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Aplikasi Kompos Daun Sengon (*Paraserianthes Falcataria* L.) sebagai Substitusi Pupuk Anorganik Terhadap Pertumbuhan dan Produksi dua Varietas Kedelai (*Glycine Max* L.)

The Application of Sengon (Paraserianthes Falcataria L.) Leaf Compost as Inorganic Fertilizer Substitute on the Growth and Production of two Soybean Varieties (Glycine Max L.)

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ABSTRACT

Improvement of cultivation techniques and increasing soil fertility through the use of organic fertilizers need to be considered to increase optimal growth and yield of soybean plants. This study was aimed to examine the effect of the substitution of compost leaves of sengon on inorganic fertilizer on the growth and production of two varieties of soybean. The study was conducted on January to April 2019 at greenhouse, Laboratory of Ecology and Plant Production, Faculty of Animal and Agricultural Science, Diponegoro University. The study used completely randomized factorial design with 6 x 2 factorial pattern and 5 replications. The first factor consisted of no compost and an inorganic fertilizer substitution, 25%, 50%, 75%, 100% compost substitution, respectively, and 100% of inorganic fertilizers. The second factor was detam 3 prida and malica. The parameters observed were number of branches, number of trifoliate leaves, number of pods, number of seeds, total production of seeds, the 100-seed weight. Data were analyzed using ANOVA and continued with DMRT test at 5% level. The results showed that substitution dose of 75% compost (26.19 N/ha) showed the highest results for all observed parameters, except for the number of trifoliate leaves, and showed the highest yield compared to no substitution on all plant parameters. On the basis of the data found throughout the experiment may be concluded that 75% compost of leaves sengon was the most suitable doses to be applied at the cultivation of soybean especially varieties of detam 3 prida and malica.

*Keywords**:** compost, detam, malika, soybean*

ABSTRAK

Perbaikan teknik budidaya dan meningkatkan kesuburan tanah melalui penggunaan pupuk organik perlu diperhatikan untuk meningkatkan pertumbuhan dan hasil tanaman kedelai yang optimal. Penelitian bertujuan untuk menguji pengaruh substitusi pupuk kompos daun sengon terhadap pupuk anorganik pada pertumbuhan dan produksi dua varietas kedelai. Penelitian dilaksanakan pada Januari – April 2019 di *greenhouse*, Laboratorium Ekologi dan Produksi Tanaman, Fakultas Peternakan dan Pertanian, Universitas Diponegoro. Rancangan Acak Lengkap pola faktorial 6 x 2 dengan 5 ulangan. Faktor pertama terdiri dari tanpa pupuk anorganik dan tanpa substitusi kompos (P0), kompos 25% (P1), kompos 50% (P2), kompos 75% (P3), kompos 100% (P4), dan substitusi 0% kompos pupuk anorganik 100% (P5). Faktor kedua adalah dua varietas kedelai detam 3 prida (A1) dan malika (A2). Parameter yang diamati adalah jumlah ranting, jumlah daun trifoliat, jumlah polong, jumlah biji, produksi total biji, berat 100 biji. Data dianalisis menggunakan uji ANOVA dan dilanjutkan dengan uji DMRT pada taraf signifikan 5%. Hasil penelitian menunjukkan bahwa pemberian dosis substitusi 75% Kompos (26,19 N/ha) memberikan hasil tertinggi pada semua parameter yang diamati, kecuali jumlah daun trifoliat, serta menunjukkan hasil tertinggi dibanding tanpa substitusi pada semua parameter tanaman. Berdasarkan pada data yang ditemukan pada penelitian dapat disimpulkan bahwa dosis kompos daun sengon 75% adalah dosis paling sesuai untuk diaplikasikan pada budidaya kedelai khususnya varietas detam 3 prida dan malika.

Kata kunci : detam, kedelai, kompos, malika

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INTRODUCTION

Soybean is one of the important commodities in Indonesia after rice and corn, and also is a source of vegetable protein. Soybeans cultivated in Indonesia so far are yellow-skinned species, while black soybeans are still less in demand. Soybean needs are increasing from year to year in line with population growth and public awareness of plant-based foods. However, soybean production in 2015 was 963,183 tons, an increase of only 0.8% compared to the previous year (Badan Pusat Statistik, 2015).

Black soybean varieties have a better advantage than yellow varieties in terms of nutritional content. Black soybeans are used as culinary raw materials such as soy sauce which derived from black soybeans. The need for soybean commodities continues to increase every year. The increasing needs must be balanced with the level of soybean production. The proportion of soybean use for soy sauce is 325220 tons of soybeans (Ginting and Yulifianti, 2014).

Sengon is a tree legume plant that can bind free nitrogen in the air in an unavailable form (N_2) for plants. Symbiosis with rhizobium N2 is converted to NO_3- or NH_4^+ available to plants. Sengon leaf which has potential as forage for ruminant food rich in nitrogen, phosphorus, potassium and calcium. Widiyanto and Sudomo (2014) stated that the production of peanut in the treatment of sengon pruning litter (1146.8 kg/ha) was greater than other treatments.

The use of inorganic fertilizers continuously can have a negative impact, namely, a decrease in the quality of soil and water. Soil fertility is an important aspect of farming life in order to produce good food. Efforts that can be done to overcome these problems are to implement organic farming.

This research aims to examine the effect of sengon (P. falcataria L.) leaf compost as a substitution of inorganic nitrogen fertilizer and the interaction between the treatment of sengon leaf compost substitution and black soybean varieties on the growth and production of black soybeans.

MATERIALS AND METHODS

The research was carried out in January - April 2019 in the greenhouse and the Plant Production and Ecology Laboratory, Faculty of Animal Husbandry and Agriculture, Diponegoro University, Semarang.

The research area is located at 7º05'41.23º South Latitude and 110º44'03.10º East Longitude with an altitude of 256.0 meters above sea level (masl), with an average daily temperature of 28.1ºC, rainfall 3.100 mm/year, 75% air humidity (Central Statistics Agency, 2019).

The materials used in this research were black soybean seeds of Detam 3 Prida and Malika varieties, cow dung, sengon leaf, EM4. The equipment used consists of seedlings tray, pots, shovels, measuring cups, measuring tapes, bamboo poles, lux meters, ovens, scales, analytical scales, stationery, cameras, Erlenmeyer flasks, pipettes, spectrophotometer, flame-photometers, and cuvettes.

The research was conducted using a factorial completely randomized design. The first factor is the dosage of sengon leaf compost, namely control (P0), 25% compost (P1), 50% compost (P2), 75% compost (P3), 100% compost (P4), and substitution 0% inorganic fertilizer compost 100% (P5). The second factor is Detam 3 Prida (A1) and Malika (A2) soybean varieties. The two research factors resulted in 12 treatment combinations with each being repeated five times hence 60 unit experiments were obtained.

The research began with the making of sengon leaf compost with a composition consisting of 100 kg of sengon leaf, 0.125 liters of bioactivator, 125 g of sugar, and 100 liters of water. The procedure for making compost begins with preparing the leaves of sengon for drying in the wind. The dried leaves of the sengon are separated from the stem branches and put in a bucket. Other ingredients are put in jerry cans and stirred until homogeneous. The solution is then watered on the leaves of the sengon and then closed and incubated for 2 weeks. During incubation the temperature continues to be monitored.

Preparation of planting media is done by means of soil taken, then dried in a greenhouse. The dry wind soil is then sieved and samples taken for nutrient content analysis. Soil samples and sengon leaf compost are then analyzed in the laboratory for nutrient content (N, P, K, C organic soil). Chemical analysis was carried out before planting and after harvesting. The soil is then put into a pot measuring 35 x 35 cm with a weight of 7 kg each per pot.

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Soybean planting is done by then moving the soybean seeds (age 2 WAP) from the tray into the planting media in the pot. Furthermore, the application of sengon leaf compost and urea fertilizer is in accordance with the treatment. Compost and urea fertilizer application is done by perforating the soil in a circle around the soil surface according to the treatment dose. Fertilization is done based on the recommended fertilization of soybean plants.

The parameters observed included the number of twigs (fruit), number of trifoliate leaves (fruit), number of pods per plant (fruit), number of seeds per plant, the weight of seeds (g) and weight of 100 seeds (g). The research data obtained were analyzed using ANOVA with a confidence level of 95% difference in the middle value was tested using DMRT at a significance level of 5%.

RESULTS AND DISCUSSION

Number of branches

Based on the variance analysis results it showed that there was no interaction effect between the dose of sengon leaf compost substitution and soybean varieties on the number of branches. The treatment of sengon leaf compost dose substitution and soybean varieties each had a significant influence on the number of twigs. The number of branches in the treatment of sengon leaf compost dose substitutes and soybean varieties, and Duncan's multiple range test are presented in Table 1.

The number of soybean branches in the substitution treatment of 75% compost (5.43 pieces) was significantly higher compared to all other treatments. The treatment of nitrogen fertilizer is needed in the initial growth of plants as a process of cell elongation in the vegetative phase of plants. It is in accordance with the statement of Muzammil et al. (2010) that the application of nitrogen fertilizer on plants plays an important role in increasing plant height and diameter, the number of branches, and plant rigidity. The number of branches of soybean plants is also influenced by soybean varieties. The number of soybean branches in the treatment of detam soybean varieties (4.88 fruits) was significantly higher than malica soybean (3.81 fruits). The different number of twigs is caused by soybean varieties, both of which have different genetic characteristics. In accordance with the opinion of Kumudini et al. (2007) that the number of soybean branches is determined by plant genetics.

Amount of Trifoliate Leaves of Soybean Plants

Based on the variance analysis results showed that there was no interaction effect between compost substitution dose and soybean varieties on the number of trifloliate leaves. The treatment of compost substitution dose and soybean variety did not significantly affect the number of trifloliate leaves of soybean plants.

Table 1. Number of Black Soybean Branches at Various Doses of Sengon Leaf Compost Substitution and Different Soybean Varieties.

Compost Substitution Dose	Soybean Varieties		Averages
	Detam 3 Prida (A1)	Malica (A2)	
Control (P0)	4,14	3,20	3,67^{c}
25% compost (P1)	4,70	3,40	4,05^{bc}
50% compost (P2)	4,90	4,03	4,47^{b}
75% compost (P3)	5,73	5,13	5,43^{a}
100% compost (P4)	5,07	3,57	4,32^{b}
0% inorganic fertilizer compost 100% (P5)	4,77	3,53	4,15^{bc}
Averages	4,88^{a}	3,81^{b}	

Note: Figures followed by different superscripts in the average row and average column showed significant differences based on the DMRT test α = 5%.

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Table 2. Number of Black Soybean Trifoliate Leaves at Various Doses of Compost in Sengon Leaf Compost and Different Soybean Varieties.

Compost Substitution Dose	Soybean Varieties		Averages
	Detam 3 Prida (A1)	Malica (A2)	
Control (P0)	18,52	15,64	17,08
25% compost (P1)	17,44	18,56	18,00
50% compost (P2)	18,94	15,70	17,32
75% compost (P3)	18,18	19,08	18,63
100% compost (P4)	17,10	15,40	16,25
0% inorganic fertilizer compost 100% (P5)	18,66	15,70	17,18
Averages	18,14	16,68	

Based on the variance analysis results showed that there was no interaction effect between compost substitution dose and soybean varieties on the number of trifoliate leaves. The treatment of compost substitution dose and soybean variety did not significantly affect the number of the trifoliate leaves of soybean plants. The number of trifoliate leaves in the treatment of compost substitution doses and soybean varieties, based on and distance test.

Table 2 showed that the substitution of sengon leaf compost up to 100% can offset the role of inorganic fertilizer. This proves that the use of organic fertilizers can increase the efficiency of using inorganic fertilizers, to minimize the use of inorganic fertilizers. This is in accordance with the opinion of Musnawar (2005) that the use of organic fertilizers can increase the efficiency of inorganic fertilizer use because organic fertilizers can increase the availability of water and nutrients in the soil, increase the activity of microorganisms, increase humus levels and improve soil structure. Supported by Novizan's opinion (2007) that organic fertilizer also provides macro and micro-nutrients, increasing the exchange capacity of soil cations and increasing the activity of soil microorganisms, thus making plants nutrient sufficient. Fertilizer application in sufficient quantities can be used optimally for plant growth.

Number of Pods

Based on the variance analysis results, it showed that there is an interaction effect between the compost substitution dose and soybean varieties on the number of pods. The treatment of compost substitution dosage and soybean varieties each had a significant influence on the number of pod parameters. The number of pods in the treatment of compost substitution doses and soybean varieties based on Duncan's multiple range test is presented in Table 3.

The number of soybean pods in the substitution treatment of 75% compost (136.40 pieces) was not significantly different from substitution of 50% compost (129.30 pieces) and 100% compost (128.00 pieces), but significantly different from the treatment of 25% compost (119.10 units), 0% compost (112.60 units), and control (106.50 units). High and suitable nutrient content for compost proven to be able to optimize plant growth. This is in accordance with the results of research by Harsono and Suryantini (2011) which stated that the nutrients contained in organic fertilizers greatly support the process of forming soybean pods. The high concentration of compost use resulted in a decrease in the use of inorganic fertilizers and the use of organic fertilizers can increase the efficiency of the use of inorganic fertilizers. Supported by Musnawar (2005) that the use of organic fertilizers can increase the efficiency of inorganic fertilizer use, as well as increase water and nutrients in the soil, increase the activity of microorganisms, increase humus levels and improve soil structure.

The number of Malika soybean pods (133.80 fruits) was significantly higher than the number of Detda 3 Prida soybean pods (110.17 fruits). Different genetic characteristics between

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the two soybean varieties are thought to influence the appearance of both. In the opinion of Gabesius et al. (2012) that the diversity of the number of pods produced between varieties is influenced by the genetics of the dominant variety, and also supported by a suitable growing environment so that high yields can be obtained.

Number of Seeds

Based on the variance analysis results, it showed that there is an influence of the interaction between compost substitution dose and soybean varieties on the number of seeds. In the parameters of the number of seeds, only the treatment of compost substitution dose had a significant effect on the number of seeds and soybean varieties do not have a significant effect on the number of seeds.

Table 3. Number of Black Soybean Pods in Various Combination Doses of Sengon Compost Substitution and Different Soybean Varieties.

Compost Substitution Dose	Soybean Varieties		Averages
	Detam 3 Prida (A1)	Malika (A2)	
Control (P0)	95,80^{c}	117,20^{abc}	106,50^{d}
25% compost (P1)	107,60^{bc}	130,60^{ab}	119,10^{bc}
50% compost (P2)	115,80^{abc}	142,80^{a}	129,30^{ab}
75% compost (P3)	125,20^{abc}	147,60^{a}	136,40^{a}
100% compost (P4)	109,40^{bc}	146,60^{a}	128,00^{ab}
0% inorganic fertilizer compost 100% (P5)	107,20^{bc}	118,00^{abc}	112,60^{cd}
Averages	110,17^{b}	133,80^{a}	

Note: Numbers followed by different superscripts in the average row and average column showed significant differences based on the DMRT test α = 5%

Table 4. The Number of Black Soybean Seeds in Different Combinations of Sengon Leaf Compost Substitution Doses and Different Soybean Varieties.

Compost Substitution Dose	Soybean Varieties		Averages
	Detam 3 Prida (A1)	Malika (A2)	
Control (P0)	145,20^{b}	164,20^{b}	154,70^{c}
25% compost (P1)	183,20^{ab}	190,20^{ab}	186,70^{b}
50% compost (P2)	215,00^{ab}	203,60^{ab}	209,30^{ab}
75% compost (P3)	217,60^{ab}	261,00^{a}	239,30^{a}
100% compost (P4)	93,80^{ab}	208,80^{ab}	201,30^{b}
0% inorganic fertilizer compost 100% (P5)	180,80^{ab}	198,60^{ab}	189,70^{b}
Averages	189,27	204,40	

Note: Numbers followed by different superscripts in the average row and average column showed significant differences based on the DMRT test α = 5%

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The difference in the number of seeds that occurs due to differences in plant response to the application of nutrients supplied. According to Marliah et al. (2012) the number of seeds per plant is more than 100 grains, classified as soybean that has the potential to produce high production. According to Adisarwanto and Wudianto (2008), the soybean seed filling phase is an important part. The presence of sufficient water is a requirement when plants enter a period of flowering, pod formation and seed filling.

Total Seed Production

Based on the variance analysis results, it showed that there is an interaction effect between compost substitution dose and soybean varieties on total seed production. The treatment of compost substitution dose significantly affected the total seed production parameters, but the treatment of soybean varieties did not significantly affect the total seed production. The total production of seeds in the treatment of compost substitution doses and soybean varieties, based on Duncan's multiple range test is presented in Table 5.

Based on table 5, it showed that the compost substitution dosage treatment has an effect on the total production of soybean seeds. The total production of soybean seeds in the substitution treatment of 75% compost (30.90 g) was not significantly different from the substitution of 100% compost (27.23 g), but significantly different from the substitution of 50% compost (24.91 g), 0% compost (22.90 g), 25% compost (21.48 g), and control (20.06 g). This showed that increasing the dose of sengon compost substitution to 75% increased total seed production, but decreases again at a percentage of 100%. Application of abundant nutrients to plants can cause poisoning to plants which cause stunted growth, thereby reducing crop production.

Table 5. Total Production of Black Soybean Seeds at Various Doses of Sengon Leaf Compost Substitution and Different Soybean Varieties.

Compost Substitution Dose	Soybean Varieties		Averages
	Detam 3 Prida (A1)	Malika (A2)	
Control (P0)	24,19^{a-d}	15,93^{cd}	20,06^{d}
25% compost (P1)	26,87^{ab}	16,09^{d}	21,48^{cd}
50% compost (P2)	27,50^{ab}	22,33^{a-d}	24,91^{bc}
75% compost (P3)	29,21^{a}	32,60^{a}	30,90^{a}
100% compost (P4)	29,19^{a}	25,27^{a-d}	27,23^{ab}
0% inorganic fertilizer compost 100% (P5)	26,50^{abc}	19,30^{bcd}	22,90^{bcd}
Averages	27,24	21,92	

Note: Numbers followed by different superscripts in the average row and average column showed significant differences based on the DMRT test $\alpha = 5\%$

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Table 6. Weight of 100 Black Soybean Seeds at Various Doses of Sengon Leaf Compost Substitution and Different Soybean Varieties.

Compost Substitution Dose	Soybean Varieties		Averages
	Detam 3 Prida (A1)	Malika (A2)	
Control (P0)	11,72^{ab}	7,89^{c}	9,80
25% compost (P1)	12,24^{ab}	8,31^{c}	10,66
50% compost (P2)	12,48^{a}	8,83^{bc}	11,71
75% compost(P3)	12,93^{a}	10,99^{abc}	11,97
100% compost (P4)	12,84^{a}	10,58^{abc}	10,63
0% inorganic fertilizer compost 100% (P5)	11,79^{ab}	9,47^{abc}	10,28
Averages	12,34^{a}	9,35^{b}	

Note: Numbers followed by different superscripts in the average row and average column showed significant differences based on the DMRT test $\alpha = 5\%$

According to Istarofah and Salamah (2017) stated that the application of adequate nutrients and in accordance with plant needs is the best choice because it can increase plant growth and production.

Based on table 5, it showed that the different of soybean varieties applied have not been able to show differences in total seed production between the two varieties. According to Pandiangan and Rasyad (2017) that the greater the total production of seeds, the greater the weight of 100 seeds. Genetic and environmental factors affect the size of the seeds. According to Sarawa et al., (2014) stated that varieties have different genetic advantages hence each variety has a different production.

The difference in total production of plant seeds is due to soybean varieties, both of which have different genetic characteristics. This is consistent with the statement of the Indonesian Center for Various Beans and Sweet Potato Crops Research (2013) that the Detam 3 Prida variety is medium-sized soybean seeds and 11.8 g/100 seed size and the Agricultural Research and Development Agency (2008) that the Malika variety is soybean seed with small in size and the size of seeds is 9-10 g/100 seeds.

Weight of 100 Seeds

Based on the variance analysis results, it showed that there is an influence of the interaction between compost substitution dose and soybean varieties on the weight of 100 seeds. The treatment of soybean varieties significantly affected the weight parameters of 100 seeds, but the treatment of compost substitution dose did not significantly affect the weight of 100 seeds. The weight of 100 seeds in the treatment of compost substitution doses and soybean varieties, based on Duncan's multiple range test is presented in Table 6.

The weight of 100 seeds can be a reflection of the size of the soybean seeds. In accordance with the opinion of Mejaya et al. (2010) that high yielding varieties of soybeans with high yield, large seed size and early maturity and preferred by consumers. Adisarwanto (2005) stated that small-seeded soybeans weighing 6-10 g/100 seeds, medium seeds weighing 11-13 g/100 seeds, and large weighing more than 13 g/100 seeds. The size of 100 soybean seeds can be used as a parameter of high production. If the weight of 100 seeds is high, more results will be obtained.

CONCLUSION

Based on the research results, it can be concluded that in the Detam 3 Prida and Malika soybean cultivation, organic compost fertilizer can be used, especially the 75% sengon leaf compost from the amount of fertilizer applied.

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