Response of Growth and Yield of Soybean (*Glycine max* l. Merril) to the Method and Dose of Leachate Liquid Organic Fertilizer Application

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ABSTRACT

The high demand for soybeans cannot yet be met by domestic production. Thus, a way to increase soybean production is necessary, one of which is to use liquid organic fertilizer derived from landfill leachate. This study aimed to examine the application method of liquid organic fertilizer (LOF) from landfill leachate to the soil and leaves and to determine the concentration giving the best growth and yield of soybean plants. The study was a field-research arranged in a completely randomized design (CRD) consisting of six treatments and four replications, which was carried out in a greenhouse. The treatments include A (0 LOF/L water), B (20 ml LOF/L water), C (30 ml LOF/L water, D (40 ml LOF/L water), E (50 ml LOF/L water) and F (60 ml LOF/L water). The liquid organic fertilizer was applied through the soil and leaves at a dose according to the treatments. The results showed that the application of liquid organic fertilizer from landfill leachate was better applied to the soil than to the leaves. The liquid organic fertilizer given had a significant effect on the leaf area (cm2), crop weight (g), and plant seed weight (g), but not on the plant height (cm) and stem diameter (cm). Liquid organic fertilizer application is better given to the soil than to the leaves based on the independent T test. The liquid organic fertilizer from landfill leachate at a concentration of 40 ml/L of water had the best effect on the growth and yield of soybean plants.

Keywords: soil application, foliar application, liquid fertilizer, soybean

ABSTRAK

Tingginya kebutuhan kedelai belum dapat dipenuhi oleh produksi dalam negeri sehingga perlu cara untuk meningkatkannya. Salah satu cara untuk meningkatkan produksi kedelai adalah menggunakan pupuk organik cair yang berasal dari lindi tempat pembuangan akhir sampah (TPA). Tujuan penelitian ini untuk mengetahui cara aplikasi POC dari lindi TPA yang diberikan ke tanah dan ke daun serta untuk mengetahui takaran POC dari lindi TPA yang terbaik terhadap pertumbuhan dan hasil tanaman kedelai. Rancangan yang digunakan adalah Rancangan Acak Lengkap (RAL) dengan 6 perlakuan dan 4 ulangan, yang dilaksanakan di rumah kaca. Perlakuannya adalah: A (0 POC/L air), B (20 ml POC/L air), C (30 ml POC/ L air, D (40 ml POC/L air), E (50 ml POC/ L air) dan F (60 ml POC/L air). Metode aplikasi POC diberikan melalui tanah dan daun dengan dosis sesuai perlakuan. Hasil penelitian menunjukkan bahwa pemberian POC dari lindi TPA lebih baik diberikan ke tanah dibandingkan melalui daun untuk semua pengamatan. Pemberian POC tidak berpengaruh nyata terhadap tinggi tanaman (cm) dan diameter batang (cm), namun berpengaruh nyata terhadap luas daun (cm^2), berat brangkas tanaman (g), dan berat biji tanaman (g). Aplikasi POC lebih baik diberikan ke tanah dibandingkan melalui daun berdasarkan uji independent T test. Konsentrasi 40 ml/L air merupakan aplikasi POC dari lindi TPA terbaik terhadap pertumbuhan dan hasil tanaman kedelai.

Kata Kunci: POC, aplikasi tanah, aplikasi daun, kedelai

INTRODUCTION

Soybean is consumed by Indonesian people as a cheap source of protein to meet their nutritional needs. However, domestic soybean production has not been able to meet the consumption needs of the community. Based on the Badan Pusat Statistik (2018), Indonesian soybean production reached only 982,598 tons, with total imports of 2.6 million tons.

There are many ways to increase soybean production, one of which is fertilization using liquid organic fertilizer. The purpose of fertilization is to improve the level of soil fertility so that plants get enough nutrients to improve the quality and quantity of their growth and development (Aisyah et al., 2008). Liquid organic fertilizer can be given through roots (soil) and leaves. According to Hadisuwito (2012), liquid organic fertilizer is a solution of the decomposition of organic materials derived from plant residues, animal, and human wastes containing more than one element. This fertilizer has advantages as it provides available nutrients more quickly, does not damage the soil and plants

and contains microorganisms.

The application of liquid organic fertilizer to the soil has several benefits. According to Subowo (2010), aside from being a source of nutrients for plants, organic fertilizer applied to the soil improves the chemical, physical and biological fertility of the soil. The content of organic matter is also a source of nutrition for soil microorganisms, which can increase soil fertility. Meanwhile, the application of liquid organic fertilizer to the leaves enables the macro and micronutrients to be dissolved quickly, making them easier to be absorbed by plants. The application of liquid organic fertilizer through soil and leaves has advantages and disadvantages, but there is no information related to the best way to provide LOF from landfill leachate.

According to Hasnelly et al. (2018), liquid organic fertilizer from landfill leachate has nutrient content of 2.73% N, 1.25% P, 1.21% K, 0.19 ppm S, 11.59% Ca, 0.21% Mg, 0.20% Na, 1.84% Mn, and 1.15% B, with a pH of 7.32, which is enriched with *Bacillus* sp, *Pseudomonas flourescens,* *Azotobachter,* and *Azospirillum*.

Microorganisms contained in liquid organic fertilizer can play a role in increasing the amount and availability of nutrients absorbed by plants to increase plant growth and yield. According to Sharma (2002), the activity of microorganisms can be beneficial in increasing the content of several nutrients in the soil, increasing the availability of nutrients in the soil, increasing the efficiency of nutrient absorption, suppressing pathogenic soil borne microbes through competitive interactions, producing growth regulators that can increase the development of plant root systems, and increasing the activity of heterotrophic soil microorganisms that are beneficial through the application of organic matter. According to Parmar et al. (2016); Gupta et al. (2015); Saharan and Nehra (2011), *Bacillus*, *Pseudomonas* and *Rhizobium* bacteria can increase the solubility and availability of phosphate in the soil, increase potassium availability and be applied separately or in combination with other root microbes.

Puspita et al. (2016) concluded that the administration of 14 ml/L leachate-based liquid organic fertilizer on celery plants affected the height and number of leaves of the plant. The research results of Sinuraya et al. (2015) suggested that the administration of liquid organic fertilizer at a concentration of 40 ml / L resulted in the highest shoot and root dry weight, seed dry weight / sample, and dry weight of 100 seeds. However, the best application method of LOF from landfill leachate along with the exact dose for soybean plants has not been reported. Thus, this study aimed to examine the response of plants to the application of liquid organic fertilizer from landfill leachate to soil and leaves and to determine the best concentration of growth and yield of soybean plants in the greenhouse.

MATERIALS AND METHODS

The research was conducted at the Lubuk Tenam Muara Bungo Seed and Horticultural Institute from 30 January 2019 to 20 May 2019. The materials used in this research were soybean seeds cv. Anjasmoro, liquid organic fertilizer from Gamut Muara Bungo landfill leachate, urea fertilizer, TSP, KCl, dolomite, biochar, microorganisms (*Bacillus* sp, *Pseudomonas flourescens*, *Azotobachter*, and *Azospirillum*) and Ultisol soil.

The study is a field-research arranged in a Completely Randomized Design (CRD) consisting of six treatments and four replications within each treatment. This research consisted of two parts, in which Part I was the application of liquid organic fertilizer to the soil, and Part II was the application of liquid organic fertilizer application by spraying to the leaves. Meanwhile, the treatments were the doses of the liquid organic fertilizers, including 0

(A), 20 (B), 30 (C), 40 (D), 50 (E), and 60 (F) ml liquid organic fertilizer/L water.

The planting media used were Ultisol soil at a thickness of 20 cm if the layer was smoothed and sifted. The soil was given 1.1 tons/ha dolomite lime, which is equivalent to 5.5 g/polybag (2 x Al-dd with Al-dd 0.3 me/100g). Furthermore, the soil was put into polybags as much as 10 kg / polybag. After the soil was incubated for 2 weeks, the soybean seeds were planted in the middle of the polybag, with two seeds in each polybag. Watering was done regularly, and after 2 weeks, only one seedling with the best growth was left in each polybag.

Landfill leachate from Gamut Muara Bungo was screened. Subsequently, biochar, which was mashed and filtered with a 140-mesh size sieve, was added to 80 g/L of leachate, then stirred and filtered after three hours. Microorganisms (*Bacillus sp*, *Pseudomonas flourescens*, *Azotobachter*, and *Azospirillum*), each as much as 1.5 ml with a population of 10^8, were then added. The liquid organic fertilizer from the landfill leachate was given every four days to the soil (splashed directly onto the ground) and leaves (sprayed all over the plant leaves) in accordance with the treatment, starting from three weeks after planting until three weeks before harvest. Watering was done in the morning and evening using water can. The components of growth and yields observed were plant height (cm), leaf area (cm^2), stem diameter (cm), crop weight (g), and weight of soybean seeds (g), The data obtained were analyzed using analysis of variance (ANOVA) and tested using the Duncan New Multiple Range Test (DNMRT) at 5% level. To compare the plant responses to the application methods, which were through the leaves and soil, an independent sample T test was carried out using SPSS 16.0.

RESULTS AND DISCUSSION

The liquid organic fertilizer concentration of the landfill leachate, applied to both soil and leaves, did not significantly affect plant height and stem diameter of soybean plants (Table 1 and 2). This is because soybean plants have nodules that are able to fix nitrogen from the air so that the plants can grow well. According to Pasaribu et al. (1989), nitrogen source needed by soybean plants comes from the soil and N atmosphere through symbiosis with Rhizobium bacteria. Rhizobium forms root nodules at the roots of soybean plants and tethers N from the air, which then used by soybean plants to meet the N requirements. About 50-75% of the total plant need for nitrogen can be met in effective fixation.

Leaf area and plant dry weight are not only

Table 1. Effects of liquid organic fertilizer (LOF) from landfill leachate application through leaves on the plant height, stem diameter, leaf area, and crop weight

Treatment	LOF application through leaf			
	Plant height (cm)	Stem diameter (cm)	Leaf area (cm2)	Crop weight (g)
A (0 ml LOF)	65.25 a	0.56 a	1897.46 a	18.26 a
B (20 ml LOF /L water)	63.75 a	0.56 a	2312.68 bc	21.15 b
C (30 ml LOF /L water)	63.75 a	0.56 a	2388.53 c	25.22 c
D (40 ml LOF /L water)	64.25 a	0.56 a	2733.06 d	28.04 d
E (50 ml LOF /L water)	65.38 a	0.55 a	2126.73 abc	23.17 bc
F (60 ml LOF /L water)	66.00 a	0.56 a	2091.98 ab	21.17 b
CD (%)	8.07	6.57	10.09	6.32

Remarks: Means followed by the same letters in the same column are not significantly different based on DMRT at α 5%.

Table 2. Effects of liquid organic fertilizer landfill leachate application through soil on the plant height, stem diameter, leaf area, and crop weight

Treatment	LOF application through soil			
	Plant height (cm)	Stem diameter (cm)	Leaf area (cm2)	Crop weight (g)
A (0 ml LOF)	70.69 a	0.69 a	2416.45 a	25.84 a
B (20 ml LOF /L water)	69.25 a	0.70 a	2497.02 a	29.22 b
C (30 ml LOF /L water)	69.76 a	0.70 a	2779.32 a	32.22 c
D (40 ml LOF /L water)	70.53 a	0.70 a	3795.16 b	35.21 d
E (50 ml LOF /L water)	71.45 a	0.70 a	2697.51 a	30.94 bc
F (60 ml LOF /L water)	72.31 a	0.70 a	2460.37 a	30.74 bc
CD (%)	6.1	4.67	12.23	3.89

Remarks: Means followed by the same letters in the same column are not significantly different based on DMRT at α 5%.

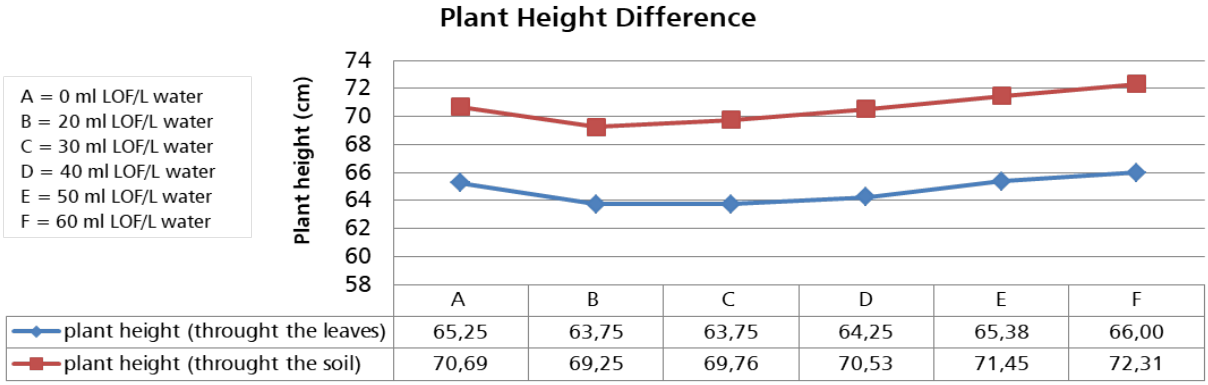
determined by the availability of nitrogen but are also influenced by other factors. The increase in leaf area is influenced by the supply of nutrients for plants, temperature, humidity, soil acidity, biotic factors, and radiation energy. The large leaf area causes the net assimilation rate to increase, thereby increasing the relative growth rate and dry weight of the plant (Gardner et al., 1991). Increased nitrogen uptake by plants is one of the factors that affect the increase in plant dry weight (Mengel and Kirkby, 2001). Sudaryani and Sugiharti (1989) added that the production of plant dry matter was influenced by the reception of sunlight and the uptake of carbon dioxide and water in plants.

However, plant height and stem diameter of soybean plants given liquid fertilizer through soil (Tabel 2) are higher than those given through leaves (Table 1). This is because the liquid organic fertilizer given to soil contains microorganisms, which can increase the availability and nutrient uptake for plants. Meanwhile, the activity of microorganisms the liquid organic fertilizer given to the leaves is not active. According to Hasnelly et al. (2018), liquid organic fertilizer from landfill leachate was enriched with *Bacillus* sp, *Pseudomonas flourescens*, *Azotobachter*, and *Azospirillum* bacteria. According to Simarmata (2013), microorganisms are able to dissolve nutrients and increase nutrient availability for plants. In general, liquid organic fertilizer application through the soil showed higher values in all variables (Table 2) compared to the application through the leaves (Table 1).

Based on the results of the t test, it was found that the liquid organic fertilizer application to the soil resulted in the significantly higher values of plant height, stem diameter, leaf area and weight of plant stem compared to the liquid organic fertilizer application through the leaves (Figures 1, 2, 3, and 4).

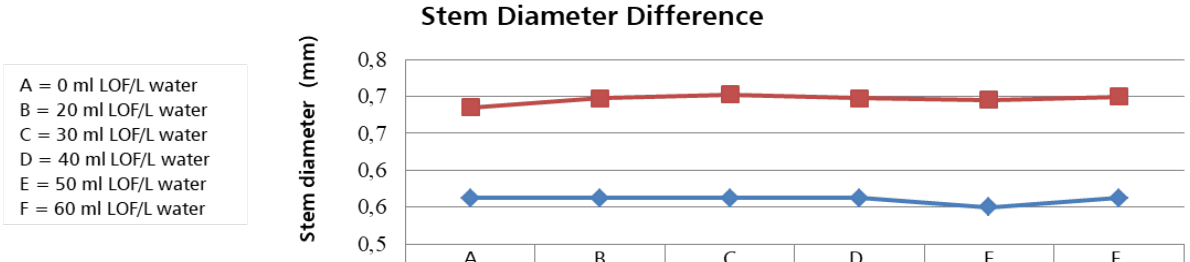
The leaf area of the plants given by LOF through the soil showed a higher value compared to those given LOF through the leaves (Table 1), with the best treatment of 40 ml LOF / L water (D). Likewise, the application of LOF through the soil (Table 2) significantly increased crop weight compared to the application through leaves (Table 1). However, the increasing LOF concentration resulted in a decrease in leaf area and crop weight of the plant. This shows that the nutrient needs of plants have been met at a dose of 40 ml / L of water.

At a concentration of 40 ml LOF / L water, nutrient balance for plants has been achieved, resulting in the better growth compared to other concentrations. According to Buckman and Brady (1982), the adequacy and availability of nutrients for plants depend on the type and amount of



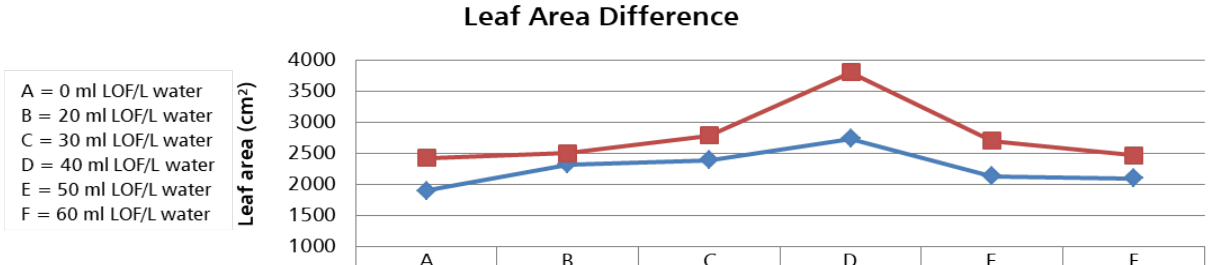
	A	B	C	D	E	F
plant height (throught the leaves)	65,25	63,75	63,75	64,25	65,38	66,00
plant height (throught the soil)	70,69	69,25	69,76	70,53	71,45	72,31

Figure 1. Plant height as affected by LOF application to the soil and leaves



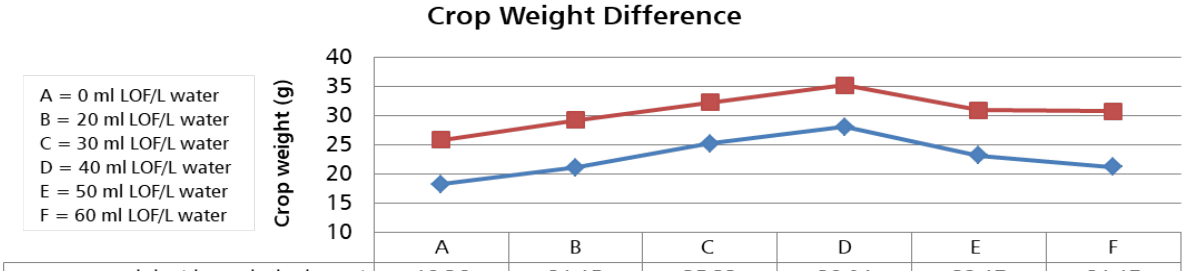
	A	B	C	D	E	F
stem diameter (through the leaves)	0,56	0,56	0,56	0,56	0,55	0,56
stem diameter (through the soil)	0,69	0,70	0,70	0,70	0,70	0,70

Figure 2. Stem diameter as affected by LOF application to the soil and leaves



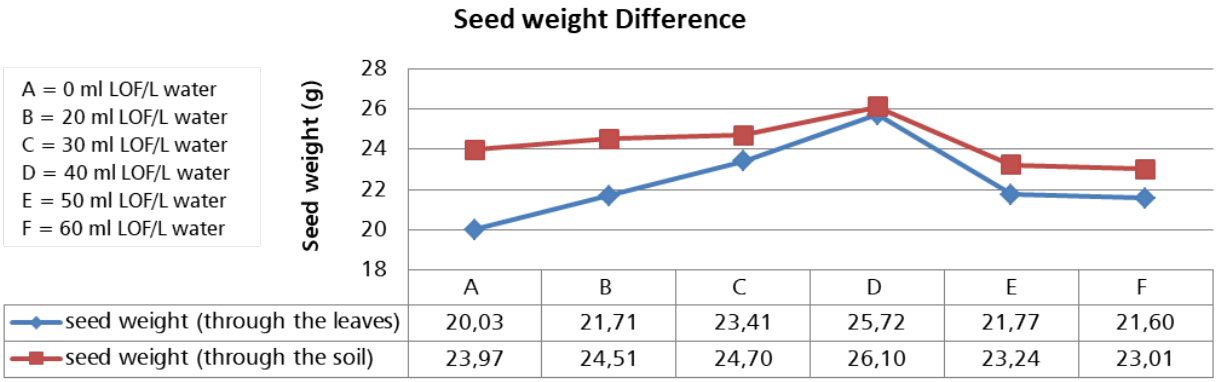
	A	B	C	D	E	F
leaf area (through the leaves)	1897,46	2312,68	2388,53	2733,06	2126,73	2091,98
leaf area (through the soil)	2416,45	2497,02	2779,32	3795,16	2697,51	2460,37

Figure 3. Leaf area as affected by LOF application to the soil and leaves



	A	B	C	D	E	F
crop weight (through the leaves)	18,26	21,15	25,22	28,04	23,17	21,17
crop weight (throug the soil)	25,84	29,22	32,22	35,21	30,94	30,74

Figure 4. Crop weight as affected by LOF application to the soil and leaves



	A	B	C	D	E	F
seed weight (through the leaves)	20,03	21,71	23,41	25,72	21,77	21,60
seed weight (through the soil)	23,97	24,51	24,70	26,10	23,24	23,01

Figure 5. Seed weight as affected by LOF application to soil and leaves

nutrients available in the soil, which are in an appropriate balance for plant growth. As a result of the availability of nutrients needed by plants, it will support better and optimal growth.

According to Wibowo et al. (2012), leaf area illustrates the ongoing process of photosynthesis. The greater the leaf area, the higher the photosynthesis rate, thereby resulting in higher amount of photosynthate the leaves. Leaf area is also strongly influenced by nutrient availability. Salisbury and Ross (1995) stated that absorption of nutrients, especially nitrogen, influenced leaf area formation.

The application of liquid organic fertilizer from landfill leachate through soil (Table 2) is better than the application through leaves (Table 1). This shows that the role of microorganisms contained in the liquid organic fertilizer is quite influential in increasing the availability and absorption of nutrients for plants. Nasahi (2010) stated that the availability of nutrients was closely related to the microbial activity involved.

The application of liquid organic fertilizer from landfill leachate significantly affected the weight of soybean seeds, applied to both the leaves and the soil, with the best concentration of 40 ml LOF / L water (Table 3). According to Nurhayati (2011), Rhizobium is able to increase nitrogen fixation and seed yield, which can reduce the use of artificial fertilizers and increase fertilizer efficiency. Furthermore, the results of the study by Sinuraya et al. (2015) suggested that the method of giving liquid organic fertilizer by watering tend to increase the yield of soybean crop production in all observations.

Table 3. Effects of liquid organic fertilizer from landfill leachate application through leaves and soil on the plant seed weight

Treatment	Seed weight (g) (application through the leaves)	Seed weight (g) (application through the soil)
A (0 ml LOF)	20.03 a	23.97 ab
B (20 ml LOF /L water)	21.71 ab	24.51 ab
C (30 ml LOF /L water)	23.41 bc	24.70 bc
D (40 ml LOF /L water)	25.72 c	26.10 c
E (50 ml LOF /L water)	21.77 ab	23.24 ab
F (60 ml LOF /L water)	21.60 b	23.01 a
CD (%)	7.84	3.97

Remarks: Means followed by the same letters in the same column are not significantly different based on DMRT at □ 5%.

The different weight of seeds is inseparable from the availability of nutrients at the time of seed formation. According to Taufik et al. (2010), the fulfillment of nutrient for plants causes the metabolism to run optimally so that the formation of protein, carbohydrates and starches is not inhibited. As a result, the accumulation of metabolic material in seed formation will increase, thereby producing seeds with maximum size and weight.

CONCLUSION

Liquid organic fertilizer from landfill leachate is better given to the soil than to the leaves, indicated by the higher values in plant height, stem diameter, and leaf area.

The effect of liquid organic fertilizer from landfill leachate application on the growth and yield of soybean plants in the greenhouse was best at a concentration of 40 ml LOF / L water.

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