The effect of organic fertilizers on growth several varieties of soybeans

M Rizwan¹, M Dalimunthe¹, I A Pasaribu¹, H Satriawan²

¹ Department of Agrotechnology, Faculty of Agriculture, Universitas Islam Sumatera Utara, Gedung Johor, Medan, Indonesia.
² Department Agrotechnology, Faculty of Agriculture, Almuslim University, Bireuen, Aceh, Indonesia 24211

* E-mail: muhammadrizwanagr@gmail.com; satriawan_80@yahoo.co.id

Abstract. This study aims to analyse the effect of three types of organic fertilizers on the vegetative growth several varieties of soybeans. This study used a factorial randomized block design with two treatment factors, namely organic fertilizers and varieties. The first factor is: organic fertilizer from 3 levels, namely: K₁ (1.5 kg of compost), K₂ (1.5 kg of goat manure), and K₃ (1.5 kg of chicken manure). The second factor is: soybean plant varieties consist of 4 levels, namely: V₁ (Dena 1), V₂ (Devon 1), V₃ (Anjasmo) and V₄ (Derap 1). The parameters observed were plant height, number of branches, number of leaves, amount of chlorophyll, leaf area, and flowering age. The results of our research is organic fertilizers have a significant effect and are able to increase the growth of soybean plants except for leaf area and flowering age. Types of varieties had a significant effect and were able to increase plant height, number of branches, leaf area, and flowering age, but had no significant effect on the parameters of the number of leaves and the amount of chlorophyll. Moreover, there isn't interaction effect between the two treatments for all parameters.

1. Introduction
Soybean is the third most important food commodity in Indonesia after rice and maize, where processed soy products such as tofu, tempeh and soy sauce have become the main source of protein for Indonesian people. This is evidenced by the increase in national soybean consumption published by the Ministry of Agriculture in 2016 which states that national soybean consumption continues to increase every year, in 2015 the total national soybean consumption was 1,563,827.04 tons and increased in 2016 to be as big as 2,486,775.94 tons, from these data, soybean consumption in 2015–2016 has increased by 59%. The increase in consumption is not accompanied by an increase in total soybean production in Indonesia, in 2015 there was a significant deficit between total consumption and total soybean production in Indonesia, there was a deficit of 600,644.04 tons, of the total production in 2015 was 963,183.00 tons, and to meet the national demand for soybeans, in this case the government is still importing soybeans [1].

Based on these facts, efforts aimed at increasing the productivity of soybean plants need to be done with improving the physical properties of the soil. This is because soybean plants are generally planted...
in paddy fields at the end of the rainy season, so that water is one of the obstacles in achieving the best growth and maximum yield. It is hoped that organic fertilizers from chicken coops and compost will be able to function in improving the physical properties of the soil, especially soil structure through improving the physical properties of the soil. Improvement of soil physical properties can stimulate soil granulation, spur development of better plant roots so that plants can search for water and nutrients more optimally. Thus, the application of inorganic fertilizers in high amounts can be controlled.

Manure is solid and liquid manure from livestock mixed with food scraps and cage mats which can function as a stabilizer for soil aggregates [2; 3]. However, the size of the effect of manure applied to the improvement of soil physical properties will greatly depend on the level of maturity and the dose of manure applied [4]. In soil conditions with low levels of organic matter availability, the application of large amounts of manure is needed. However, if the level of availability of soil organic matter is high, the application of manure is not required. The ideal average content of organic matter is around 2.5% - 5% [5]. The use of manure can improve soil fertility and increase the efficiency of using inorganic fertilizers, thereby accelerating plant growth. The content of N, P, K in manure is not too high [6, 7, 8] but can improve soil permeability, porosity, soil structure, water holding power and soil cation content. This study aims to analyse the response of several soybean varieties to different organic fertilizers.

2. Methods

2.1. Place and Time of Research
The research was conducted in the experimental field at the Faculty of Agriculture, Islamic University of North Sumatra, Medan Johor Sub-district, Medan City. The research field are located at altitude ± 25 meters above sea level, with flat topography. This research was started from March to June 2020.

2.2. Tools and Materials
The tools were used in this study are: a set of SPAD tools, hand sprayer, hoe, triped machete, analytical scales, cutter blades, buckets, treatment boards, research boards, standard stakes, calculators, documentation tools, writing instruments and others that support the implementation of the research. Whereas, the materials of this research were: Varieties of soybean Dena 1, Devon 1, Anjasmoro, Derap 1, compost, chicken manure, goat manure, and other materials that support the research.

2.3. Research Method
This study was used a factorial randomized block design (RBD) with two factors. The first factor is organic fertilizer consisted of 3 levels, and the second is soybean plant variety type factor consisted of 4 levels. The first factor consists of three levels, namely: K1 = compost fertilizer (8 kg / plot); K2 = goat manure (8 kg / plot); K3 = Fertilizer for the chicken house (8 kg / plot). The second factor consist of four levels, namely: V1 = Dena 1 variety; V2 = Devon variety 1; V3 = Anjasmoro variety; V4 = Derap variety 1.

The plant growth parameters observed were: 1) Plant height (cm). Plant height is measured from the base of the stem at the soil surface to the point of growth. Plant measurements were carried out when the plants were 2 WAP. To prevent measurement errors, each sample plant is marked with a stake. Observation of plant height was carried out at intervals of 1 week until the plants entered the generative growth stage. 2) Number of branches (branches). Observation of the number of branches was carried out when the plants were 2 WAP. With 1 week interval of calculation. The number of branches is done by counting the number of existing branches. Observation of the number of branches is stopped when the plant enters the generative growth phase (flower appears). 3) Number of leaves (strands). Observation of the number of leaves was carried out when the plants were 2 WAP at 1 week intervals. The calculation of the number of leaves is done by counting the number of perfectly open leaves. 4) Amount of Chlorophyll (grain / cm). Observation of the amount of chlorophyll was carried out using a Chlorophyll meter SPAD (Soil Plant Analysis Development) tool. Measuring the amount
of leaf chlorophyll, place the leaf sample in the chlorophyll meter head slot then press it down, when the head is closed above the leaf, the meter will sound and the measurement result will appear on the screen. Calculation of the amount of leaf chlorophyll is done once. Calculation of the amount of leaf chlorophyll was only carried out on sample plants. 5) Leaf Area Index (cm²). Leaf area calculations are carried out at the end of vegetative growth, marked by the appearance of soybean plant flowers. Leaf area calculation is done once. The calculation is only carried out on the sample plants. Leaf area measurement uses a leaf area meter. 6) Flowering Age (days). Observation of flowering age is done by counting the days starting from when the soybean plant is planted until the plants produce flowers.

3. Results and discussion

3.1. Plant Height

The results of analysis of variance showed that the test of several types of organic fertilizers had no significant effect on plant height at 2 and 3 WAP but had a significant effect at 4 WAP. The effect of several types of soybean plant varieties did not significantly affect plant height at 2 and 3 WAP, but had a significant effect at 4 WAP. The interaction between organic fertilizer and variety tests had no significant effect on plant height in each planting (Table 1).

Table 1. Plant height at 4 weeks after planting

| Treatment      | Variety     | K1 (Compost) | K2 (Goat Manure) | K3 (Chicken Manure) | Average |
|----------------|-------------|--------------|------------------|---------------------|---------|
| Varieties      |             |              |                  |                     |         |
| V1 (Dena1)     | 33.67       | 32.83        | 35.67            | 34.06 a             |         |
| V2 (Devon 1)   | 31.83       | 31.83        | 32.42            | 32.03 b             |         |
| V3 (Anjasmoro) | 32.83       | 36.17        | 35.67            | 34.89 a             |         |
| V4 (Derap 1)   | 29.00       | 33.25        | 31.75            | 31.33 b             |         |
| Average        | 31.83 b     | 33.52 a      | 33.88 a          |                     |         |

Note: Figures followed by different letters in the same treatment group are significantly different at the 5% level based on the DMRT test.

Several types of organic fertilizers had a significant effect on the height of soybean plants with the highest plants obtained in the K3 treatment (chicken manure) resulting in the highest plants, namely 33.88 cm, which was not significantly different from the K2 treatment (goat manure), which was 33.52 cm, and the two treatments were significantly different from the K1 treatment (compost), namely 31.83 cm.

The results showed that among the organic fertilizers used, it was seen that chicken manure showed the highest average plant, although not significantly different from goat manure. Manure or organic fertilizer contains different nutrients because each animal has its own characteristics which are determined by the source of organic matter and the type of food and age of the animal. Such as the nutrients found in chicken manure, the nutrients are 3.21% nitrogen, 3.21% phosphor, 1.57% potassium, 1.57% Ca, 1.44% Mg, 250 ppm Mn and 315 ppm Mn[9] (Dwipa, 2020). Nutrients in goat manure N 2.10%, P2O5 0.66%, K2O 1.97%, Ca 1.64%, Mg 0.60%, Mn 233 ppm and Zn 90.8 ppm [10].

Anjasmoro variety produces the highest plants than other varieties. The difference in response shown in the height of the soybean plant was due to different varieties, presumably due to differences in genetic traits of the four varieties tested. This difference in genetic traits causes differences in the response of the four varieties to various environmental conditions, so that the growth activities shown
are different. This is in accordance with the statement of [11] that the difference in growth power between varieties is determined by genetic factors.

3.2. Number of Branches

Analysis of variance showed that the organic fertilizer test had no significant effect on the number of branches at 2 WAPs but had a significant effect on 3 and 4 WAPs. The treatment of several varieties had no significant effect on the number of branches at the age of 2 and 3 WAP but had a significant effect on the age of 4 WAP. The average difference test for the application of several types of organic fertilizers and soybean plant varieties on the number of branches at the age of 4 WAP can be seen in table 2.

Table 2. Number of branches soybean at 4 weeks after planting

| Treatment       | Organic fertilizers | Average |
|-----------------|---------------------|---------|
|                 | K₁ (Compost)        | K₂ (Goat Manure) | K₃ (Chicken Manure) |
| V₁ (Dena1)      | 19,00               | 17,75    | 18,33               | 18,36 a |
| V₂ (Devon 1)    | 14,42               | 15,25    | 18,17               | 15,94 b |
| V₃ (Anjasmoro)  | 13,42               | 15,83    | 17,25               | 15,50 b |
| V₄ (Derap 1)    | 15,58               | 15,33    | 19,33               | 16,75 ab |
| Average         | 15,60 b             | 16,04 b  | 18,27 a             |

Note: Figures followed by different letters in the same treatment group are significantly different at the 5% level based on the DMRT test.

Table 2 shows that the application of organic fertilizers has a significant effect on the number of branches. The highest number of branches in the K₃ treatment (chicken manure), namely 18.27 branches, was significantly different from the K₂ treatment (goat manure), namely 16.04 branches and K₁ treatment (compost), namely 15.60 branches.

The treatment of chicken manure has the highest number of branches. This condition is suspected that the N content in chicken manure is higher than other organic fertilizers (goat manure and compost). The effect of increasing the number of branches is related to the supply of nutrients to the plant and fixing nitrogen in the air through root nodules. The availability of nitrogen contained in chicken manure affects the number of branches of soybean plants. Nitrogen plays an active role during vegetative growth of plants. The results of this study are in accordance with the statement from [12] that applying fertilizers with higher nitrogen content can accelerate the growth and development of plant organs so that they experience faster increase in the number of leaves, plant height and branch growth.

Table 2 also shows that several types of soybean plant varieties have a significant effect on the number of branches. The highest number of branches was obtained in treatment V₁ (Dena 1), namely 18.36 branches, which was not significantly different from treatment V₄ (beat 1), namely 16.75 branches but significantly different from treatment V₂ (Devon 1), namely 15.94 branches and treatment V₃ (Anjasmoro) which is 15.50 branches. Treatment V₄ was not significantly different from treatment V₂ and V₃. These results indicate that the dena-1 variety is more responsive to organic fertilizers.

3.3. Number of leaves

Analysis of variance showed that organic fertilizers had no significant effect on the number of leaves at 2 WAP but had a significant effect at 3 and 4 WAP. The treatment of several varieties had no significant effect on the number of leaves at each observation (Table 3).


Table 3. Number of leaves soybean at 4 weeks after planting

| Treatment   | Organic Fertilizer | K₁ (Compost) | K₂ (Goat Manure) | K₃ (Chicken Manure) | Average |
|-------------|--------------------|--------------|------------------|---------------------|---------|
| Varieties   |                    |              |                  |                     |         |
| V₁ (Dena1)  |                    | 40,92        | 47,42            | 41,00               | 43,11   |
| V₂ (Devon 1)|                    | 33,33        | 39,08            | 42,58               | 38,33   |
| V₃ (Anjasmoro)|                   | 32,58        | 41,58            | 41,50               | 38,56   |
| V₄ (Derap 1)|                    | 36,08        | 43,42            | 43,92               | 41,14   |
| Average     |                    | 35,73 b      | 42,88 a          | 42,25 a             |         |

Note: Figures followed by different letters in the same treatment group are significantly different at the 5% level based on the DMRT test.

The provision of several types of organic fertilizers had a significant effect on the number of leaves of soybean plants with the highest number of leaves in goat manure treatment (K₂), which was 42.88, which was not significantly different from chicken manure (K₃), namely 42.25 strands and secondly the treatment was significantly different from compost (K₁), namely 35.73 strands.

Macro nutrient elements in organic fertilizers such as nitrogen (N) have an important role in leaf growth, high levels of nitrogen nutrients will produce more and larger leaves. Leaves are an important part of plants, because of the chlorophyll content, the photosynthesis process can take place in the leaves. This concurs with [13] which states that the nutrient nitrogen is very useful for plants for growth and development.

Table 3 also explains that the type of variety has no significant effect on the number of leaves of soybean plants. Treatment V₁ (Dena 1) produced the highest number of leaves, namely 43.11, followed by treatment V₄ (Derap 1), namely 41.14 strands, then treatment V₃ (Anjasmoro), namely 38.56 leaves and treatment V₂ (Devon 1), namely 38.33 strands. The four treatments were not significantly different from one another.

3.4. Total Chlorophyll

Analysis of variance showed that the organic fertilizer test had a significant effect on the amount of chlorophyll, while the use of several varieties had no significant effect on the amount of chlorophyll. The average difference test for the application of several types of organic fertilizers and soybean plant varieties on the amount of chlorophyll were shown in table 4.

Table 4. Total chlorophyll several varieties of soybean

| Treatment   | Organic Fertilizer | K₁ (Compost) | K₂ (Goat Manure) | K₃ (Chicken Manure) | Average |
|-------------|--------------------|--------------|------------------|---------------------|---------|
| Varieties   |                    |              |                  |                     |         |
| V₁ (Dena1)  |                    | 39,62        | 42,20            | 43,79               | 41,87   |
| V₂ (Devon 1)|                    | 41,64        | 40,51            | 41,14               | 41,10   |
| V₃ (Anjasmoro)|                   | 38,95        | 41,64            | 43,05               | 41,22   |
| V₄ (Derap 1)|                    | 40,84        | 42,29            | 43,08               | 42,07   |
| Average     |                    | 40,26 b      | 41,66 a          | 42,76 a             |         |

Note: Figures followed by different letters in the same treatment group are significantly different at the 5% level based on the DMRT test.
The type of organic fertilizer had a significant effect on the amount of chlorophyll, the highest amount was in the K3 treatment (chicken manure), that is 42.76 grains / cm, not significantly different from the K2 treatment (goat manure) that is 41.66 grains / cm was significantly different from the K1 treatment (compost) which was 40.26 grains / cm³.

The dominant nitrogen element found in manure functions in increasing vegetative growth of plants, especially to spur leaf growth, with more leaf chlorophyll, the higher the photosynthate produced, so that the higher the photosynthate is translocated, the photosynthate is used for plant growth and development including new leaf formation. According to [14] nitrogen can accelerate growth and provide greater yields encouraging the growth of vegetation such as leaves, stems, roots which have an important role in plants. In this case, treatment using chicken manure produced the highest amount of chlorophyll. According to [15, 16] states that providing organic material, especially chicken manure, can increase plant growth and chlorophyll in leaves. Nitrogen is closely related to chlorophyll synthesis and protein and enzyme synthesis [17].

3.5. Leaf Area
Analysis of variance showed that the organic fertilizer test had no significant effect on the leaf area of soybean plants, while the use of several varieties had a significant effect on the leaf area of soybean plants (table 5).

Table 5. Leaf area of several varieties of soybean

| Treatment       | Organic Fertilizer | Average |     |
|-----------------|--------------------|---------|-----|
|                 | K₁ (Compost)       | K₂ (Goat Manure) | K₃ (Chicken Manure) |     |
| Varieties       |                    |         |     |
| V₁ (Dena1)      | 38,77              | 39,23   | 39,60 | 39,20 d |
| V₂ (Devon 1)    | 43,00              | 43,45   | 43,36 | 43,27 a |
| V₃ (Anjasmoro)  | 41,79              | 42,58   | 41,47 | 41,95 b |
| V₄ (Derap 1)    | 32,27              | 31,99   | 32,45 | 32,24 c |
| Average         | 38,96              | 39,32   | 39,22 |     |

Note: Figures followed by different letters in the same treatment group are significantly different at the 5% level based on the DMRT test.

From Table 5, it can be seen that the type of organic fertilizer has no significant effect on the leaf area index with the widest leaves being in the K₂ treatment (goat manure), which is 39.32 cm², which is not significantly different from the K₃ treatment (chicken manure), namely 39.22 cm² and K₁ (compost) which is 38.96 cm².

In addition, it was known that the V₂ treatment (Devon 1) produced the widest leaves, namely 43.27 cm², which was significantly different from other treatments. The narrowest leaf was in treatment V₄ (Derap 1), which was 32.24 cm², which was significantly different from treatment V₁ (Dena 1) which was 39.20 cm² and treatment V₃ (Anjasmoro) which was 41.95 cm². Each variety shows a significant difference in the mean value between the four varieties. The devon 1 variety has the widest leaves compared to the other three varieties. The difference in leaf area is the result of variations in leaf formation. In addition, genetic factors also affect the leaf area of the varieties planted [18, 19].

3.6. Flowering Age
The analysis of variance showed that the organic fertilizer test had no significant effect on the flowering age of soybean plants while the use of several varieties had a significant effect on the
flowering age of soybean plants. The average difference test for the application of several types of organic fertilizers and soybean plant varieties on flowering can be seen in Table 6.

| Treatment | K1 (Compost) | K2 (Goat Manure) | K3 (Chicken Manure) | Average |
|-----------|--------------|------------------|---------------------|---------|
| V1 (Dena1) | 34.33        | 34.75            | 35.08               | 34.72 a |
| V2 (Devon 1) | 30.33        | 30.17            | 30.00               | 30.17 b |
| V3 (Anjasmoro) | 33.75        | 34.17            | 34.67               | 34.19 a |
| V4 (Derap 1) | 30.33        | 30.08            | 30.17               | 30.19 b |
| Average | 32.19        | 32.29            | 32.48               |         |

*Note: Figures followed by different letters in the same treatment group are significantly different at the 5% level based on the DMRT test.*

From Table 6, it can be seen that several types of organic fertilizers have no significant effect on flowering age with the highest flowering age in the K3 treatment (chicken manure), which is 32.48 days, which is not significantly different from the K2 treatment (goat manure), which is 32.29 days and K1 (compost) which is 32.19 days. Several types of varieties significantly affected the flowering age of soybean plants with the longest flowering age in treatment V1 (Dena 1), namely 34.72 days, which was not significantly different from treatment V3 (Anjasmoro), namely 34.19 days, both treatments were significantly different from treatment V4 (Derap 1) is 30.19 days and treatment V2 (Devon 1) is 30.17 days. Treatment V4 was not significantly different from treatment V2.

Derap 1 was the variety that had the shortest flowering age followed by Devon 1 variety. While Dena 1 and Anjasmoro varieties had the longest flowering age. [20] state that plants will show a ripe harvest if the total energy adopted has reached a certain level (growing degree day) and a certain level of difference is different for each plant, generally due to genetic factors. Harvest age is influenced by the speed of flowering plants. This is in line with the research of [21], that the length of the reproductive phase and the seed maturation phase for each variety is generally the same. The long life span of rice plants is caused by the long vegetative phase.

4. Conclusions

1. The type of organic fertilizer has a significant effect on the growth of soybean plants, namely plant height, number of branches, number of leaves, and amount of chlorophyll, but does not significantly affect leaf area and flowering age.
2. Varieties have a significant effect on the growth of soybean plants, namely plant height, number of branches, leaf area, and flowering age, but do not significantly affect the number of leaves and the amount of chlorophyll.
3. There is no interaction effect between the treatment of organic fertilizer types and varieties of all observed parameters.
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