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Inorganic Fertilizer Efficiency Using Liquid Organic Fertilizer On Peanut Growth And Production (Arachis Hypogaea L.)

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Abstract

Fertilization is important in increasing crop production. The use of liquid organic fertilizer (LOF) in addition to inorganic fertilizer in crop cultivation is expected to reduce the use of inorganic fertilizer and increase growth and production. The research aimed to determine the effect of LOF on peanut growth and production and to obtain the right dose to reduce the use of inorganic fertilizer doses. The research used a factorial Randomized Group Design (RGD) with two factors. The first factor was LOF dose (0, 3, 5, and 7 ml/L/Plot) and the second factor was inorganic fertilizer dose (0, 25, 50, and 100% of the recommended dose). Data analysis using ANOVA and DMRT. The results showed that the dose of LOF had a very significant effect (P<0.01) on plant height, number of leaves, leaf area, number of filled pods, and total number of pods. The best dose in improving all these parameters was LOF 3 ml/L/Plot. The combination treatment of LOF and inorganic fertilizer had a very significant effect (P<0.01) on the number of filled pods, but not significant effect (P>0.05) on other parameters. The best combination of LOF dose and inorganic fertilizer was C1A1 (3 ml/L/Plot LOF + 25% Inorganic) which produced almost the same number of filled pods as C0A2 (0 ml/L/Plot LOF + 50% Inorganic), and higher than other treatments. The C1A3 treatment also produced higher fresh pod weight and dry pod weight than the other treatments. The application of LOF 3 ml/L/Plot + 25% inorganic fertilizer from the recommended dose can increase peanut production, and can reduce the use of inorganic fertilizer by 75%.

1. INTRODUCTION

Nutrients are the essential elements needed for plant growth and development. Lack nutrient in soil is a major limiting factor for plants in achieving optimal growth and production [1] . In practice, it is very common for farmers to use excessive amounts of inorganic fertilizers in an effort to increase production yields [2]. Inorganic fertilizers are practical, readily available, and can meet the needs of plant nutrients, especially macronutrients such as Nitrogen (N), Phosphorus (P), and Potassium (K). Meanwhile, inorganic fertilizers that have been commonly used by farmers such as Urea, TSP, and others are quite expensive, more over after the government revoked subsidies on fertilizer prices [3].

Apart from the price issue, there are still many disadvantages caused by the unwise use of inorganic fertilizers. Their prolonged use and inappropriate doses can degrade soil fertility, changing the physical, chemical and biological properties of the soil so that soil fertility decreases and cannot be planted with certain types of crops [4, 5,]. The use of high doses of inorganic fertilizers without being balanced with the use of organic fertilizers results in decreased soil organic matter content and not optimal crop production [6]. Inorganic fertilizers can also cause changes in the balance of soil elements, soil pollution, and inorganic fertilizer residues stored in crops can threaten the health of people who consume them [7]. Another drawback of inorganic fertilizers is that they are known to contain very little to no micronutrients, yet optimal plant growth also requires them [8].

The disadvantages and shortcomings of inorganic fertilizers are expected to be minimized by applying organic fertilizer, in this case liquid organic fertilizer (LOF). Organic fertilizers have the ability to increase soil organic matter content, which is an important indicator of soil quality and crop productivity [9]. Organic fertilizers have slow-release characteristics that can be available longer in the soil than inorganic fertilizers [10]. LOF contains macro and micro nutrients (S, Ca, Mg, B, Mo, Cu, Fe, Mn, and organic material), and the absorption of nutrients is easier than solid fertilizer [11]. In addition to being rich in macro and micro nutrients, LOF also contains growth hormones and functional microbes that can improve soil fertility, and maintain ecological balance, and its application to crop cultivation can minimize the use of inorganic fertilizers [12]. LOF can be applied easily so that it saves costs in maintenance, namely by spraying or watering, and the resulting agricultural production also tends to be high [13]. Organic fertilizers can serve to minimize production costs and can reduce the use of NPK fertilizers on crops, such as Biosaka fertilizer [14]. The availability of LOF in the market is relatively stable with cheaper prices, so it can increase farmer empowerment and local wisdom [15]. Therefore, the use of inorganic fertilizers needs to be combined with LOF so that it can add nutrients needed by plants and increase soil organic matter sources [16].

In this study, a combination of LOF with inorganic fertilizers was used in the growth and production of peanut (*Arachis hypogeae* L.). The demand for peanuts in Indonesia reaches an average of 900,000 tons annually [17]. Meanwhile, peanut production in the last period has decreased, causing Indonesia to still be a net importer country, importing peanuts at an average of 254,373 tons/year [17]. Increasing peanut production in Indonesia is still not programmed by the government to achieve self-sufficiency, as is the case with soybean [18]. Cultivation technology applied by farmers is still traditional and stagnant [19].

The use of improved varieties and modification of the fertilizer used is expected to help improve peanut production. In this study, peanut varieties were used *HypoMa 1*, which is a high-yielding variety with a potential dry pod yield of 3.70 tons/ha [20]. HypoMa 1 is

also moderately resistant to leaf spot and rust, moderately resistant to bacterial wilt (*Ralstonia solanacearum*), and tolerant of being planted on alfiso soils [21]. The LOF used was from PT Xpro Nusantara Raya, which is made from fruit waste and enriched with soil decomposing microbes for supporting micronutrients. This study aims to obtain the dosage of LOF that can be combined with inorganic fertilizers and at the same time the efficiency of inorganic fertilizers in peanut growth and production.

2. MATERIALS AND METHODS

This research was conducted from January to March 2022. The research location was on the farm of CV Hadid Indonesia Berkarya located in Gaga Village, Pakuhaji District, Tangerang Regency, Banten Province. The location is at an altitude of 11 metres above sea level, with a temperature of average 27°C, the average humidity of 82.6%/day, sandy clay soil type and neutral soil pH.

This study used a factorial Randomized Group Design (RGD) consisting of two factors. The first factor was the dose of LOF which consisted of 4 levels: 0, 3, 5, and 7 ml/L per plot. The second factor was a single inorganic fertilizer dose (urea, SP36, and KCl) consisting of 4 levels, namely 0%, 25%, 50%, and 100% of the recommended dose. Each treatment was repeated 3 times. Each replication consisted of 1 plot containing 8 plants.

Preparation and Planting

The research was conducted on paddy fields that had not been planted with cultivated crops for a long time. The land was cleaned, hilled, stoned, and levelled until homogeneous. On the land, replicate plots were made with the size of 1 m x 1.2 m, 50 cm distance between plots. In each plot, 8 planting holes (2 rows) 3 cm deep, 25 cm x 40 cm apart were made ready for planting seeds.

Before planting, the seeds were soaked in a fungicide solution (anthracic) for 15 minutes to make the seeds more resistant to disease and to select viable seeds. The viable seeds are taken out and drained until no fungicide solution is still dripping. Next, the selected seeds were directly planted.

Two peanut seeds were inserted into each planting hole and covered with the surrounding soil. The weeding and replanting were carried out. After one week of planting, one plant per hole was selected for further observation. The plants selected were those with the same height and number of leaves.

Each planting hole only took or left one plant for the research sample and the rest were uprooted.

Fertilization

LOF application was done once a week starting from 1 MST to 10 MST with the dosage according to the treatment. Each replicate plot used 1L of LOF. LOF was poured evenly onto the surface of the plot. Inorganic fertilizer was applied at 1 and 4 weeks after planting with the dosage according to the treatment. Inorganic fertilizer was applied by immersed at ±5 cm from the planting hole and then covered with soil.

Harvesting

Peanut variety HypoMa 1 can be harvested at the age of ±91 days. Harvesting is done in the afternoon by pulling out plants that have met the harvest criteria, such as 75% of the leaves turn yellow and fall (fall off), most of the pods (80%) are old, the pod skin is quite hard and blackish brown in color, the seed coat is thin and shiny, and the pod cavity is filled with seeds.

Data Analysis

Data were analyzed using Analysis of Variance (ANOVA). The results of variance that differed significantly ($P < 0.05$ and $P < 0.01$) were followed by Duncan's Multiple Range Test (DMRT) at the 5% confidence level to determine the treatments that gave significantly different effects. The software used in the analysis is SPSS 25

3. RESULTS and DISCUSSION

Peanut Growth

LOF dosage affected all growth parameters of peanut plants, namely plant height, number of leaves, and leaf area (P<0.01). Treatment C1 (3 ml/L/Plot) produced the highest average plant height and leaf area, while the highest average number of leaves was produced by treatment C3 (7 ml/L/Plot) (Table 1).

Inorganic fertilizer treatments also affected the number of leaves and leaf area (P<0.01) but did not affect the height of peanut plants (P>0.05). The A3 treatment (100% inorganic fertilizer dosage as recommended) produced the highest average plant height, number of leaves, and leaf area, but was not significantly different from the A2 treatment (50% inorganic fertilizer as recommended) (Table 1).

Table 1. Effect of liquid organic fertilizer, inorganic fertilizer, and their combination on plant height, number of leaves, and leaf area of peanut plants

Fertilizer	Treatments	Plant height (cm)	Number of leaves (leaflets)	Leaf area (cm^2)
LOF	C0	40,72^{b}	27,83^{a}	15,22^{bc}
	C1	41,84^{b}	29,52^{a}	15,87^{c}
	C2	38,96^{ab}	31,83^{ab}	14,23^{ab}
	C3	36,98^{a}	36,65^{b}	13,89^{a}
Inorganics	A0	38,18	29,06^{a}	13,16^{a}
	A1	39,80	29,04^{a}	14,55^{b}
	A2	39,60	31,94^{ab}	15,68^{c}
	A3	40,92	35,79^{b}	15,83^{c}
Combination	C0A0	35,79	26,25	12,17
	C0A1	42,54	26,92	14,62
	C0A2	42,27	24,92	17,20
	C0A3	42,29	33,25	16,90
	C1A0	42,67	26,75	15,35
	C1A1	42,75	27,92	16,94
	C1A2	41,04	29,42	16,09
	C1A3	40,92	34,00	15,12
	C2A0	37,67	28,75	12,74
	C2A1	36,63	28,67	13,28
	C2A2	38,17	32,92	15,02
	C2A3	42,40	37,00	15,87
	C3A0	36,60	34,50	12,38
	C3A1	37,29	32,67	13,36
	C3A2	36,93	40,50	14,39
	C3A3	37,08	38,92	15,44

Description: C0=0 ml/L/Plot, C1=3 ml/L/Plot, C2=5 ml/L/Plot, dan C3=7 ml/L/Plot liquid organic fertilizer, A0=0%, A1=25%, A2=50%, A3=100% inorganic fertilizer from the recommended dose. Numbers followed by different letters in the same column for each variable indicate significantly different based on Duncan's test at the 5% level.

Peanut Production

LOF application affected the number of filled pods (P<0.01) but had no effect (P>0.05) on other production parameters. Treatment C1 (LOF 3 ml/L/plot) produced the highest average number of filled pods and total pod number of peanut plants (Table 2).

Table 1. Effect of LOF, inorganic fertilizer, and their combination on the number of filled pods, total number of pods, fresh pod weight, dry pod weight, and 100 seed weight of peanut plants

Fertilizer	Treatments	Number of pods filled	Total number of pods	Fresh pod weight (g)	Dry pod weight (g)	100 seed weight (g)
LOF	C0	40,92^{bc}	52,42	75,19	67,26	53,00
	C1	42,75^{c}	54,92	74,31	65,16	53,30
	C2	38,42^{ab}	51,50	70,03	62,29	54,83
	C3	36,83^{a}	52,17	65,71	58,64	54,72
Inorganics	A0	36,42^{a}	48,50^{a}	63,94	57,19	52,40
	A1	41,17^{b}	53,33^{b}	74,63	66,35	53,80
	A2	39,83^{b}	54,33^{b}	73,61	65,14	54,88
	A3	41,50^{b}	54,83^{b}	73,06	64,67	54,78
Combination	C0A0	28,33^{a}	41,00	60,80	53,83	49,13
	C0A1	43,67^{cd}	53,00	77,52	70,77	49,23
	C0A2	45,33^{d}	59,00	83,13	74,47	56,45
	C0A3	46,33^{d}	56,67	79,30	69,97	57,21
	C1A0	42,00^{bcd}	53,00	67,61	59,27	53,94
	C1A1	45,33^{d}	59,33	80,41	70,37	50,22
	C1A2	43,00^{bcd}	55,00	77,00	67,20	52,60
	C1A3	40,67^{bcd}	52,33	72,21	63,81	56,41
	C2A0	36,00^{bc}	48,67	65,80	59,47	51,61
	C2A1	39,67^{bcd}	52,33	75,57	65,90	59,89
	C2A2	35,33^{b}	52,33	70,70	63,37	56,25
	C2A3	42,67^{bcd}	52,67	68,06	60,42	51,56
	C3A0	39,33^{bcd}	51,33	61,53	56,20	54,91
	C3A1	36,00^{bc}	48,67	65,03	58,37	55,85
	C3A2	35,67^{b}	53,00	63,62	55,53	54,21
	C3A3	36,33^{bc}	55,67	72,66	64,47	53,92

Description: C0=0 ml/L/Plot, C1=3 ml/L/Plot, C2=5 ml/L/Plot, dan C3=7 ml/L/Plot liquid organic fertilizer, A0=0%, A1=25%, A2=50%, A3=100% inorganic fertilizer from the recommended dose. Numbers followed by different letters in the same column for each variable indicate significantly different based on Duncan's test at the 5% level.

Inorganic fertilizer had an effect (P<0.01) on the number of filled pods and a significant effect (P<0.05) on the total number of pods, but no significant effect (P>0.05) on other production parameters. Treatments A1 (25%), A2 (50%), and A3 (100%) were not significantly different and had higher number of filled pods and total number of pods than treatment A0 without inorganic fertilizer. The A3 treatment with the highest dose of inorganic fertilizer produced the highest average number of filled

pods and total number of pods of peanut plants (Table 2).

The combination treatment of LOF and inorganic fertilizer affected the number of filled pods ($P<0.01$), but had no effect on other production parameters ($P>0.05$). Treatment C1A1 (LOF 3 ml/L/Plot + 25% inorganic fertilizer) produced the highest number of filled pods compared to other treatments, which could match the number of filled pods in the treatment with 100% inorganic fertilizer dose.

4. DISCUSSION

LOF application affects peanut plant growth, which increases plant height, number of leaves, and leaf area (Table 1). LOF dose of 3 ml/L/Plot can already increase peanut plant growth, namely plant height and leaf area. However, the number of leaves required a higher LOF dose of 7 ml/L/Plot. The treatment dose of 7 ml/L/Plot produced the highest number of leaves. The more the addition of organic matter into the soil, the greater the nutrients that are translocated for plant growth rate [22]. LOF given can increase soil fertility because it contains soil microbes that could convert nutrients into a form that is available and can be absorbed by plants. The fulfilment of nutrients will make the photosynthesis process in plants take place optimally and produce enough photosynthate to sustain plant growth [23]. Photosynthate produced in the form of reduced sugar is used as a source of energy for vegetative organs of plant (roots, stems, and leaves), as well as accumulated in fruits, seeds or other storage organs [24].

The application of inorganic fertilizer also affects peanut growth. Inorganic fertilizer doses of 100% (as recommended) and 50% (half the recommended dose) increased plant height, number of leaves and leaf area by producing the highest average values (Table 1). Half the recommended dose of inorganic fertilizer can already provide sufficient nutrients for peanut plant growth. Basically, inorganic fertilizer is a source of nutrients that are already in a form available to plants and can be directly absorbed. When given to plants either singly or in combination with LOF, it will be well absorbed by plants. The nitrogen element in the fertilizer will be utilized quickly and optimally for plant growth. The element of nitrogen given in the NPK fertilizer affects plant height. Nitrogen indirectly affects the results of photosynthesis because nitrogen plays a role in the formation of chlorophyll [25]. The results of photosynthesis will be used for plant growth and development. Increased photosynthate in the vegetative phase causes cell division, elongation, and differentiation. The result of this process is the addition of plant organs such as branches and leaves [26].

The tendency to increase growth at half-recommended and recommended doses of inorganic fertilizer (A2 and A3) indicates that the macronutrients needed for plant growth have been fulfilled. The high effect of growth and production of peanut plants correlates with the level of dosage of inorganic fertilizer application [12]. High fertilizer levels (75 kg/ha urea + 100 kg/ha SP36 + 50 kg/ha KCl) is considered to provide sufficient nutrients to support the growth and production of peanut plants. This is because inorganic fertilizers provide macronutrients for plant growth, especially essential elements such as nitrogen (N), phosphate (P) and potassium (K).

N nutrients are used by plants for vegetative growth through the process of forming organic compounds in plants such as amino acids and proteins [26]. Increased provision of N elements for plants will cause increased formation of new cells that will affect the process of extension and widening of leaves, increase height and encourage the process of vegetative development [27]. Meanwhile, K and P nutrients are interdependent, K elements function as a transport medium that carries nutrients from the roots including P nutrients to the leaves and translocated assimilates from the leaves to all plant tissues [28].

On a single factor basis, LOF and inorganic fertilizer can increase the growth of peanut plants. When combined, the two fertilizers did not affect peanut growth. However, the combination treatment of 3 ml/L/Plot LOF with a quarter dose of inorganic fertilizer (C1A1) can produce higher average plant height than other treatments, including when compared to 100% inorganic fertilizer (Table 1). This shows that the C1A1 treatment was successful in reducing the use of inorganic fertilizer doses by 75% of the recommended dose. By using LOF 3 ml/L/Plot, the use of inorganic fertilizer can be reduced to 75% in terms of peanut growth.

Plant growth in the form of vegetative organs greatly affects the production of peanut plants. The effect of LOF and inorganic fertilizer doses, as well as the combination of the two on peanut production is not much different from its growth. The application of LOF 3 ml/L/Plot increased the number of filled pods and the total number of pods of peanut plants (Table 2). This indicates that the application of LOF has been able to provide sufficient nutrients for the development of peanut plants, so that the plants grow well and achieve high production levels. LOF can help increase soil biological activity which makes microorganisms in the soil able to release P bonds, so that P-availability will increase [6]. The LOF with organic matter content in it can break down nutrients bound to soil minerals, so that the absorption of nutrients is better and their availability to plants will increase [29]. Element P plays an important role in the growth of flowers and seeds, encourages root growth, increases the percentage of flower formation into seeds, and increases plant resistance to pest attacks. Sufficient P element needs allow plants to utilize it for physiological processes to increase seed filling and the quantity of pithy seeds [30].

The use of LOF 3 ml/L/Plot is promising to increase peanut growth and production, because it has a good impact at a low dose. Other studies used higher doses of LOF. The application of LOF 6 ml/l water/1.2 m^2 had a significant effect on peanut growth and production [31]. The application of LOF 60 ml/30 l water/100 m^2 which is lower also has a significant effect on peanut growth and production [16]. Even the use of LOF is also able to increase plant growth and production and reduce the use of AB Mix in hydroponic farming [32].

norganic fertilizer application also affects peanut production. All doses of inorganic fertilizer can increase the number of filled pods and total pods. However, the quarter (A1), half (A2) and full (A3) recommended doses did not differ significantly. All three had almost the same number of filled pods and total number of pods and were higher than the A0 treatment without inorganic fertilizer (Table 2). This indicates that the application of inorganic fertilizer at a quarter of the recommended dose (low dose) can already provide nutrients for plants, especially in pod formation. In contrast to another research that requires high fertilization to support the growth and production of peanut plants [12]. This is related to the continuity of pod and seed formation which depends on the content of essential nutrients contained in the soil [25].

Peanut production was also affected by the combination of LOF and inorganic fertilizer. The combination of LOF 3 ml/L/Plot with a quarter dose of inorganic fertilizer (C1A1) produced the highest number of filled pods compared to the other treatments, which could match the number of filled pods of treatments with 50% and 100% inorganic fertilizer doses. In other parameters such as total pod number, fresh pod weight and dry pod weight, the C1A1 treatment also had a higher average than the other treatments. However, for the 100 seed weight parameter, the C2A1 treatment (5 ml/L/Plot LOF + 25% Inorganic) tended to produce the highest average compared to other treatments. This shows that the LOF treatment combined with 25% inorganic fertilizer from the recommended dose can produce high production compared to other treatments, especially compared to

the treatment with 100% inorganic fertilizer dose. LOF 3 ml/L/Plot was able to provide good nutrients in the production of peanut plants, so that the number of filled pods, total number of pods and pod weight produced were high.

Treatments C0A3 (0 ml LOF + 100% Inorganic) and C1A1 (3 ml LOF + 25% Inorganic) produced the highest average number of filled pods compared to other treatments (Table 2). This shows that the C1A1 treatment is very good at making the use of inorganic fertilizer more efficient, reducing the use of inorganic fertilizer to 75% of the recommended dose, and still has the potential to increase peanut production. Based on observations of production results, it shows that the combination treatment of LOF with inorganic fertilizer is symbiotic in the production of peanut plants. This is because the presence of microorganisms contained in LOF can increase fertilization efficiency, so that the nutrients contained in organic fertilizer are easily absorbed by plants [11]. The addition of LOF helps increase soil biological activity, so that microorganisms in the soil can release P bonds so that P becomes available to plants [33].

In pod filling, peanut plants require high Ca and K during the filling period. Therefore, the increase in the number of filled pods and pod weight is due to the sufficiency of both macro and micronutrients provided through the combined fertilization of LOF and inorganic fertilizers. Peanuts that lack Ca and K elements will form small seeds, low oil content, and low seed weight [34]. The 100-seed weight of peanut is directly proportional to pod weight and influenced by seed size [34]. This indicates that larger peanut pods and seeds can contribute to higher yields, and vice versa. The weight of plant seeds depends on the amount of dry matter contained in the seeds and the shape of the seeds which is influenced by genes contained in the plant [35].

In addition to the above, the number of filled pods and pod weights both fresh and dry are also strongly influenced by the activity of transporting photosynthetic products for seed filling. The pod weight parameter gives an idea of how much photosynthetic products are stored in seeds [36]. The results of photosynthesis or assimilation are translocated to fruits or seeds and used for food reserves in plant development. The results of photosynthesis are influenced by the availability of nutrients and water for the process of translocating photosynthate into seed formation [35].

5. CONCLUSION

LOF application can increase plant height, number of leaves, leaf area, number of filled pods, and total number of pods, tends to increase fresh pod weight and dry pod weight, namely the combination treatment of LOF 3 ml/L/Plot and inorganic fertilizer 25% of the recommended dose. The fertilizer combination treatment also increased the storability of peanuts. The LOF dose of 3 ml per plot combined with inorganic fertilizer at 25% of the recommended dose can reduce inorganic fertilizer use by 75% and has the potential to increase peanut production.

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