at a concentration of 600 ml l^{-1} has not been sufficient to assure the different growth of the sweet corn, probably due to successive application of LOF during the growth of sweet corn. However, after entering the reproductive stage, addition of LOF is sufficient. A previous study also confirmed that LOF from dairy cattle up to the rate of 100 ppm also did not affect the growth of sweet corn [25].

Moreover, the LOF has a substantial effect on the yield indicated by its unhusked ear diameter, unhusked and husked ear weights, following the quadratic equation with R^2 more than 0.71 for all variables. The quadratic equation indicates that increased LOF concentration will increase the yield variables to their optimum points. The

optimum point for unhusked ear diameter is 241.67 ml l^{-1} of LOF to reach 5.57 mm, unhusked ear weight is 247.26 ml l^{-1} to obtain $319.75 \text{ g plant}^{-1}$, and husked ear weight is 240.65 ml l^{-1} to achieve $215.12 \text{ g plant}^{-1}$. Therefore, LOF is applied at a concentration of approximately 250 ml l^{-1} to reach the optimum yield of sweet corn.

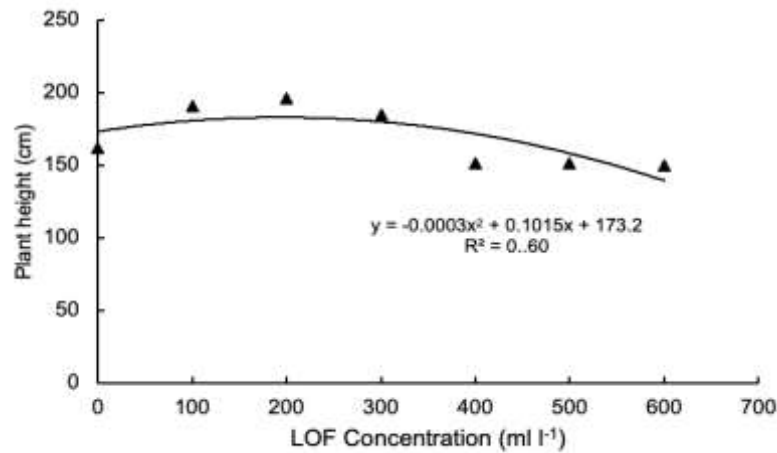


Fig. 4. Sweet corn height as affected by the concentration of LOF

Table 2. The effect of LOF on the number of leaves and shoot weight of sweet corn

LOF Concentration (ml l^{-1})	Number of leaves	Shoot fresh weight (g)	Shoot dry weight (g)
0	10.00	256.00	180.80
100	10.55	367.00	266.83
200	10.55	398.00	279.37
300	11.22	366.67	270.60
400	10.00	225.33	160.43
500	10.11	239.00	163.63
600	10.33	238.67	172.50

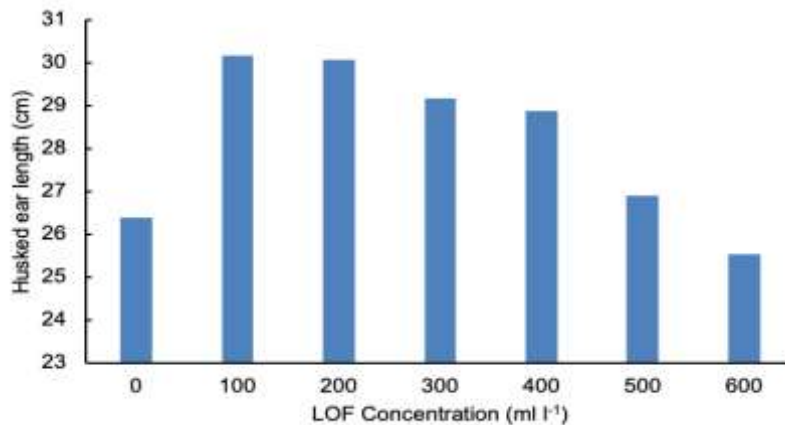


Fig. 5. Husked ear length of sweet corn under different concentrations of LOF

Increasing the yield of sweet corn to the optimum point is attributed to the increase in nutrient availability from LOF as increased concentration. Even though there was no significant effect on sweet corn growth, nutrients were readily available during the seed filling of sweet corn. On the other hand, the yield decline after the optimum point of LOF concentration might be related to the imbalanced nutrient uptake of N, P, and K by sweet corn. The LOF used in this study has a much higher content of N (5.74%) than P (0.29%) and K (0.48%). The high N content at a higher LOF concentration may cause the lower uptake of P and K. An experiment by [26] suggested that applying the proper dose and balance to the other plant nutrients, mainly P and K is vital to ensure high fertilizer efficiency. A previous study by [27]

concluded that there should be the interactive effect of N and K on leaf photosynthetic to reach maximal plant growth. Excessive supply of N leads to K deficiency symptom. Our study resulted that the LOF contained much higher N than K.

The high rate of LOF applied at weeks 6 and 7 might have caused the excessive absorption of N at which sweet corn already performs the generative period (tasseling). A study by [28] showed that an excessive supply of N can lower the corn yield. Earlier studies also revealed that LOF from vegetable waste with high concentration precisely had a negative effect on the plant yield. Research carried out by [29] found that adding LOF from vegetable waste at a concentration of

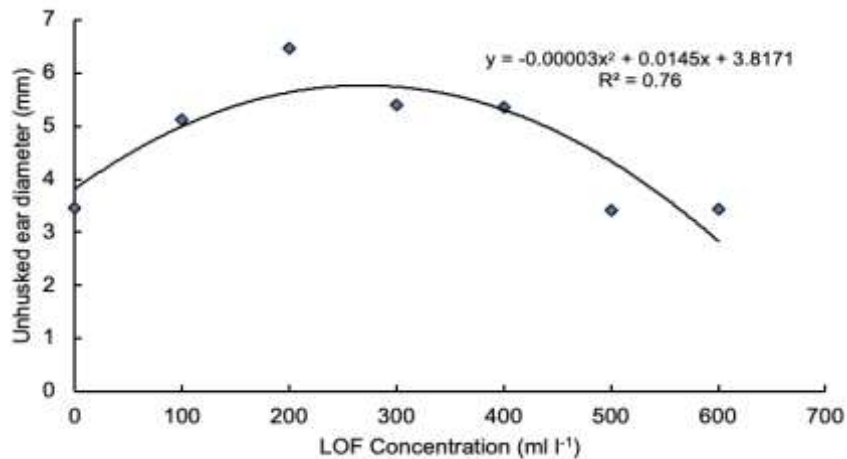


Fig. 6. The effect of LOF on unhusked ear diameter of sweet corn

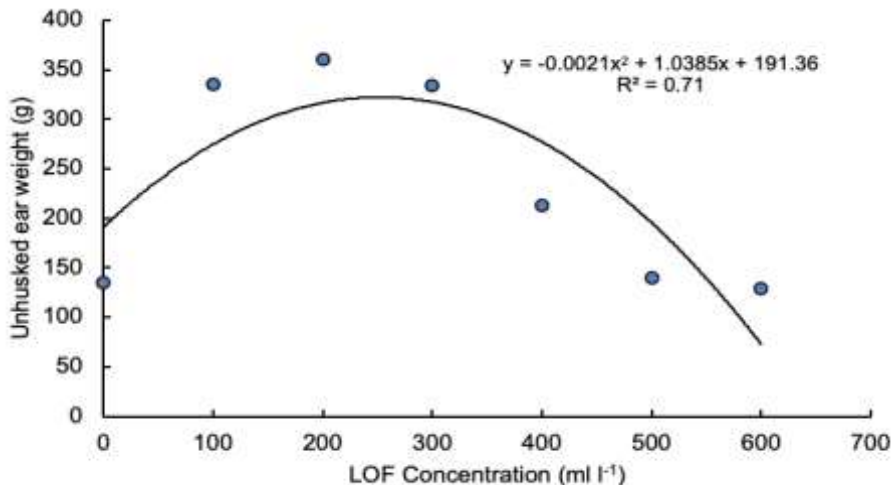


Fig. 7. The effect of LOF on unhusked ear weight of sweet corn

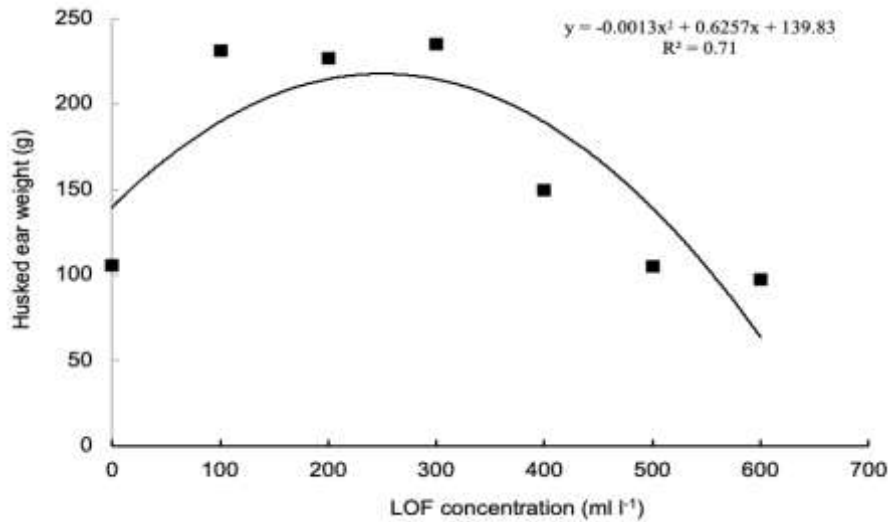


Fig. 8. The effect of LOF on husked ear weight of sweet corn

8% provided the most significant fruit weight of chili papers. However, the variables decreased at higher concentrations (10%, 12%, and 14%). Another study by [30] showed that the fresh weight of mustard significantly decreased at the vegetable-based LOF concentration of 12% compared to 8%. Liquid organic fertilizer from tomato extract also did not significantly influence the yield of sweet corn [31].

4. CONCLUSION

The optimum concentration of vegetable waste-based LOF for sweet corn yield is approximately 250 ml l⁻¹. Applying LOF from vegetable waste to concentration of 600 ml l⁻¹ linearly increased the TSOC and TSN of the soil. The TSN and TSOC increases by 0.9 ppm and 7 ppm respectively, with raising 1 ml l⁻¹ LOF concentration. The study verified that, vegetable based LOF application increased total soil nitrogen and total soil organic carbon in the soil.

ACKNOWLEDGEMENTS

The sincere appreciation goes to the Faculty of Agriculture, the University of Bengkulu, for providing facilities. The authors also thank Soil Science Laboratory technicians for assisting with the soil analysis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rajiman P, Yudoyono, Sulistyaningsih E, Hanudin E. The effect of soil amendments on the physical properties of soil and the yield of shallots on the sandy land of Bugel beach, Kulon Progo Regency. *Agrin Journal*. 2008;12(1):67-77. Available: <https://jurnalagrin.net/index.php/agrin/article/view/80>
2. Gunadi S. Technology for utilizing marginal land in coastal areas. *Journal of Environmental Technology*. 2002;3(3):232-236. Available: <https://dx.doi.org/10.29122/jtl.v3i3.260>
3. Sakiah Sembiring M, Hasibuan J. Entisol land characteristics with and without cover crop (*Mucuna bracteata*) on rubber plantation. *IOP Conf. Ser.: Earth Environ. Sci*. 2018;122:012043. Available: <https://iopscience.iop.org/article/10.1088/1755-1315/122/1/012043/pdf>
4. Nariratih I, Danamik MMB, Sitanggang G. The availability of nitrogen in three types of soil is due to the application of three organic materials and their uptake in corn plants. *Journal of Agrotechnology*. 2013; 1(3):479-488. Available: <https://www.neliti.com/publication/s/94978/ketersediaan-nitrogen-pada-tiga-jen-tanah-akibat-pemberian-tiga-bahan-organik#id-section-content>
5. Muktamar Z, Justisia B, Setyowati N. Quality enhancement of humid tropical soils after application of water hyacinth

- (*Eichornia crassipes*) compost. Journal of Agricultural Technology. 2016;12(71): 1715-1727.
Available:[http://www.aatsea.org/images/conference_publications/pdf/v13_n7_2_2017_December/19_IJAT_13\(7.2\)_2017_Muktamar%20Zainal_Environmental%20Science,%20Soil%20and%20Water%20Conservation.pdf](http://www.aatsea.org/images/conference_publications/pdf/v13_n7_2_2017_December/19_IJAT_13(7.2)_2017_Muktamar%20Zainal_Environmental%20Science,%20Soil%20and%20Water%20Conservation.pdf)
6. Sianturi SM, Muktamar Z, Chozin M. Enhancing soil chemical properties and sweet corn growth by solid organic amendments in Ultisol. Terra, Journal of Land Restoration. 2019; 2(1):1-8.
Available:<https://ejournal.unib.ac.id/index.php/terrajournal/article/view/7404/pdf>
 7. Liu X, Chen Q, Zhang H, Zhang J, Chen Y, Yao F, Chen Y. Effects of exogenous organic matter addition on agricultural soil microbial communities and relevant enzyme activities in southern China. Sci Reports. 2023;13:8045.
Available:<https://doi.org/10.1038/s41598-023-33498-0>
 8. Muktamar Z, Setyowati N, Wiyanti E. The improvement of selected soil chemical properties using singapore daisy based compost in Ultisols. International Journal of Agriculture and Biological Sciences. 2022;6(Jan-Feb.):41-48.
Available:<https://zenodo.org/record/6596782#.ZB6sPS8RpQJ>
 9. Muktamar Z, Sudjarmiko S, Fahrurrozi F, Setyowati N, Chozin M. Soil chemical improvement under application of liquid organic fertilizer in closed agricultural systems. International Journal of Agricultural Technology. 2017;13(7.2):1715-1727.
Available:[http://www.aatsea.org/images/conference_publications/pdf/v13_n7_2_2017_December/19_IJAT_13\(7.2\)_2017_Muktamar%20Zainal_Environmental%20Science,%20Soil%20and%20Water%20Conservation.pdf](http://www.aatsea.org/images/conference_publications/pdf/v13_n7_2_2017_December/19_IJAT_13(7.2)_2017_Muktamar%20Zainal_Environmental%20Science,%20Soil%20and%20Water%20Conservation.pdf)
 10. Martinez-Alcantara B, Martinez-Cuenca MR, Bermejo A, Legaz F, Quiñones A. Liquid organic fertilizers for sustainable agriculture: Nutrient uptake of organic versus mineral fertilizers in citrus trees. PLOS ONE. 2016;11 (10): e0161619.
Available:<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5072554/pdf/pone.0161619.pdf>
 11. Phibunwatthanawong T, Riddech N. Liquid organic fertilizer production for growing vegetables under hydroponic conditions. International Journal of Recycling of Organic Waste in Agriculture. 2019;8:369–380.
Available:<https://doi.org/10.1007/s40093-019-0257-7>
 12. Kusumasari R, Santoso SJ, Triyono K. Effect of application of liquid organic fertilizer cattle urine on growth and yield of 3 (three) Eggplant Varieties (*Solanum melongena* L.). Innofarm: Journal of Agricultural Innovation. 2022; 24(2):73-76.
Available:<https://doi.org/10.33061/innofarm.v24i2.7749>
 13. Rusdiyana Indriyanti DR, Marwoto P, Iswari RS, Cahyono E. The influence of liquid organic fertilizer from peanut and banana peels toward vegetative growth of spinach. J. Science Education Research. 2022;8(2):528-533.
Available:<https://jppipa.unram.ac.id/index.php/jppipa/article/view/1331/1098>
 14. Wahida, Suryaningsih NLS. Analysis of the nutrient content of liquid organic fertilizer from household waste in Merauke Regency. Agricola Journal. 2016;6(1):23-30.
Available:<https://doi.org/10.35724/ag.v6i1.398>
 15. Haryanta W, Sa'adah TT, Thohiron M. Physico-chemical characterization of liquid organic fertilizer from urban organic waste. Chemical Engineering Transactions. 2022;96:457-462.
Available:https://erepository.uwks.ac.id/14990/1/Naskah_Cet_Psycho-Chemical-DwH.pdf
 16. Muktamar Z, Sudjarmiko S, Chozin M, Setyowati N, Fahrurrozi. Sweet corn performance and its major nutrient uptake following application of vermicompost supplemented with liquid organic fertilizer. International Journal on Advanced Science Engineering Information Technology. 2017;7(2):602-608.
Available:<http://dx.doi.org/10.18517/ijaseit.7.2.1112>
 17. Fahrurrozi F, Muktamar Z, Setyowati N, Chozin M, Sudjarmiko S. Nutrient properties of tithonia-enriched liquid Organic fertilizer as affected by different types of animal feces and its effects on

- fresh weight of loose-leaf lettuce (*Lactuca sativa* L.). International Journal on Advance Science Engineering Information Technology. 2020;10(2):730-735.
DOI: 10.18517/ijaseit.10.2.4748
18. Rohmawan DR, Muktamar Z, and Fahrurraozi F. Water hyacinth-based liquid organic fertilizer increased growth and yields of organically grown cucumber. International Journal of Ag. And Env. Research 2020;6(6):843-852.
Available:https://ijaer.in/2020files/ijaer_06_62.pdf
 19. Anggita T, Muktamar Z, Fahrurrozi F. Improvement of selected soil chemical properties and potassium uptake by mung beans after application of liquid organic fertilizer. Terra, Journal of Land Restoration. 2018;1(1):1-7.
Available:https://ejournal.unib.ac.id/index.php/terrajournal/article/view/4123/pdf_1
 20. Febrianna M, Prijono S, Kusumarini N. The role of liquid organic fertilizer to improve nitrogen uptake and the growth and yield of mustard (*Brassica juncea* L.) in sandy soil. Jurnal Tanah dan Sumberdaya Lahan. 2018;5(2):1009-1018.
 21. Utami SN, Handayani S. The change in the chemical properties of Entisols for organic agriculture system. Ilmu Pertanian. 2003; 10(2):63-69.
Available:<https://doi.org/10.22146/ipas.59030>
 22. Rahmah A, Izzati M, Parman S. The effect of liquid organic fertilizer from white mustard (*Brassica chinensis* L.) on the growth of sweet corn (*Zea mays* L. var. Saccharata). Buletin Anatomi dan Fisiologi. 2014;22(1):65-71.
Available:<https://www.neliti.com/publications/60067/pengaruh-pupuk-organik-cair-berbahan-dasar-limbah-sawi-putih-brassica-chinensis>
 23. Suryani R, Masulili A, Sutikarini, Tamtomo F. Utilization of liquid organic fertilizer from pineapple waste to improving growth of sweet corn plant in red yellow podzolic Soil. International of Multi Discipline Science. 2022;5(1):30-36.
Available:<https://journal.stkip Singkawang.ac.id/index.php/IJ-MDS/article/view/3160/pdf>
 24. Sinaga NS, Luta DA, Tarigan RRA. Increasing the growth and production of sweet corn (*Zea mays* Saccharata) by applying chicken manure and vegetable waste liquid organic fertilizer. Juatika, Journal Agronomi Tanaman Tropika. 2023;5(2):322-329.
 25. Fahrurrozi, Muktamar Z, Dwatmadji, Setyowati N, Sudjatmiko S, Chozin M. Growth and yield responses of three sweet corn (*Zea mays* L. var Saccharata) varieties to local based liquid organic fertilizer. International Journal on Advance Science Engineering Information Technology. 2016;6(3):319-321.
Available:<http://dx.doi.org/10.18517/ijaseit.6.3.730>
 26. Syafruddin. Management of nitrogen fertilizer application on maize J. Litbang Pert. 2015;34(3):105.116.
Available:<https://media.neliti.com/media/publications/30948-ID-manajemen-pemupukan-nitrogen-pada-tanaman-jagung.pdf>
 27. Li J, Hu W, Lu Z, Meng F, Cong R, Li X, Ren T, Lu J. Imbalance between nitrogen and potassium fertilization influences potassium deficiency symptoms in winter oilseed rape (*Brassica napus* L.) leaves. The Crop Journal. 2022;10(2):565-576.
Available:<https://doi.org/10.1016/j.cj.2021.06.001>
 28. Saragih R, Hamim H, Nurmauli N. The effect of urea dose and time application to increase the growth and yield of sweet corn (*Zea mays*, L) pioneer 27). J. Agrotek Tropika. 2013;1(1):50-54).
Available:<http://dx.doi.org/10.23960/jat.v1i1.1890>
 29. Yunita F, Damhuri, Sudrajat DL. The effect of liquid organic fertilizer from vegetable waste on the growth and yield of chili pepper (*Capsicum annum* L.). Jurnal. AMPIBI. 2016;1(3):47-55.
Available:<http://ojs.uho.ac.id/index.php/am-pibi/article/view/5045>
 30. Indrajaya AR, Suhartini. The quality and effectivity test of liquid organic fertilizer of vegetable waste on the growth and productivity of mustard plant. Jurnal Prodi Biologi. 2018;7(8):579-589.
 31. Setyowati N, Chozin M, Nadeak YA, Hindarto KS, Muktamar Z. Sweet corn

(*Zea mays* Saccharata Sturt L.) growth and yield response to tomato extract liquid organic fertilizer. American Journal of Multidisciplinary Research

and Development (AJMRD). 2022;4(3):25-32.

Available:<https://www.ajmrd.com/wp-content/uploads/2022/03/D432532.pdf>

© 2023 Muktamar et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/107424>