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Characteristics of Pineapple Waste as Liquid Organic Fertilizer and Its Effect on Ultisol Soil Fertility

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ABSTRACT
The Purpose to increase soil fertility can be carried out through the provision of liquid organic fertilizers by utilizing agricultural waste including pineapple waste. The research aims to determine the potential and chemical characteristics of pineapple peel waste and to determine the effect of liquid organic fertilizer dosage on increasing soil fertility of Ultisols. The research was conducted at the Faculty of Agriculture, Panca Bhakti University, Jl. Komyos Sudarso Pontianak had been held from June 2022-August 2022. The research used a completely randomized design (CRD), with dosage treatment of liquid organic fertilizer from pineapple plant waste P0 = 0 ml/l water, P1 = 15 ml/l water, P2 = 20 ml/l water, P3 = 25 ml/l water, P4 = 30 ml/l water, P5 = 35 ml/l water, P6 = 40 ml/l water, P7 = 45 ml/l water, P8 = 50 ml/l water. Data were analyzed using ANOVA, which showed a significant difference followed by an Honest Significant Difference (HSD) Test at the 5% level. Treatment of the dose of liquid organic fertilizer from pineapple waste can increase the fertility of ultisol, especially in soil pH, % C organic, % N of total soil, C/N ratio, and P and K content in Ultisol soil. Treatment of the dosage of liquid organic fertilizer for pineapple plant waste of 50 ml/l was the treatment that gave the best results on the parameters of soil pH, % C organic, % N of total soil, C/N ratio, the content of P and K elements in the soil.

INTRODUCTION

One of the centres for the development of agricultural commodities in West Kalimantan is developed on Ultisol land. The soil in the Ultisol group spread across West Kalimantan is the Red Yellow Podsolic. Judging from the soil texture, most of the West Kalimantan area consists of PMK soil type (Podsolic red-yellow), which covers an area of about 9.2 million hectares or 64.83 per cent of the total area of West Kalimantan 14.7 million hectares (Badan Pusat Statistik, 2018).

PMK soil is marginal land with potential for agriculture. The nature of this soil has a very low organic matter content, acid soil reaction, low alkali saturation, high Al content, and low productivity. In

addition, it has macronutrients such as phosphorus and potassium which are often deficient, thus inhibiting plant growth (Sarwono, 2015). These characteristics are obstacles in its use as agricultural land but can be overcome by fertilization technology, liming, and organic matter management.

The application of organic matter into the soil can be done by utilizing organic waste originating from agricultural activities which are processed into organic fertilizer. Organic fertilizers are fertilizers made from organic materials such as vegetable scraps, livestock manure and so on and also from living creatures that have died. The decomposition of organic materials and dead living things causes changes in physical properties from the previous form (Riwandi et al., 2017).

Liquid organic fertilizer is very useful for increasing agricultural production both in quality and quantity, reducing environmental pollution, and sustainably improving land quality. In addition, liquid organic fertilizer contains complete macro and micronutrients. Although the nutrients are in small quantities, all of their macro and micro nutrient needs can be met (Asnur & Kurniasih, 2018).

Liquid organic fertilizer in its application can be used as basic fertilizer and fertilizer after plants grow. Liquid organic fertilizer can improve the physical, chemical and biological properties of the soil, help increase crop production, improve the quality of plant products, reduce the use of inorganic fertilizers and as an alternative to manure (Parman, 2007). Research in China showed that the average yield of plants using liquid organic fertilizers increased by 11% compared to other organic fertilizers (Riwandi et al., 2017).

One of the agricultural wastes that can be used as raw material for organic fertilizer is pineapple peel. Pineapple producers in West Kalimantan come from Kubu Raya Regency. Pineapple production in Kab. Kubu Raya in 2017 amounted to 13,298 tons of the total pineapple production in West Kalimantan which totalled 34,951 tons (Badan Pusat Statistik, 2018). Pineapple in its utilised, as an industrial raw material in the processing of pineapple juice and consumed in the form of fresh fruit. However, in its utilization, it produces waste in the form of pineapple skin that is not utilized. The composition of pineapple waste on average reaches 40%, of which 5% is the scales (skin).

An alternative that can be done in the utilization of waste is that it can be used as a basic material for making liquid organic fertilizer. Based on the nutritional content, it turns out that pineapple skin contains carbohydrates and sugars that are quite high. Pineapple skin contains 81.72% water; 20.87% crude fibre; 17.53% carbohydrates; 4.41% protein and 13.65% reducing sugar. In the form of POC pineapple peel contains P 23.63 ppm, K 08.25 ppm, N 01.27%, Ca 27.55 ppm, Mg 137.25 ppm, Na 79.52 ppm, Na 79. 52 ppm, Fe 1 .27 ppm, Mn 28.75 ppm, Cu 0.17 ppm, Zn 0.53 ppm and Organic C 3.10% (Susi et al., 2018).

The application of this liquid organic fertilizer can be a solution for Ultisol soils which are classified as soils that are poor in organic matter and are marginal lands. A study Nurcholis et al. (2020) on the cultivation of long bean plants by utilizing pineapple peel as a liquid organic fertilizer by giving the best results at a concentration of 450 ml/l of water for the growth and production of long bean plants. The application of liquid organic fertilizer must pay attention to the concentration or dose applied to plants. This is different from the results of research Khoiriyah and Nugroho (2018) which states that POC treatment with a concentration of 10 ml/l with 2 applications (5 ml each). Suryani et al. (2022), the dose of liquid organic fertilizer of pineapple plant waste 75 ml/l was the treatment that gave the best results in improving the growth of sweet corn plants in red-yellow podsolic soil.

Thus, it is necessary to research the use of liquid organic fertilizer derived from pineapple peel organic waste which is applied to Ultisol soil. The research goal was to determine the best treatment dose of pineapple waste as liquid organic fertilizer and its effect on ultisol soil fertility.

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METHOD

The research was conducted at the Faculty of Agriculture, Panca Bhakti University, Jl. Komyos Sudarso Pontianak has it been done June 2022-August 2022. The tools used were a polybag, loose, hoe, plastic drum, knife/machete, and tarpaulin. The material used were pineapple waste, clean water, sugar, EM4, and ultisol soil.

The study used a completely randomized design (CRD), with doses of liquid organic fertilizer from pineapple plant waste P_0 is control, P_1 is 15 ml/l water, P_2 is 20 ml/l water, P_3 is 25 ml/l water, P_4 is 30 ml/l water, P_5 is 35 ml/l water, P_6 is 40 ml/l water, P_7 is 45 ml/l water, P_8 is 50 ml/l water. The parameters analyzed were: soil pH, soil organic C, total N, available P, soil K, Bulk Density (BD), soil pores, and soil moisture content. Data were analyzed using ANOVA, which showed a significant difference followed by an Honest Significant Difference (HSD) Test at the 5% level.

This research began by making liquid organic fertilizer by adding 12 kg of pineapple peel waste that had been mashed, then mixing 3.6 kg of granulated sugar, adding 1800 ml of EM4 and 12 L of water into a plastic drum, then stirred well so that it was well mixed, then tightly covered with plastic and allowed to stand for 2 weeks until the ingredients ferment well. After 2 weeks the solution was marked by the presence of water drops closed in the fermentation container, the solution smelled, and there was a layer of white fungus on the surface of the solution and on the walls of the container, the liquid organic fertilizer was filtered clean and stored in a closed bottle.

RESULTS AND DISCUSSION

Chemical Composition Analysis of Liquid Organic Fertilizer

The results of the chemical composition analysis carried out on Liquid Organic Fertilizer (POC) pineapple plant waste can be seen in Table 1.

Table 1
Analysis of POC Chemical Composition of Pineapple Waste

Analysis Parameters			Value
pH H_2O	-	-	3.06
Organic Carbon	C	(%)	2.77
Total Nitrogen	N	(%)	0.02
C/N ratio			138.50
Extraction H_2SO_4 H H_2O_2			
Phosphor	P	(ppm)	9.15
Potasium	K	(ppm)	1099.93
Calcium	Ca	(ppm)	108.66
Magnesium	Mg	(ppm)	184.45
Iron	Fe	(ppm)	10.09
Mangan	Mg	(ppm)	2.97
Copper	Cu	(ppm)	9.63
Zink	Zn	(ppm)	15.06

Soil Analysis Before Treatment

Ultisol Soil Analysis Before Treatment can be seen in Table 2.

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Table 2
Ultisol Soil Analysis Before Treatment

Analysis Parameters		Value
pH H_2O	-	4.89
pH KCl	-	4.67
Organic-C	(%)	0.59
Total Nitrogen	(%)	0.08
Extraction Bray I		
P_2O_5	(ppm)	7.26
Extraction NH_4 OAC 1N pH : 7		
Calcium	(cmol $(^+)$ kg^{-1})	0.42
Magnesium	(cmol $(^+)$ kg^{-1})	0.19
Potassium	(cmol $(^+)$ kg^{-1})	0.23
Natrium	(cmol $(^+)$ kg^{-1})	0.33
Cation Exchange Capacity (CEC)	(cmol $(^+)$ kg^{-1})	7.27
Alkali Saturation	(%)	16.09
Extraction KCl 1 N		
Aluminum	(cmol $(^+)$ kg^{-1})	0.27
Hydrogen	(cmol $(^+)$ kg^{-1})	0.10

Ultisol Soil Analysis After Treatment

1) Soil pH

The results of the analysis of variance showed that the application of POC to Ultisol soil had a significant effect on soil pH. The effect of giving POC on the soil pH value is presented in Table 3.

Table 3
Effect of Liquid Organic Fertilizer on Ultisol soil pH

Dose POC	**Average pH**	**Criteria**
P_0 (0 ml/l)	4.89^a	Acid
P_1 (15 ml/l)	5.36^{ab}	Acid
P_2 (20 ml/l)	5.82^{ab}	Little Acid
P_3 (25 ml/l)	5.91^{ab}	Little Acid
P_4 (30 ml/l)	6.00^{ab}	Little Acid
P_5 (35 ml/l)	5.92^{ab}	Little Acid
P_6 (40 ml/l)	5.83^{ab}	Little Acid
P_7 (45 ml/l)	6.07^{ab}	Little Acid
P_8 (50 ml/l)	6.31^b	Little Acid

The application of liquid fertilizer from pineapple plant waste had a significant effect compared to no POC treatment on ultisol soil. The application of organic fertilizer gave the best treatment, namely the P8 treatment with soil pH reaching 6.31. Soil pH parameters can be an indicator of the decomposition process of organic fertilizers. During the decomposition stage, organic acids are formed. This acidic condition will encourage fungal growth and will decompose lignin and cellulose in organic fertilizers (Aidismen, 2014). These organic acids will become neutral, usually reaching a pH of 6-8. According to Sutedjo (2002), the pH value of the soil can determine whether or not the ions are easily absorbed by plants. Generally, nutrients are absorbed by plant roots at a neutral soil pH of 6-7 because at that pH most are not easily soluble in air. In general, macro-nutrients such as N, P, K and Mg, Ca and S are more widely available in soil solutions that have a soil pH of 6 -7.5.

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2) %C soil organic

The results of the analysis of variance showed that the application of POC on Ultisol soil had a significant effect on % C organic in Ultisol soil. The treatment gave the best results at a dose of 50 ml/l, with %C organic reaching 1.35%. The effect of giving POC on %C organic soil is presented in Table 4.

Table 4
Effect of Liquid Organic Fertilizer on %C Organic Soil Ultisol

Dose POC	%C organic	Criteria
P_0 (0 ml/l)	0.59^{bc}	very low
P_1 (15 ml/l)	0.74^{bc}	very low
P_2 (20 ml/l)	0.88^{c}	very low
P_3 (25 ml/l)	0.71^{bc}	very low
P_4 (30 ml/l)	0.53^{bc}	very low
P_5 (35 ml/l)	0.33^{ab}	very low
P_6 (40 ml/l)	0.12^{a}	very low
P_7 (45 ml/l)	0.74^{bc}	very low
P_8 (50 ml/l)	1.35^{d}	low

According to Afandi et al. (2015), carbon is a food source of soil microorganisms, so the presence of organic C in the soil will stimulate the activity of microorganisms, increase the decomposition process of POC in the soil and also reactions that require the assistance of microorganisms, such as nitrogen fixation. Wahyudi (2009) stated that the increase in C-Organic is caused by carbon (C) which is the main constituent of the organic material itself. The addition of organic matter is directly proportional to the increase in soil C-Organic. Thus, the application of liquid organic fertilizer from pineapple plant waste material can be a source of organic matter and the application of POC to the soil will increase the organic matter content in the soil. Although the effect of organic fertilizer showed a very significant overall effect on soil samples, it showed that the application of liquid organic fertilizer had not been effective in increasing %C organic which was relatively low.

3) %N Total Soil

The effect of applying liquid organic fertilizer from pineapple plant waste material has a significant effect on the total %N in Ultisol soil, which is presented in Table 5.

Table 5
Effect of Liquid Organic Fertilizer Application on Total %N of Ultisol Soil

Dose POC	%N total soil	Criteria
P_0 (0 ml/l)	$0,08^{ab}$	very low
P_1 (15 ml/l)	$0,1^{ab}$	low
P_2 (20 ml/l)	$0,11^{ab}$	low
P_3 (25 ml/l)	$0,1^{ab}$	low
P_4 (30 ml/l)	$0,08^{ab}$	very low
P_5 (35 ml/l)	$0,06^{ab}$	very low
P_6 (40 ml/l)	$0,04^{a}$	very low
P_7 (45 ml/l)	$0,1^{ab}$	Low
P_8 (50 ml/l)	$0,16^{b}$	Low

Based on the results of research that has been done that the application of POC pineapple peel waste increases the availability of N nutrients, although it is not yet effective because the total %N content of the soil is relatively low. The treatment that gave the highest %N of total soil was that nitrogen was easily lost by evaporation and carried by water through percolation. According to (Asnur & Kurniasih, 2018), with the provision of organic fertilizer, these nutrients will be bound by organic matter so that

they can be available to plants. According to (Sarwono, 2015) Nitrogen is the main component of various important substances in plants. About 40-50% protoplasm content. Nitrogen in the soil is needed by plants in large quantities, especially in the vegetative growth phase. Entering the generative growth, the need for nitrogen is decreasing.

4) C/N Ratio

The results of the analysis of variance showed that the application of liquid organic fertilizer from pineapple plant waste had no significant effect on the C/N ratio in Ultisol soil. The effect of giving POC on %C organic soil is presented in Table 6.

Table 6
Effect of Liquid Organic Fertilizer on C/N Soil Ultisol Rasio Ratio

Dose POC	C/N ratio	Criteria
P_0 (0 ml/l)	7.3^{a}	low
P_1 (15 ml/l)	7.4^{ab}	low
P_2 (20 ml/l)	8^{ab}	middle
P_3 (25 ml/l)	7.1^{ab}	low
P_4 (30 ml/l)	6.6^{ab}	low
P_5 (35 ml/l)	5.5^{ab}	low
P_6 (40 ml/l)	3^{a}	Very low
P_7 (45 ml/l)	7.4^{bc}	low
P_8 (50 ml/l)	8.44^{c}	middle

Based on these results, the application of POC pineapple peel waste can reduce the C/N ratio in the soil. Where the quality of organic fertilizers is determined by the magnitude of the ratio between the amount of carbon and nitrogen (C/N ratio). If the C/N ratio is high, it means that the ingredients for organic fertilizer have not been completely decomposed. Based on the results of this study, the application of liquid organic fertilizer that was incubated for 2 weeks had a significant effect, with the best treatment being the POC treatment of pineapple plant waste at a dose of 40 ml/l with a C/N ratio of 3 (very low). Riwandi et al. (2017), if the C/N ratio has reached 12 – 20, it means that the nutrients have been released through the mineralization process so that they can be used by plants. In addition, the determining factor for the value of the C/N ratio is the length of fermentation. In this study, the length of fermentation was carried out within 2 weeks. According to Hartatik and Setyorini (2012), the higher the C/N ratio, the longer the process of overhauling organic matter.

5) P Content in Soil

Based on the results of the analysis of variance, the application of liquid organic fertilizer from pineapple plant waste had a significant effect on the P content in Ultisol soil. The effect of POC application on the P content in the soil is presented in Table 7.

Table 7
Effect of Liquid Organic Fertilizer on P Content in Ultisol Soil

Dose POC	P content in soil (ppm)	Criteria
P_0 (0 ml/l)	7.26^{a}	very low
P_1 (15 ml/l)	17.53^{b}	middle
P_2 (20 ml/l)	27.8^{c}	high
P_3 (25 ml/l)	33.95^{d}	high
P_4 (30 ml/l)	40.09^{e}	very high
P_5 (35 ml/l)	37.33^{de}	high
P_6 (40 ml/l)	34.56^{d}	very high
P_7 (45 ml/l)	46.67^{f}	very high
P_8 (50 ml/l)	58.78^{f}	very high

These results indicate that the application of POC pineapple peel waste has a significant effect on the P content in the soil. The best treatment was obtained in the treatment of giving pineapple plant waste liquid organic fertilizer with a dose of 50 ml/l with a P content in the soil of 58.78 ppm with a very high category. The availability of phosphorus is closely related to soil pH. Nutrients are easily absorbed by plant roots at a neutral soil pH (pH 6 – 7) because most nutrients are easily soluble in water. According to Novizan (2005), some phosphorus is chemically bound by other nutrients so compounds are difficult to dissolve in water. Phosphorus is one of the essential elements that have an important role in plant growth. The role of element P is in terms of energy storage and transfer as well as biochemical reactions such as; ion transfer, osmotic action, photosynthetic reactions, and glycolysis. Phosphorus is a constituent of every cell, and plays an active role in transferring cell energy, converting carbohydrates and increasing the work efficiency of chloroplasts. Yuliarti (2009), suggested that phosphorus is useful for forming roots, as a basic material for protein, helping the process of assimilation and respiration, accelerating fruit ageing, and increasing the yield of grains and tubers.

6) K content in the soil

The results of the analysis of variance in the application of liquid organic fertilizer from pineapple plant waste had a significant effect on the K content in Ultisol soil, which is presented in Table 8.

Table 8
Effect of Liquid Organic Fertilizer on K Content in Ultisol Soil

Dose POC	K (meq/100 g tanah)	Criteria
P_0 (0 ml/l)	0.23^{ab}	low
P_1 (15 ml/l)	0.2^{ab}	low
P_2 (20 ml/l)	0.16^{a}	low
P_3 (25 ml/l)	0.19^{ab}	low
P_4 (30 ml/l)	0.22^{ab}	low
P_5 (35 ml/l)	0.2^{ab}	low
P_6 (40 ml/l)	0.18^{ab}	low
P_7 (45 ml/l)	0.21^{ab}	low
P_8 (50 ml/l)	0.24^{b}	low

Potassium is easily soluble in water. The high exchangeable potassium content is about 4% of the total K contained in the soil. Based on soil chemical criteria, the application of liquid organic fertilizer from pineapple plant waste has a low K content in ultisol soils. The presence of potassium in the soil is about 90-98% in the form of primary minerals that cannot be absorbed by plants. About 1 – 10% is trapped in the colloidal soil because potassium is positively charged. Najiyati et al. (2005) stated that potassium functions to enhance drought resistance and to form proteins and carbohydrates.

CONCLUSIONS

Liquid organic fertilizer from pineapple plant waste could increase ultisol soil fertility, especially on soil pH, %C organic, %N total soil, C/N ratio, and content of P and K elements in the soil. The dose treatment of pineapple plant waste liquid organic fertilizer 50 ml/l was the treatment that gave the best results on the parameters of soil pH, %C organic, %N total soil, C/N ratio, and P and K elements in the soil. Thus, liquid organic fertilizer from pineapple peel waste material can be recommended as an alternative fertilizer that can be applied to plants at a dose of 50 ml/l.

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