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Management of Liquid Organic Waste from Palm Oil Plant and Compost Cow to the Growth and Production of Sweet Corn (*Zea mays* saccharata Sturt)

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The growth and production of sweet corn (*Zea mays* saccharata Sturt) are strongly influenced by good genetics and environmental factors, including how to cultivate the soil so that the availability of nutrients is quite balanced. The long-term goal of this research is to determine the effectiveness of a combination of palm oil mill effluent (LCPKS) and cow dung waste (LKTS) with EM4 bio-activator applied to sweet corn (*Zea mays* saccharata Sturt).

This study used a factorial randomized block design (RBD) consisting of 2 factors with 12 treatment combinations and 3 replications to obtain 36 research plots. The factors studied are the formulation factor of a mixture of palm oil mill effluent with cow dung waste, which is denoted by (A) consisting of A1 = 70% palm oil mill waste and 30% cow dung, A2 = 50% effluent palm oil mill and 50% cow dung waste, A3 = 30% palm oil mill waste and 70% cow dung waste. The dose factor with the symbol (D) consists of, D0 = control, D1 = 1.5 kg per plot, D2 = 3 kg per plot, D3 = 4.5 kg per plot.

The parameters observed were plant height (cm), biomass samples (grams), sample production (grams) and plot production (kg). The results showed that different waste mix formulations and

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administration of different doses did not significantly influence plant height parameters because compost maturity must be assessed by measuring two or more compost parameters to prevent phytotoxicity. Therefore, quality assurance must be carried out on compost to determine the factors that cause phytotoxicity and also research must be intensified in determining lines that will be able to degrade waste faster, more efficiently and also produce non-toxic compost that mixes the soil produced in plant growth. In addition, care must be taken in selecting raw materials for composting. The results showed that the mixed waste formulations significantly affected the biomass of the sample, where the highest average was obtained in processing A3 (30% of palm oil mill waste and 70% of cow dung waste. The research results also showed that dosing had a very significant effect on biomass parameter sample, sample production and plot production where the highest average is in the D3 treatment (4.5 kg per plot).

Keywords: Palm oil mills liquid waste; cow dung waste; sweet corn; phytotoxicity; composting.

1. INTRODUCTION

North Sumatera Province is the largest palm oil-producing area in Sumatra with a total area of 405,799.34 hectares with the production of fresh fruit bunches of 5,428,535.14 tons to give a very large and positive interest to the welfare of especially in the province of North Sumatera. The existence of these oil palm factories in addition to providing great benefits also gives a negative impact on the community. Negative impact on the community in the form of waste that the value of Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) is still high because it has not been processed optimally by the factory of oil palm. Palm oil industry waste consists of solid waste, including palm mud, palm fruit, palm kernel shells, and liquid waste that is the end result of the process of palm oil processing in the factory (Provincial statistics agency, North Sumatera [1]).

Every 1 tonne of Crude Palm Oil produces 5 tons of liquid waste with BOD (biological oxygen demand) 20,000-60,000 mg/L. The waste produced by palm oil mills is a solid waste and liquid waste. Solid waste in the form of shells and fiber is used as a fuel boiler or coir mesh and empty bunching is reused as mulch (fertilizer for plants). The resulting liquid waste must follow the predefined standards and cannot be disposed of directly because it will have an impact on environmental pollution. The Parameter that becomes one of the control indicators for liquid waste disposal is a BOD (biological oxygen demand) number. The BOD number means a number indicating oxygen demand [2].

This ingredient is formulated as relatively few ingredients but has the potential to polluting and damage the environment of life and resources. As a waste, its presence is quite alarming mainly sourced from the factory. Oil palm-based industry is a relatively profitable investment, but it is worth noting also the pollution caused when not implemented properly management [3].

Palm oil liquid waste (POLW) comes from condensate, clarification stations, and Hydrocyclon or better known as Palm Oil Mill Effluent (POME) is a non-toxic (non-toxic) waste, but has high pollution due to its organic content with a BOD value ranging from 18,000-48,000 mg/L and COD values range from 45,000-65,000 mg/L [4].

Waste from the oil palm mill process includes palm oil mill effluent (POME), generated mainly from oil extraction, washing and cleaning up processes. POME contains cellulosic material, fat, oil, and grease. Discharging untreated effluent into water streams may cause considerable environmental problems. The solid wastes generated are mainly decanter cake, empty fruit bunches, seed shells and fibre from the mesocarp. POME, as well as the solid wastes, may rapidly deteriorate the surrounding environment if not dealt with properly. Hence there is an urgent need for a sustainable waste management system to tackle these wastes. As these wastes are organic in origin, they are rich in plant nutrients [5].

Manure is an organic fertilizer that can play the role of soil improvement material. Manure can prevent erosion, land movements and soil cracks. Manure and other organic fertilizers increase the soil's ability to bind moisture, improve soil structure and soil enrichment. Manure promotes the growth and development of bacteria and other soil creatures. Manure has a substance of N, P, K Low, but many contain microelements. The content of nitrogen in the manure will be gradually released. Thus the

provision of sustainable manure will help in establishing the soil fertility in the long term. In addition, the use of organic fertilizer can release the dependence of farmers from the outside world in this case fertilizer factory by familiarizing the use of organic fertilizer will make farmers do not become swayed by companies both chemical fertilizers and organic fertilizer factories. Cow manure has a high fiber content such as cellulose. This is evident from the measurement results of the C/N ratio is quite high > 40. High levels of C in cow dung inhibit the use of pond straightness because it will suppress the growth of major plants. The most common among these byproducts is the empty fruit bunch, palm oil mill sludge (POMS), palm kernel cake (PKC) and decanter cake. Palm kernel oil (white palm oil) is obtained from the seed known as kernel or endosperm. When the oil has been extracted from the kernel, what remains is known as 'palm kernel cake' (PKC). This is rich in carbohydrate (48%) and protein (19%) and is used as cattle feed [6].

Chavalparit et al. [7] reported that average values of waste generation rate per ton FFB from palm oil mills in Thailand were 140 kg of fibre, 60 kg of shells, 240 kg of empty fruit bunch (EFB) and 42 kg of decanter cake.

Composting is an environmentally less burden technology because of its recycling capability of organic wastes discharged from industrial and municipal plants or livestock farming. Recent global problems of food shortage have been caused by the rising cost of chemical fertilizers, and composting at low cost has been reevaluated as an important alternative fertilizer production method. High-quality compost is produced by the interaction of many organisms that have suitable properties for the composting processes. Nevertheless, little information has been reported about in situ functions and roles of individual microbes in the composting processes, because many microbes related to composting are difficult to isolate and are characterized by conventional cultivation methods [8].

One adult ox tail produces ± 4,000 kg of dirt/year. Organic fertilizer derived from cattle dung can produce some of the nutrients needed by plants, as seen in Table 1. In addition to producing macronutrients, livestock waste also produces a number of micronutrients, such as Fe, Zn, Bo, Mn, Cu, and Mo. So it can be said that the waste of this livestock can be regarded as an alternative fertilizer to maintain crop production [9].

Cow dung harbors a diverse group of microorganisms that may be beneficial to humans due to their ability to produce a range of metabolites. Nowadays, there is an increasing research interest in developing the applications of cow dung microorganisms as a bioremediation agent to hydrocarbon contaminated soils. Microorganisms capable of degrading hydrocarbon pollutants have been identified and isolated from cow dung. These organisms include; Micrococcus sp., Bacillus sp., Pseudomonas sp., Enterobacter sp., Proteus Klebsiella, Aspergillus sp., Rhizopus and Penicillium. Therefore, cow dung is an effective, economical and eco-friendly bioremediation agent that can lead to the complete mineralization of hydrocarbon. The post-remediation assessment of residual hydrocarbons in contaminated soil can be done with gas chromatographic fingerprinting technique and phytotoxicity bioassay [10].

2. MATERIALS AND METHODS

The materials used in this study are sweet corn seed varieties Bonanza, liquid waste palm oil Mill (LWPOM) with cow dung waste (CDW), a mixed ingredient of bio-activator. The equipment used in the study land, hoe, machetes, sprinklers, metered, plastic rope, sling board, ruler, stationery and scales. To weigh crop production.

The research method used is a method of group random design (GRD) factorial consisting of 12 treatments 3 repeated combinations. The factors tested are the first factor of the mixture of liquid waste of palm oil Mills (LWPOM) and the cow dung waste (CDW). Factor II is the number of doses given to the plant, and the material used in this research is liquid waste palm oil Mills (LWPOM) and cow dung waste (CDW) with the addition of Bio-activator that will be applied to the plant Sweet Corn (*Zea mays* saccharata Strut). In detail the treatment combination is structured as follows:

A. The mixture of the first factor between the liquid waste of palm oil Mills (LWPOM) and cow dung waste (CDW) with a reduce symbol "A "

Table 1. Formulation of waste mixture

Treatment	Types of waste	
	LWPOM	**CDW**
A1	70% (Liquid)	30% (Solid)
A2	50% (Liquid)	50% (Solid)
A3	30% (Liquid)	70% (Solid)

B. The second factor of the dose is symbolized by the letter "D"

D0 = 0 (kontrol)
D1 = 1,5 kg/plot
D2 = 3 kg/plot
D3 = 4,5 kg/plot

C. Chart: Combination of treatment:

A_1D_0	A_2D_0	A_3D_0
A_1D_1	A_2D_1	A_3D_1
A_1D_2	A_2D_2	A_3D_2
A_1D_3	A_2D_3	A_3D_3

D. Number of repeats

$(t-1)(n-1) \geq 15$
$(12-1)(n-1) \geq 15$
$11(n-1) \geq 15$
$11n-11 \geq 15$
$11n \geq 11 + 15$
$11n \geq 26$
$n \geq 26/11$
$n \geq 2{,}36$……3 Deuteronomy

The method used in this study is the randomized design of factorial groups consisting of 2 treatment factors with 12 combinations and 3 repeats. Factors consist of I:

$Yijk = \mu + \rho i + \alpha j + \beta k + (\alpha\beta)_{jk} + \varepsilon_{ijk}$

Description:

Y_{ijk} = The results of the observation on the I block, a factor to give the liquid waste mixture of palm oil and cow dung to the J and the administration of the dose amount to-K.
μ = Middle-Value effect
ρ i = Block effect to-i
αj = Effect of the provision of a liquid waste mixture of palm oil mills and cow manure to-j.
βk = Effect of the administration of dosage amounts to-k.
$(\alpha\beta)_{jk}$ = Effect of interaction between the factors of the provision of a liquid waste mixture of palm oil mills and cow dung to-j and the administration of dosage levels to-k.
ε_{ijk} = Error effect on the I-block, contributing factor to the liquid waste mixture of palm oil mills and cow manure to-j and the administration of dosage levels t-k [11].

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

The measurement data of the research results statistically shows that the treatment of liquid waste mixing of palm oil mills with cattle dung does not give a real influence on the sweet corn plants at the age of 2, 4, 6 and 8 weeks after planting. While the treatment of different dosing administration – the difference is not noticeable to the height of the plant at the age of 2, 4, 6 and 8 weeks after planting. Opinion T. M. Obuotor et al. [12] composting is a contribution to sustainable solid waste management. This is an efficient way to reduce difficulties in getting good results. However, there is a need to examine composting methods and the final product obtained to make the compost maturation free from potential hazards that may be posed to plant and human growth through biomagnification. This study revealed that compost maturity must be assessed by measuring two or more compost parameters to prevent phytotoxicity. Therefore, quality assurance must be carried out on compost to determine the factors that cause phytotoxicity and also research must be intensified in determining strains that will be able to degrade waste faster, more efficiently and also produce non-toxic compost which will increase soil and consequently plant growth. In addition, care must be taken in selecting raw materials for compost preparation.

3.2 The Heavy Biomass per Sample (gram)

The results of the research after analysis based on statistics showed that the treatment of liquid waste mixing of palm oil mills and cow dung for the biomass of sampling on the sweetened corn plant is a real effect. Meanwhile, for the administration of the dose gives a very noticeable effect on the weight parameters of the sample biomass.

Fertilizers given to plantations have a maximum limit in fertilizers provided by each plant that has reserves in the amount not available that are available domestically which contain contents that will provide normal growth if nothing will result in abnormal growth, and every growth the plants needed have one growing point which is active in the vegetative phase but the compilation phase of the generative plant phase of the transition phase.

On histogram combination of a liquid waste mixture of palm oil mills and cow manure on the sweet corn crop to the heavy biomass of the sample is presented in Fig. 1.

The results of an analysis of the influence of the number of doses of the biomass parameter of the sample showed a linear relationship, as presented in Fig. 2.

3.3 Weight Production Sampling (gram)

The results of the research based on statistical analysis showed that the treatment of a liquid waste mixture of palm oil mills and cow dung against the production of samples is not real. While the administration of the dosage amounts to a real dose of the production weight of samples.

The results of an analysis of the influence of the number of doses on the sample production parameters showed a linear relationship, as presented in Fig. 3.

3.4 Production Weight per Plot (kg)

The results of the study after the statistically analyzed showed that the combination treatment of a liquid waste mixture of palm oil mills and cow dung waste is not a real influence on the weight of the production of per plot for the dosage amount very noticeable effect on the production weight per plot.

Table 2. Average biomass sampling (grams) due to the provision of a liquid waste mixture of palm oil plants and cattle dung with various doses

Treatment	Sampling biomass (gram)	
A = Waste mixtures		
A1 = 70% LWPOM + 30% CDW	1190,63	bB
A2 = 50% LWPOM+ 50% CDW	1245,83	abAB
A3 = 30% LWPOM+ 70% CDW	1283,33	aA
D = Dosage Amount		
D0= Control	1168,06	cC
D1= 1,5 kg	1243,06	bB
D2= 3 kg	1248,61	bB
D3= 4,5 kg	1300,00	aA

Description: The numbers that are by the same letter in the same column show no real difference at the rate of 5% (lowercase) and 1% (uppercase) based on double distance Test Duncan (DMRT)

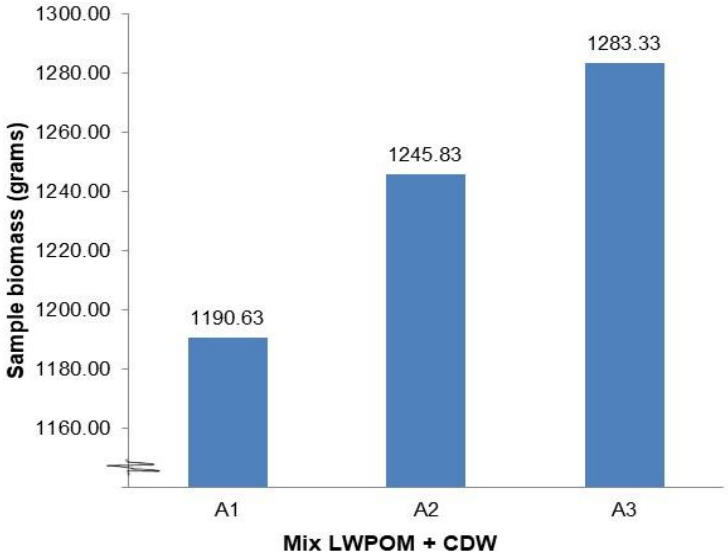

Fig. 1. The relationship between a combination of a liquid waste mixture of palm oil mill with cow dung to the weight of biomass per sample (grams)

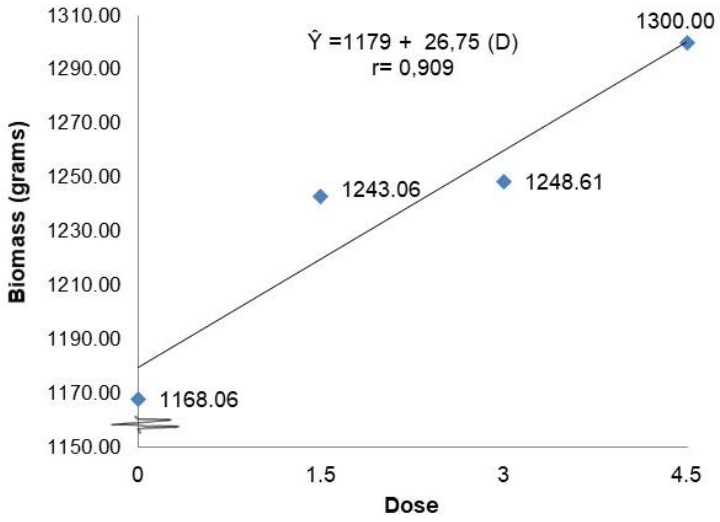

Fig. 2. The relationship between administering the number of different doses to the sampling biomass (grams)

Table 3. The average weight of production of samples (grams) due to the provision of a liquid waste mixture of palm oil plants and cattle dung with various doses

Treatment	Production of sampling (gram)	
A = Waste mixtures		
A1 = 70% Lcpks+ 30% Lkts	247,71	Unreal
A2 = 50% Lcpks+ 50% Lkts	244,06	Unreal
A3 = 30% Lcpks+ 70% Lkts	247,50	Unreal
D = Dosage Amount		
D0= Control	222,78	Cc
D1= 1,5 kg	246,81	bAB
D2= 3 kg	247,08	bA
D3= 4,5 kg	269,03	aA

Description: The numbers that are by the same letter in the same column show no real difference at the rate of 5% (lowercase) and 1% (uppercase) based on double distance Test Duncan (DMRT)

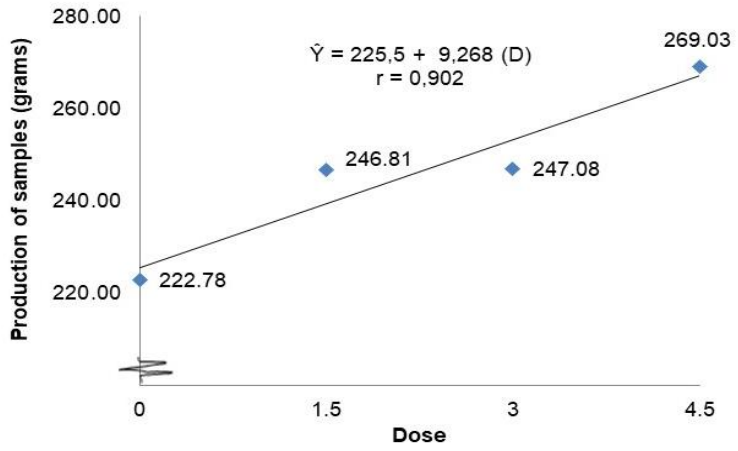

Fig. 3. The relationship between administering the number of different doses to the production weight of the sample (grams)

Table 4. The average weight of production per plot (kg) due to the provision of a liquid waste mixture of palm oil plants and cattle dung with various doses

Treatment	Sampling biomass (gram)	
A = Waste mixtures		
A1 = 70% LWPOM + 30% CDW	3,56	Unreal
A2 = 50% LWPOM+ 50% CDW	3,55	Unreal
A3 = 30% LWPOM+ 70% CDW	3,53	Unreal
D = Dosage Amount		
D0= Control	3,09	cB
D1= 1,5 kg	3,56	abAB
D2= 3 kg	3,61	aA
D3= 4,5 kg	3,92	aA

Description: The numbers that are by the same letter in the same column show no real difference at the rate of 5% (lowercase) and 1% (uppercase) based on double distance Test Duncan (DMRT)

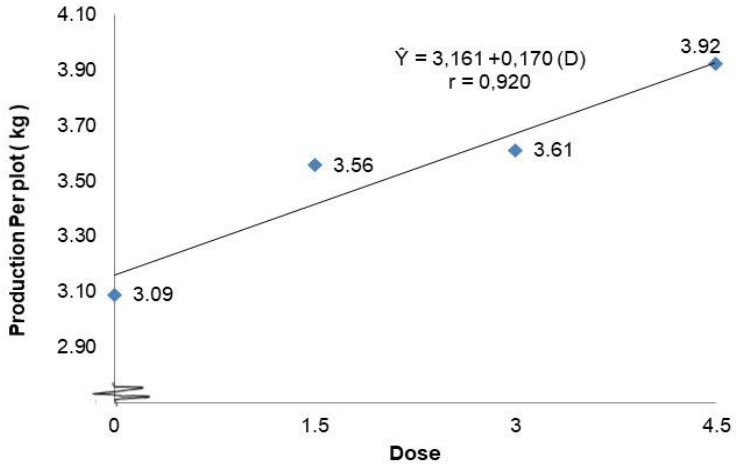

Fig. 4. The relationship between administering the number of different dosages to the production weight of per plot (kg)

The results of an analysis of the influence of the number of doses of the per plot production parameters showed a linear relationship, as presented in Fig. 4.

This is in accordance with the results of laboratory analysis that has been done against the liquid waste mixture of palm oil and cow waste, namely:

Table 5. NPK content from laboratory analysis of agricultural Faculty of North Sumatera University

Elements	A1	A2	A3
N-total	0,09%	0,10%	0,08%
P_2O_2	0,053%	0,067%	0,072%
K_2O	0,168%	0,240%	0,231%

Indicates fertilizer given by the plant has a maximum limit in the provision of fertilizer itself because each plant has a capacity in the absorption of nutrients available in the soil where the availability of balanced nutrients will provide Normal growth when the nutrient deficiency will result in abnormal growth and any upright plant growth has one growing point active in the vegetative phase but when the plant enters the generative phase it is a sign of the organism to enter the final phase of plant growth.

4. CONCLUSION

1. Formulation of liquid waste mixing of palm oil mills and waste of cattle manure provides an unreal influence on crop high parameters, sampling production, per plot production where the best treatment or the highest is A3 (30% liquid waste of palm oil mills and 70% of cow dung waste).
2. Dosing provides a tangible influence on the high parameter of the plant but gives

a real Sagat effect on the biomass parameters of the sampling, the production of samples, the production of Per plot, where the best treatment or the highest is D3 (4.5 kg Per plot).

3. This study revealed that compost maturity must be assessed by measuring two or more compost parameters to prevent phytotoxicity. Therefore, quality assurance must be carried out on compost to determine the factors that cause phytotoxicity and also research must be intensified in determining strains that will be able to degrade waste faster, more efficiently and also produce non-toxic compost which will increase soil and consequently plant growth. In addition, care must be taken in selecting raw materials for compost preparation.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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