

Study of Liquid Organic Fertilizer Application with Empty Palm Oil Bunch Ash Nano on Soyabean (*Glycine max*)

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ABSTRACT

Proper fertilization is an effort to increase soybean production. This study aimed to examine the effect of Liquid Organic Fertilizer (LOF) application enriched with Empty Palm Oil Bunch (EPOB) Ash Nano and determine the optimal concentration on soybean growth and yield. This research was carried out at the Experimental Field of the Faculty of Agriculture, Universitas Muhammadiyah Yogyakarta. This research was conducted using a single factor experimental method which was arranged in a Completely Randomized Design. The treatments tested were rabbit urine LOF; Rabbit urine LOF + EPOB Ash Nano 1%; Rabbit urine LOF + EPOB Ash Nano 2%; Rabbit urine LOF + EPOB Ash Nano 3% and rabbit urine LOF + EPOB Ash Nano 4%. The results showed that the application of rabbit urine LOF + EPOB Ash Nano 4% could increase soybean growth and was able to increase the dry weight of 100 seeds. Application of rabbit urine LOF enriched with EPOB Ash Nano can save nitrogen nutrient fulfillment for soybeans by up to half the recommended dose.

Keywords: Empty Palm Oil Bunch (EPOB), Liquid Organic Fertilizer (LOF), Nanotechnology, Rabbit urine, Soybean

INTRODUCTION

Soybean (*Glycine max* L.) is one of the staple foods in Indonesia, second only to rice and corn. Soybeans are generally consumed in the form of processed foods such as tofu, tempeh, soy milk, and many other snacks [1]. One of the promising national soybean varieties that has the potential to be used as raw material for the soybean processed food industry is the Anjasmoro variety. Anjasmoro soybean variety is a type of white soybean with large seed size and does not easily break [2]. The

demand for soybeans is approximately 2.3 million tons of dry beans, but production capacity in 2018 was only 982,598 tons with an area of 680,373 hectares and a productivity of 1.44 tons/hectare, while the potential yield of Anjasmoro soybeans is 2.5 tons/hectare. To meet soybean needs, the government still imports soybeans, which amounted to 2,585,809.1 tons in 2018 and increased to 2,670,086.4 tons with the growing population of Indonesia [3].

Efforts to increase soybean production require new improvements in soybean farming. One innovation that can be implemented is proper fertilization. Foliar fertilization is an effective method because nutrients in the fertilizer are easily absorbed into the plant thru the stomata [4]. One source of organic fertilizer that can be used for foliar spraying is liquid organic fertilizer from rabbit urine waste [5]. Based on research conducted by the Animal Research Institute (Balitnak) in Ciawi, Bogor Regency, in 2005, rabbit urine contains 2.72% N, 1.1% P, and 0.5% K, compared to the manure and urine of other livestock such as cows, goats, buffalo, horses, pigs, and even chickens [6]. Soybean plants require significant amounts of N, P, and K to stimulate

MATERIAL AND METHOD

The materials used include palm oil empty fruit bunch ash, Anjasmore variety soybean seeds, rabbit urine, clear nail polish, tape, NPK fertilizer, and manure. The tools used are shovels, beakers, scales, ovens, ball mills, Leaf Area Meters (LAM), polybags, sprayers, scissors, and rulers.

This research was conducted using a single factor experimental method which was arranged in a Completely Randomized Design. The treatments tested were rabbit urine LOF; Rabbit urine LOF +

both vegetative and reproductive growth [7]. According to Ispandi et al. [8], the pod formation and seed filling phases require more potassium (K) nutrients. The K content in rabbit urine LOF is the lowest percentage (%), so it is necessary to add K nutrients to improve the nutrition of rabbit urine LOF. Laboratory analysis results show that Palm Oil Empty Fruit Bunch (POEFB) ash contains sufficiently high levels of potassium (K) and sodium (Na) nutrients, with 30% K₂O and 26% Na₂O respectively [9]. The addition of palm oil empty fruit bunch ash with a particle size of 101 nm is expected to increase the nutrient content in rabbit urine, thereby affecting the growth and yield of Anjasmore soybeans.

EPOB Ash Nano 1%; Rabbit urine LOF + EPOB Ash Nano 2%; Rabbit urine LOF + EPOB Ash Nano 3% and rabbit urine LOF + EPOB Ash Nano 4%. Each treatment replicated 3 times. Rabbit urine LOF + EPOB Ash Nano dilute 10 times and then apply to soybeans with 3 sprays. The observation data were analyzed using Analysis of Variance (ANOVA) at a significance level of α 5%. The treatment differences were tested using Duncan's Multiple Range Test (DMRT).

RESULT AND DISCUSSION

Plant Height Increase (cm)

The analysis of variance results showed that the concentration of LOF + EPOB Ash Nano did not significantly affect plant height increase at 1, 2, 4, 5, and 6 weeks after planting, but it did

significantly affect plant height increase at 3 weeks after planting. The average plant height increase is presented in Table 1.

Table 1. Average Plant Height Increase from Week 1 to Week 6 After Planting

Treatment	0-1 WAP	1-2 WAP	2-3 WAP	3-4 WAP	4-5 WAP	5-6 WAP
LOF	5,39 a	6,12 a	7,49 ab	4,70 a	13,69 a	13,61 a
LOF+EPOB Ash Nano 1%	5,50 a	6,19 a	6,49 b	7,54 a	13,67 a	16,67 a
LOF + EPOB Ash Nano 2%	5,31 a	5,99 a	7,81 ab	7,74 a	17,15 a	13,44 a
LOF+ EPOB Ash Nano 3%	5,17a	6,09 a	6,80 ab	6,57 a	14,82 a	14,11 a
LOF+ EPOB Ash Nano 4%	5,50 a	5,71 a	9,06 a	8,29 a	15,17 a	10,94 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Table 1 shows that there was a significant difference between the treatments of LOF + EPOB Ash Nano(1%) and LOF + EPOB Ash Nano(4%) in the 3rd week after planting. Spraying LOF + EPOB Ash Nano(4%) had a significant effect on increasing plant height growth. This is likely because the application of LOF + EPOB Ash Nanospray in the 2nd week had been absorbed by the plants, thus influencing height growth.

Increase in the number of leaves (blades)

The analysis of variance results showed that the concentration of LOF + EPOB Ash Nano did not significantly affect the increase in the number of leaves from week 1 to week 5 after planting, but

According to Ulva et al. [10], fertilizer absorption will show a response in plants two or three days after fertilizer application. Nutrient uptake thru leaves can increase the rate of photosynthesis [11]. An increased rate of photosynthesis can trigger growth processes such as cell division and cell elongation, thereby increasing plant height Lakitan [12].

it did significantly affect the number of leaves in week 6 after planting. The average increase in the number of leaves is presented in Table 2

Table 2. Average Increase in Plant Leaf Number from Week 1 to Week 6 After Planting

Treatment	0-1 WAP	1-2 WAP	2-3 WAP	3-4 WAP	4-5 WAP	5-6 WAP
LOF	2,00 a	6,00 a	5,67 a	14,22 a	31,78a	15,00 d
LOF+EPOB Ash Nano 1%	2,00 a	5,33 a	5,56 a	10,56 a	24,33a	28,78 ab
LOF+EPOB Ash Nano 2%	2,00 a	5,67 a	5,78 a	13,33 a	35,56a	25,00 bc
LOF+EPOB Ash Nano 3%	2,00 a	5,56 a	6,33 a	13,11 a	26,44a	34,44 a
LOF+EPOB Ash Nano 4%	2,00 a	5,67 a	6,33 a	13,67 a	31,67a	16,67 c

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Table 2 shows that the observation at week 6 for the LOF + EPOB Ash Nano (3%) spraying treatment yielded better results than the LOF, LOF + EPOB Ash Nano (2%), and LOF + EPOB Ash Nano (4%) treatments. This is likely due to the nutrient content in LOF + EPOB Ash Nano (3%) being able to meet the plant's needs for leaf formation. However, the LOF + EPOB Ash Nano

(4%) treatment showed lower numbers compared to the LOF + EPOB Ash Nano (3%) treatment. This is likely due to an excess of nutrients in plants treated with LOF + EPOB Ash Nano (4%). This is in accordance with the opinion of Salisbury & Ross [13] that plant growth will be optimal if nutrient requirements are met according to the plant's needs.

Leaf Area (cm²)

The analysis of variance results showed that spraying LOF + EPOB Ash Nano at all concentrations did not significantly affect the leaf

area of soybean plants. The average leaf area of soybean plants is presented in Table 3.

Table 1. Average Leaf Area (cm²)

Explanation: Averages followed by the same letter in the same column are not significantly

Perlakuan	4 WAP	6 WAP	8 WAP
LOF	317,83 a	2054,00 a	2558,33 a
LOF+EPOB Ash Nano 1%	361,83 a	2053,00 a	2665,67 a
LOF+EPOB Ash Nano 2%	452,67 a	2421,33 a	2808,83 a
LOF+EPOB Ash Nano 3%	413,17 a	2289,33 a	2984,17 a
LOF+EPOB Ash Nano 4%	414,00 a	2355,67 a	3035,50 a

different based on analysis of variance at a 5% error level.

Table 3 shows that the average leaf area of soybean plants did not differ significantly for each treatment, meaning that spraying with 1%, 2%, 3%, and 4% (LOF + EPOB Ash Nano) resulted in the same response as spraying with LOF without the addition of EPOB Ash Nano on the leaf area of soybean plants. It is suspected that all treatments provided can meet the needs of macronutrients such as N, P, and K derived from LOF spraying, so

the addition of EPOB Ash Nano containing high potassium (K) nutrients does not have a different effect. The availability of nutrients, especially N, from LOF and EPOB Ash Nano can affect the number and area of leaves formed. According to Ikhsan [14], when there is sufficient nitrogen supply, the leaves will grow large and expand their surface area.

Number and Size of Stomata

The fingerprinting results showed that the application of LOF + EPOB Ash Nano spraying had no significant effect on the number of open and closed stomata, as well as the length and width of

stomata. The average number of open and closed stomata, as well as the length and width of stomata, are presented in Table 4.

Table 2. Average of opened, closed, length, and width stomata

Treatment	opened	closed	length	width
LOF	15,67 a	0,67 a	13,92 a	6,89 a
LOF+EPOB Ash Nano 1%	19,00 a	2,00 a	15,99 a	6,98 a
LOF+EPOB Ash Nano 2%	18,67 a	1,67 a	14,83 a	6,94 a
LOF+EPOB Ash Nano 3%	17,00 a	3,00 a	15,08 a	6,41 a
LOF+EPOB Ash Nano 4%	16,00 a	1,00 a	15,37 a	7,19 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Table 4 shows that spraying with the addition of 1%, 2%, 3%, and 4% (LOF + EPOB Ash Nano) as well as LOF without the addition of EPOB Ash Nano gave the same response to the number of open and closed stomata, as well as the length and width of the stomata. This is likely because the application of LOF spray is sufficient for the accumulation of K⁺ ions in guard cells when stomata are open. According to Agustini

(1999) and Kurnia (2005) in Hidayati [15], stomatal length can be categorized as less than long (< 20 µm), long (20-25 µm), and very long (> 25 µm). Based on the observed stomatal length measurements, which showed an average value of < 20 µm, the stomata of the Anjasmoro soybean leaves observed were classified as less than long.

Stomata are open at a relatively higher level

compared to closed stomata. This happened because it was done during the day when the light intensity was full, causing the stomata to open optimally. In line with Haryanti & Meirina's [16] opinion, stomata generally open during daylight hours, allowing the entry of CO₂ needed for photosynthesis during the day, and stomata closure

occurs gradually toward evening. According to Taluta et al. [17], the opening and closing of stomata affects their width. When stomata are open, their width increases, and conversely, when stomata are closed, their width decreases, but the length of the stomata remains the same whether they are open or closed.

Fresh Weight of Plants (g)

The analysis of variance results showed no significant difference in the observed fresh weight of plants across all treatments tested. The average

Table 3. Average of crop fresh weight

fresh weight measurement results of the soybean plants observed at weeks 4, 6, and 8 after planting are presented in Table 5.

Treatment	4 WAP	6 WAP	8 WAP
LOF	15,12 a	69,63 a	117,24 a
LOF+EPOB Ash Nano 1%	16,88 a	70,34 a	117,90 a
LOF+EPOB Ash Nano 2%	20,85 a	84,28 a	130,49 a
LOF+EPOB Ash Nano 3%	18,48 a	76,34 a	139,01 a
LOF+EPOB Ash Nano 4%	18,60 a	81,14 a	140,93 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

The fertilization method tested was direct spraying on the leaves (foliar application). According to Meirina et al. [4], the method of fertilization by foliar spraying is effective because the nutrients contained in the fertilizer are easily absorbed into the plant thru the stomata. Sufficient nutrient availability can optimize plant growth. Syekhfani [18] stated that the application of organic fertilizer is easily absorbed by plants, resulting in wider leaf growth and influencing the rate of photosynthesis. The nutrient element N plays an important role in the formation of photosynthates that will be used to form new cells,

cell elongation, and cell division. This will happen quickly as carbohydrate reserves increase, so stem growth, including plant height, leaf number, and leaf area, will proceed well, leading to an increase in plant fresh weight (Irridiana et al. 2002 in Khasnawati [19]). Table 5 shows that all treatments tested resulted in no significant difference in fresh plant weight, which is suspected to be due to the varying water content in the plants influenced by environmental factors. However, there appears to be a tendency for the addition of EPOB Ash Nano 4% to result in better fresh plant weight compared to other treatments.

Plant Dry Weight (g)

The analysis of variance results showed a significant difference in plant dry weight at 8 weeks after planting. The average plant dry weight

at 4, 6, and 8 weeks after planting is presented in Table 6.

Table 4. Average of crop dry weight

Treatment	4 WAP	6 WAP	8 WAP
LOF	2,40 a	12,14 a	26,95 b
LOF+EPOB Ash Nano 1%	2,47 a	12,63 a	32,28 ab
LOF+EPOB Ash Nano 2%	3,07 a	14,85 a	33,11 ab

LOF+EPOB Ash Nano 3%	2,94 a	11,31 a	37,28 ab
LOF+EPOB Ash Nano 4%	2,72 a	14,71 a	34,82 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Table 6 shows that there is a significant difference between the LOF treatment and the LOF + EPOB Ash Nano 4% treatment on plant dry weight at 8 weeks after soybean planting, but there is no significant difference for the 1%, 2%, and 3% treatments. This means that the LOF + EPOB Ash Nano 4% spraying treatment can influence an increase in plant dry weight. Salisbury & Ross [13]

stated that plant growth will be optimal when nutrient elements are met according to the plant's needs. Nitrogen (N) is highly needed for vegetative growth, while potassium (K) plays a role in photosynthesis. If potassium levels in the leaves are sufficient and balanced, the rate of CO₂ assimilation will proceed well. The better the plant growth, the higher the plant dry weight.

Number of Pods (Fruits)

The analysis of variance results showed that spraying LOF + EPOB Ash Nano for all treatments did not significantly differ in the number of pods. The average of pods number

soybean pods. The average number of soybean pods can be seen in Table 7.

Treatment	Full green	Not full green	Empty green	Full yellow	Not full yellow	Empty yellow
LOF	19,11 a	8,22 a	0,33 a	37,89 a	9,67 a	4,44 a
LOF+EPOB Ash Nano 1%	26,56 a	5,89 a	0,11 a	28,67 a	10,00 a	8,33 a
LOF+EPOB Ash Nano 2%	25,56 a	6,00 a	0,11 a	45,33 a	9,11 a	3,67 a
LOF+EPOB Ash Nano 3%	27,00 a	7,22 a	0,22 a	49,78 a	11,00 a	3,44 a
LOF+EPOB Ash Nano 4%	13,44 a	6,78 a	0,78 a	48,78 a	13,44 a	5,00 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Table 7 shows that spraying LOF + EPOB Ash Nano at various concentrations did not significantly differ from spraying LOF without the addition of EPOB Ash Nano in terms of the number of full, empty, or yellow pods. This means that adding EPOB Ash Nano to LOF did not affect the increase in the number of pods. This happens because rabbit urine LOF contains the elements N, P, and K needed during seed filling. According to Atmaja et al. [20], the application of liquid organic fertilizer containing nitrogen, phosphorus, and potassium can improve plant vegetative growth by increasing total leaf area and chlorophyll, which

are related to the photosynthetic process, and by increasing production yields thru the accumulation of photosynthates in the seeds.

The presence of full, partially full, and empty pods is suspected to be caused by uneven seed filling. Supported by the opinion of Kristina et al. [21] that not all pods are in the process of seed filling, especially pods that develop from the last-formed flowers, which will form half-full pods (incomplete pods) or empty pods. In addition, incomplete and empty pods can occur due to sucking pest attacks, preventing seed formation

Pod Weight (g)

The analysis of variance results showed that spraying LOF + EPOB Ash Nano did not significantly affect pod weight in soybean plants.

The average pod weight of soybean plants is presented in Table 8.

Table 6. Average of pod weight per crop (g)

Treatment	Full green	Not full green	Empty green	Full yellow	Not full yellow	Empty yellow
LOF	21,56 a	6,55 a	0,14 a	38,60 a	6,04 a	0,39 a
LOF+EPOB Ash Nano 1%	28,46 a	4,14 a	0,02 a	26,24 a	6,10 a	0,72 a
LOF+EPOB Ash Nano 2%	27,85 a	5,04 a	0,02 a	42,57 a	5,78 a	0,41 a
LOF+EPOB Ash Nano 3%	27,28 a	4,63 a	0,03 a	41,40 a	6,38 a	0,30 a
LOF+EPOB Ash Nano 4%	13,53 a	4,98 a	0,13 a	45,59 a	8,89 a	0,41 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Table 8 shows that spraying LOF + EPOB Ash Nano treatments at various concentrations (1%, 2%, 3%, 4%) and LOF EPOB Ash Nano did not significantly affect the pod weight of soybean plants. Applying LOF thru spraying (foliar) is believed to optimize nutrient absorption by plants. This is in line with the opinion of Meirina et al. [4] that the method of fertilization by foliar spraying is

effective because the nutrients contained in the fertilizer are easily absorbed into the plant thru the stomata. The plant's ability to form seeds in pods is more determined by the nutrient status available to the plant. According to Pandingan & Rasyad [22], sufficient assimilate supply during seed filling is due to increased assimilate transport from leaves and stems to the pod for the seed filling process.

Seed dry weight per plant (g)

The analysis of variance results showed that spraying LOF + EPOB Ash Nano did not significantly affect seed dry weight per plant. The average seed weight per plant is presented in Table 9.

Table 9 shows that the average seed weight per plant did not differ significantly across treatments. This means that spraying LOF can

already supply and meet the nutrient needs of the plants. The plant's ability to form seeds in pods is more determined by the nutrient status available to the plant [23]. Spraying LOF rabbit urine, whether enriched with EPOB Ash Nano or not, resulted in seed yield per plant exceeding the potential yield of the Anjasmore soybean variety by 57.14% - 70.22%.

Table 7. Average of seed dry weight per crop

Treatment	Grain weight/crop
LOF	25,52 a
LOF+EPOB Ash Nano 1%	25,53 a
LOF+EPOB Ash Nano 2%	30,71 a
LOF+EPOB Ash Nano 3%	29,66 a
LOF+EPOB Ash Nano 4%	30,69 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Weight of 100 seeds (g)

The analysis of variance results show that the treatment of LOF + EPOB Ash Nano had a significant effect on the dry weight of 100 soybean seeds. The average dry weight of 100 seeds is presented in Table 10.

seeds. The average dry weight of 100 seeds is presented in Table 10.

Table 8. Average of dry weight of 100 seeds (g)

Treatment	Dry weight of 100 seeds
LOF	18,13 ab
LOF+EPOB Ash Nano 1%	16,60 c
LOF+EPOB Ash Nano 2%	17,73 abc
LOF+EPOB Ash Nano 3%	16,72 bc
LOF+EPOB Ash Nano 4%	18,45 a

Explanation: Averages followed by the same letter in the same column are not significantly different based on analysis of variance at a 5% error level.

Table 10 shows that the LOF + EPOB Ash Nano 4% treatment was significantly different from LOF + EPOB Ash Nano 1% and %. The concentration of LOF + EPOB Ash Nano 4% in plants showed a better response to the dry weight of 100 soybean seeds. The description of the Anjasmoro soybean variety with a weight of 100 seeds shows a weight range of 14.8-15.3 grams,

while the research results on the application of LOF + EPOB Ash Nano at various concentrations have an average weight of 16-18 grams, which exceeds the 100-seed weight of the Anjasmoro variety. The application of LOF with or without the addition of EPOB Ash Nano has been able to increase the 100-seed weight of Anjasmoro soybean plants.

CONCLUSION

The application of LOF spray enriched with EPOB Ash Nano affects the growth and yield of Anjasmoro soybeans. Spraying LOF urine + 4%

EPOB Ash Nano increase growth and yield in terms of dry weight of 100 seeds.

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