

EFFECTIVENESS OF 'KASGOT' ORGANIC FERTILIZER ON THE GROWTH AND YIELD OF EDAMAME SOYBEANS ON ORGANIC FARMING

Efektivitas Pupuk Organik 'Kasgot' terhadap Pertumbuhan dan Hasil Kedelai Edamame di Lahan Organik

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ABSTRAK

Tujuan dari penelitian ini adalah mengevaluasi pertumbuhan dan hasil akibat aplikasi pupuk organik kasgot, efektivitas pupuk organik kasgot dibanding dengan pupuk organik non kasgot, menentukan kombinasi pupuk organik kasgot dan pupuk organik non kasgot dalam meningkatkan pertumbuhan dan hasil kedelai. Perlakuan disusun secara faktor tunggal dalam rancangan acak kelompok lengkap dengan 3 ulangan sebagai kelompok berdasarkan arah sinar matahari. Ada 8 perlakuan yaitu tanpa pupuk organik (kontrol) (P0), pupuk organik padat non kasgot (P1), pupuk organik cair non kasgot (P2), pupuk organik padat kasgot (P3), pupuk organik cair kasgot (P4), pupuk organik padat dan cair non kasgot (P5), pupuk organik padat dan cair kasgot (P6), dan pupuk organik non kasgot dan pupuk organik kasgot (P7). Hasil penelitian menunjukkan bahwa pemberian pupuk organik kasgot padat (5 t ha^{-1}) yang dikombinasikan dengan kasgot cair (50 ml L^{-1} air) mampu menghasilkan pertumbuhan tanaman dan jumlah polong tanaman⁻¹ terbaik. Dilaporkan juga bahwa peubah jumlah cabang, tinggi tanaman, dan bobot basah tanaman berkorelasi nyata positif terhadap variabel jumlah polong tanaman⁻¹.

Kata Kunci: magot, organik cair, organik padat, pertumbuhan, polong

ABSTRACT

The objectives of this study were to evaluate the growth and yield of edamame by application of kasgot organic fertilizer, to evaluate the effectiveness of kasgot organic fertilizer compared to non-kasgot organic fertilizer, and to determine the combination of kasgot organic fertilizer and non-kasgot organic fertilizer in increasing the growth and yield of soybeans. Treatment was arranged by single factor in completely randomized block design with three reps as block based on sunlight direction. The factor were no organic fertilizer (control) (P0), non kasgot solid organic fertilizer (P1), non kasgot liquid organic fertilizer (P2), kasgot solid organic fertilizer (P3), kasgot liquid organic fertilizer (P4), non kasgot solid and liquid organic fertilizer (P5), kasgot solid and liquid organic fertilizer (P6), and non kasgot organic fertilizer and kasgot organic. The research indicated that the combination of solid kasgot organic fertilizer (5 t ha^{-1}) and liquid kasgot (50 ml L^{-1} water) produced the best plant growth and number of pods plant⁻¹. It was also reported that the variables of number of branches, plant height, and plant wet weight positively correlated with the number of pods plant⁻¹.

Keyword: magot, liquid organic, solid organic, growth, pods

INTRODUCTION

The demand for healthy and nutritious food is currently a priority. Consumers are not only seeking filling products but also ones that are safe, healthy, beneficial, and nutritious. Edamame soybeans are one of the healthy snacks that are currently highly sought after and consumed by the public (Rahman, Tobing, and Setyono, 2019). Edamame products that are rich in nutrients and vitamins must ensure their safety by avoiding residues from inorganic fertilizers and pesticides. Therefore, organic production of edamame is one way to produce healthy, safe, and nutritious agricultural products for the community (Geng *et al.*, 2019).

One of the drawbacks of organic cultivation in the initial stages is lower crop yield (Gao *et al.*, 2020). To maintain soil fertility and ensure an adequate supply of nutrients in organic land, regular and sufficient application of organic fertilizers were necessary (Umesha *et al.*, 2014; Wang *et al.*, 2019). The organic fertilizers used can be in solid or liquid form (Sinuraya, Barus, and Hasanah, 2016; Fadli, Parwito, and Togatorop, 2021). The type of raw materials and the quality of organic fertilizers will determine the soil fertility and the success of organic edamame cultivation (Hussain *et al.*, 2020).

Currently, there are methods for biologically converting waste or garbage using black soldier fly (BSF) larvae, commonly referred to as "maggots" (Beskin *et al.*, 2018; Singh and Kumari, 2019). Maggot cultivation can yield various products, including fresh maggots, dried maggots, and kasgot fertilizer (fertilizer from BSF larvae breeding residues). In addition to solid materials, liquid fertilizer derived from the organic breakdown of maggots is also produced (Harahap, 2019; Surendra *et al.*, 2020).

Organic fertilizers derived from the metabolism of *Hermetia illucens*, or Black Soldier Fly (BSF), contain microorganisms that enrich the soil and aid in nutrient absorption by plants. In addition to microorganisms, these fertilizers also contain hormones such as auxin and gibberellin, which accelerate plant growth (Yao *et al.*, 2020; Zhu *et al.*, 2020). Furthermore, according to Harahap (2019), maggot compost has higher NPK (nitrogen, phosphorus, and potassium) values than liquid fertilizers from urine and cow dung. This indicates its potential to become a high-quality organic NPK fertilizer.

Information regarding the use of organic fertilizer derived from maggot residues (kasgot) on edamame soybeans is still minimal. Testing of kasgot fertilizer on plants has not been widely conducted. Additionally, there is a need for information on the utilization of both solid and liquid kasgot fertilizers in organic cultivation to support organic farming efforts. The research aims were to evaluate the growth and yield of edamame soybeans by the application of organic kasgot fertilizer, to evaluate the effectiveness of kasgot organic fertilizer compared to non-kasgot organic fertilizers, and to determine the optimal combination of kasgot organic fertilizer and non-kasgot organic fertilizer to improve the growth and yield of edamame.

RESEARCH METHODS

This research was conducted at the TEFA Polinela Organic Farm, which is certified organic at the Lampung State Polytechnic, from April to June 2022. The materials used in this study include Ryoko variety edamame soybean seeds, solid and liquid non-kasgot organic fertilizers, solid kasgot organic fertilizer, and liquid kasgot organic fertilizer.

The treatments consist of a single-factor design with 8 treatments of different

types of organic fertilizers and their combinations. The treatments used are as follows: no organic fertilizer (control) (P0), solid non-kasgot organic fertilizer (P1), liquid non-kasgot organic fertilizer (P2), solid kasgot organic fertilizer (P3), liquid kasgot organic fertilizer (P4), solid and liquid non-kasgot organic fertilizers (P5), solid and liquid kasgot organic fertilizers (P6), and non-kasgot organic fertilizer combined with kasgot organic fertilizer (P7). Non-kasgot solid organic fertilizer is composted cow manure mixed with rice husks and straw, while non-kasgot liquid fertilizer is the liquid that results from composting non-kasgot solid organic fertilizer.

The treatments would be applied to experimental plots in a completely randomized block design (CRBD) with three reps used as a block based on sunlight direction. There were 24 experimental units in this research. Each experimental unit will consist of soil media in 10 kg polybags. The solid organic fertilizer dosage was 5 tons ha⁻¹ (equivalent to 37.5 g polybag⁻¹) (Amir and Astuti, 2020). Meanwhile, the liquid organic fertilizer dosage was 50 ml L⁻¹ of water applied through irrigation (Sinuraya, Barus, and Hasanah, 2015). Solid organic fertilizer was applied once while mixing the planting media, while liquid organic fertilizer was applied two times: at 7 and 30 days after planting (DAP).

The variables we observed included plant growth and yield. Growth variables such as plant height, stem diameter, and number of branches were observed at 49 DAP. Meanwhile, we observed the wet weight of biomass and the number of pods per plant at the end of the research (65 DAP). Plant height was measured from the soil surface to the top of the growing point using a measuring instrument; stem diameter was measured 3-5 cm from the soil surface using a caliper; the wet weight of plant biomass was measured using an

analytical balance (accuracy 0.01); and the number of pods and number of branches per plant was observed by counting all the pods and branches formed per plant. The samples observed were 3 plants per treatment.

The homogeneity of variance among treatments was tested by Bartlett's test, and the additive model was tested by Tukey's test. If these assumptions were fulfilled, the data were analyzed for variance. Hypothesis testing was conducted using the Least Significant Difference (LSD) test. The probability of committing an error was set at 0.05. Data analysis was performed using Microsoft Excel and the data processing software Statistical Tool for Agricultural Research (STAR) version 2.0.1.

RESULTS AND DISCUSSION

The results of the anova indicate that the application of various types of organic fertilizers significantly influenced all observed variables, both vegetative and yield components of edamame soybean. A summary of the anova is presented in Table 1. The findings in Table 2 indicate that applying different types of organic fertilizers significantly increased the plant height, stem diameter, and number of branches of edamame soybeans. The highest improvements were observed in treatment P6, with increases of 27.9% (plant height), 28.8% (stem diameter), and 124.8% (number of branches) compared to the control. According to Septian, Aini, and Herlina (2015), the use of organic materials is beneficial for improving soil structure damaged by excessive use of chemical fertilizers.

Table 1. Recapitulation Results of Analysis of Variance (Anova)

Times	Effect of the type of organic fertilizer		Coefficient of variation (%)
	Value of Pr (> F)	Significance	
Plant height	0,025	*	8,3
Stem diameter	0,002	*	10,6
Number of branches	0,011	*	17,1
Number of pods	0,004	*	16,2
Plant wet weight	0,015	*	19,1

* : significant at the α level =5%

Regarding the variables of plant height and stem diameter, the application of solid and liquid Kasgot organic fertilizers (P6) resulted in taller plants compared to treatments P0 and P2, although there was no significant difference compared to treatments P1, P3, P4, P5, and P7 of organic fertilizers. Meanwhile, in terms of the number of branches variable, the application of organic fertilizer type P6 resulted in a greater number of branches compared to treatments P0, P2, and P3. However, there was no significant difference compared to treatments P1, P4, P5, and P7 (Table 2). According to Nirmala, Pramati, and Dwi (2020), Kasgot or Black Soldier Fly (BSF) larvae residue contains nutrient elements essential for plants, including both macro and micronutrients. The content includes: N = 3.276%, P = 3.387%, K = 9.74%, organic C = 40.95%, C/N ratio = 12.50%, and moisture content = 11.04%. Another study indicated that maize plants cultivated in soil enriched with BSF larvae remnants showed a 109% increase in height and 14% more leaves compared to those cultivated in conventional compost (Alattar *et al.*, 2016).

The application of organic fertilizers also enhances the growth and yield components of edamame soybeans, as evidenced by an increase in wet-weight or fresh weight per plant and pod numbers per plant (Fig. 1 and 2). The highest growth

and yield were obtained from the use of solid and liquid Kasgot organic fertilizers (P6). Application of solid and liquid Kasgot organic fertilizers (P6) increased plant fresh weight and pod numbers per plant by 136.5% and 104.3% respectively, compared to the control (Fig. 1-2). Organic fertilizers contain macro and micronutrients essential for plant growth and development. Additionally, the benefits of organic fertilizers include microbiological activity, and cation exchange capacity (Yuliana *et al.*, 2015; Mahmudah, 2017).

The study found that solid organic fertilizers were more effective than liquid organic fertilizers. Solid fertilizers generally carry a lower risk of nutrient leaching compared to liquid fertilizers, meaning that nutrients are less likely to be washed away by rain or irrigation water before plants can absorb them. This aligns with Martínez-Alcántara *et al.* (2016) research, which concluded that animal-based solid fertilizer increased total tree biomass and carbohydrate content in leaves due to its intrinsic composition. Furthermore, the research results indicate that when solid organic fertilizers were combined with liquid organic fertilizers, especially those derived from Kasgot, they showed even better results (Table 2 and Fig. 1).

Table 2. The effect of types of organic fertilizers on plant height, stem diameter, and number of branches of edamame soybeans at 49 days after planting.

Types of organic fertilizers	Observed variables		
	Plant height (cm)	Stem diameter (mm)	Number of branches
P0	25,97 ± 1,25 c [#]	8,49 ± 1,12 b	6,67 ± 1,53 d
P1	30,80 ± 1,25 ab	10,83 ± 0,55 a	11,67 ± 3,51 abc
P2	27,13 ± 0,90 bc	8,07 ± 1,47 b	8,33 ± 1,53 cd
P3	29,10 ± 2,94 abc	11,78 ± 1,68 a	10,67 ± 0,58 bc
P4	31,53 ± 1,40 ab	10,61 ± 0,80 a	12,33 ± 4,62 ab
P5	33,00 ± 0,36 a	10,72 ± 1,28 a	12,00 ± 2,00 ab
P6	33,23 ± 3,13 a	10,94 ± 0,37 a	15,00 ± 1,73 a
P7	31,73 ± 4,55 a	10,93 ± 0,48 a	13,33 ± 3,79 ab
LSD value at 5%	4,42	1,92	3,38

Note: Numbers followed by different letters in the same column indicate statistically significant differences based on the Least Significant Difference (LSD) test at 5% level. P0: no organic fertilizer (control), P1: solid organic fertilizer non-Kasgot, P2: liquid organic fertilizer non-Kasgot, P3: solid Kasgot organic fertilizer, P4: liquid Kasgot organic fertilizer, P5: liquid and solid organic fertilizer non-Kasgot, P6: solid and liquid Kasgot organic fertilizer, and P7: non-Kasgot organic fertilizer and Kasgot organic fertilizer.

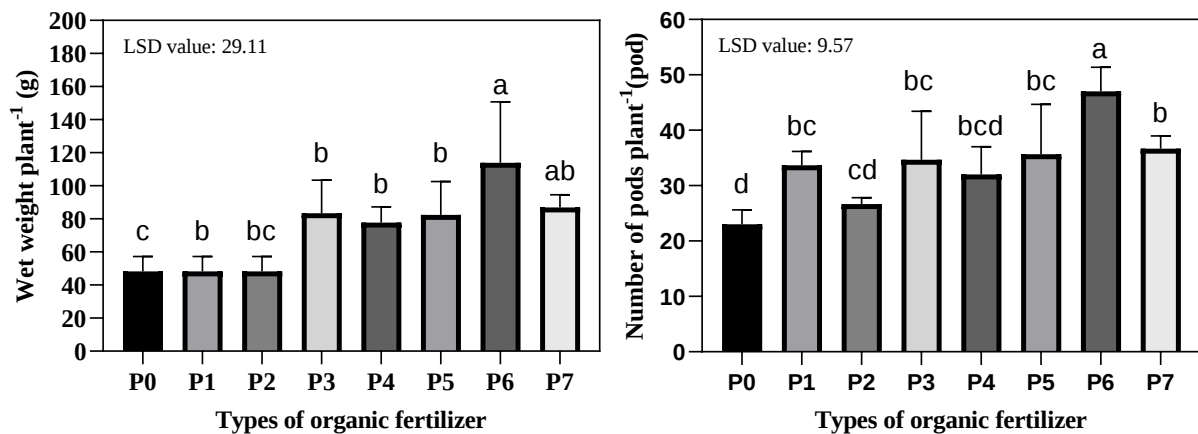


Figure 1. Effect of types of organic fertilizer on wet-weight biomass of plant (left) and number of pods plant⁻¹ (right). Different letters at the upper bar indicate statistically significant differences based on the LSD test at the 5% level. P0: no organic fertilizer (control), P1: solid organic fertilizer non-Kasgot, P2: liquid organic fertilizer non-Kasgot, P3: solid Kasgot organic fertilizer, P4: liquid Kasgot organic fertilizer, P5: liquid and solid organic fertilizer non-Kasgot, P6: solid and liquid Kasgot organic fertilizer, and P7: non-Kasgot organic fertilizer and Kasgot organic fertilizer

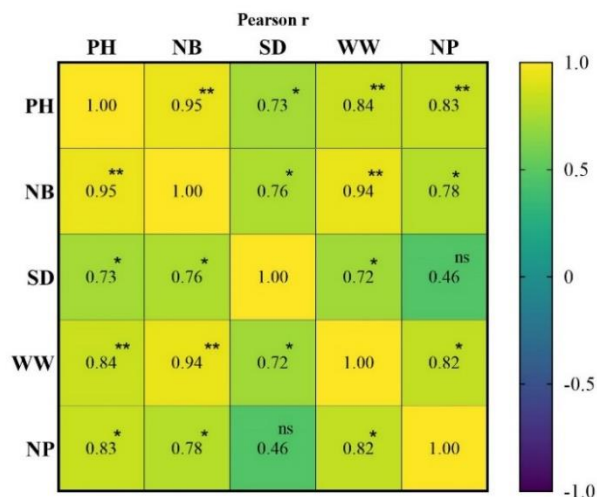


Figure 2. The Pearson correlation coefficient among the observed variables.

PH: plant height, NB: number of branches, SD: stem diameter, WW: wet weight plant⁻¹, NP: number of pods. *: significant at $\alpha=5\%$, **: significant at $\alpha=1\%$, ns: non-significant. The more yellow the color, the stronger the positive correlation between the two variables, while the darker green-purple indicates a stronger negative correlation between the two variables

The research also showed that Kasgot organic fertilizers had a significant impact on the growth and yield of edamame soybeans, leading to a substantial increase in plant fresh weight and pod numbers per plant. The highest growth and yield were obtained from the use of solid and liquid Kasgot organic fertilizers (P6). Application of solid and liquid Kasgot organic fertilizers (P6) increased plant fresh weight and pod numbers per plant by 136.5% and 104.3% respectively, compared to the control (Fig. 1). Organic fertilizers contain macro and micronutrients essential for plant growth and development. Additionally, the benefits of organic fertilizers include microbiological activity, and cation exchange capacity (Yuliana *et al.*, 2015; Mahmudah, 2017).

The correlation test results indicate that plant height, number of branches, and plant wet weight significantly correlate positively with the pod's number of edamame soybean plant⁻¹, except for stem diameter (Fig.2). This indicates that an increase in plant height, number of

branches, and plant wet weight will increase the number of pods plant⁻¹. Furthermore, it is also evident that plant height correlates significantly positively with the number of branches. An increase in plant height is accompanied by an increase in the number of branches, where each branch (node) serves as a site for soybean flowers to emerge, ultimately increasing the number of pods per plant. This result was consistent with the findings of Berhanu *et al.* (2021), who stated that plant height and the number of Other studies have also reported that the number of branches significantly positively correlates (0.81**) with the number of pods and seeds of soybean plant⁻¹ (Xu *et al.*, 2021).

CONCLUSION

This research indicates that using organic fertilizers on organic farmland can improve the growth and yield of edamame soybeans compared to control. Combination of solid kasgot organic

fertilizer (5 t ha⁻¹) and liquid kasgot (50 ml L⁻¹ water) produced the best plant growth and number of pods plant⁻¹. It was also reported that the variables of number of branches, plant height, and plant wet weight biomass positively correlated with the number of pods plant⁻¹.

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