GROWTH RESPONSE OF SOYBEAN (*Glycine max* (L) TO NPK FERTILIZER AND BIO FERTILIZER

Fenty Maimunah Simbolon[1], Muhammad Rizwan[1], Noverina Chaniago[1], Surya Agus Efendy[1]

[1] Faculty of Agriculture, Universitas Islam Sumatera Utara, Medan, Indonesia
[*)] Corresponding Author : fenty.simbolon@gmail.com

Article history: received 11 October 2020; revised November 04, 2020; accepted November 30, 2020

Abstract. This research was carried out at the Experimental Garden of the Faculty of Agriculture, Islamic University of North Sumatra, Jln. Eka Warni, Medan Johor District, Medan Municipality with a height of ± 25 meters above sea level with flat topography. The aim of the research was to determine the effect of providing biological fertilizer by reducing the dose of NPK fertilizer on the growth of soybean plants. This research used the Factorial Randomized Block Design (RAK) method with two factors studied, namely: The first factor is bio quality (H) biological fertilizer which consists of 2 treatment levels, namely H_0 (Control), H_1 (10 cc/l water); The second factor is NPK fertilizer with 4 treatment levels, namely N_0 (Control), N_1 (20 g/plot), N_2 (40 g/plot) and N_3 (60 g/plot). The parameters observed were plant height, number of branches per plant, number of root nodules. The results of the research showed that the application of biological fertilizer had a significant effect on the growth of soybean plants, namely the number of branches per plant, but had no significant effect on plant height and number of root nodules. Applying NPK fertilizer has a significant effect on plant height, but does not have a significant effect on the number of branches per plant and the number of root nodules. Meanwhile, the interaction between biological fertilizer and NPK fertilizer had no significant effect on plant height, number of branches per plant, or number of root nodules.

Keywords : NPK fertilizer, biological fertilizer, soybeans

INTRODUCTION

Soybean (*Glycine max* L. Merr) is one of the important food crop commodities in Indonesia Indonesia. In the food processing industry, soybeans are Indonesiawidely used as raw material for making tofu, tempeh and soy sauce. The need for soybeans increases every year, in line with increasing population growth and the development of animal feed factories. Per capita consumption of soybeans is currently ± 8 kg/capita/year. It is estimated that each year the need for soybean seeds is ± 1.8 million tons and soybean meal is ± 1.1 million tons (Ministry of Agriculture, 2006)

National soybean production has not been able to meet needs, because the actual harvest area is still inadequate and productivity is still low, at the farmer level at 1.3 tons/ha while the application of technology at the farmer level is still low, and human resources are still low. To increase production yields, soybean cultivation is being developed towards self-sufficiency in order to increase farmers' income and encourage economic growth in rural areas (Anonymous, 2007).

Fertilization is done because not all soil is good for plant growth. In general, agricultural land does not provide all the plant nutrients needed quickly and in sufficient quantities to achieve optimal growth. Therefore, increased production can only be achieved if additional plant nutrients are provided for optimal growth, either through liming or fertilizing (Novizan, 2007).

The use of biological fertilizer is an effort to meet plant nutrient needs naturally, by utilizing live microorganisms in the soil as inoculants to help plants facilitate or provide certain nutrients for plants. The use of biological fertilizer is also needed in efforts to increase soybean productivity because it has benefits in making the use of inorganic fertilizer more effective, in particular increasing

the availability of N and P nutrients in the soil so that it can increase crop yields (Petrokimia Gresik, 2013).

Apart from biological fertilizer, the use of NPK fertilizer is also important in supporting the growth of soybean plants. NPK fertilizer (16:16:16) is a compound fertilizer containing balanced N, P and K elements which can be used as basic and supplementary fertilizer in the growth and production of plants. The elements N and K are elements that are easily leached, so that NPK is more easily available to plants, while the P element is immobile (Anonymous, 2010).

RESEARCH METHODS

Place and time of research

This research was carried out at the Experimental Garden of the Faculty of Agriculture, Islamic University of North Sumatra, Jln. Eka Warni, Medan Johor District, Medan Municipality. Height ± 25 meters above sea level with flat topography. This research was carried out from April to July 2018 .

Research Materials and Tools

The tools used in this research were scales for weighing, hoes for cultivating the land, treatment signs, meters for measuring plant height, writing tools, calculators for calculating. The materials used in this research were Bio Quality biological fertilizer, NPK 16-16-16 fertilizer, dena 2 variety soybean seeds, Dithane M 45 fungus and Curacron 500 EC insecticide .

Research Design

research uses a factorial Randomized Block Design (RAK) which consists of 2 factors, namely: The first factor is Biological Fertilizer (H) which consists of 2 levels, namely: H 0 = Control, H 1 = Biological Fertilizer (10 cc / l water) . The second factor is the dose of NPK fertilizer (N) which consists of 4 levels, namely: N_0 = Control, N_1 = 50 kg/ha (20 g/plot), N_2 = 100 kg/ha (40 g/plot), N_3 = 150 kg/ha (60 g/plot). The parameters observed were plant height (cm) , number of branches per plant (branches) , number of root nodules (nodules) .

RESULTS AND DISCUSSION

Research result

1. Plant Height (cm)

The results of the analysis of variance showed that the treatment of giving biological fertilizer on the response to plant height growth at the age of 4 WAP had no significant effect. The results of the analysis of NPK fertilizer application on the growth response of soybeans had a significant effect on plant height parameters at 4 WAP. Meanwhile, the combination treatment of giving biological fertilizer with giving NPK fertilizer had no significant effect on plant height parameters at the age of 4 WAP. Below is presented data on the height parameters of soybean plants at the age of 4 WAP.

Table 1. Average Plant Height (cm) of Soybeans at 4 WAP with Biological Fertilizer and NPK Fertilizer Treatment

Organic fertiliser	NPK Fertilizer				Average
	N_0	N_1	N_2	N_3	
H_0	27.67	28.07	28.47	29.67	28.47
H_1	28,20	28.00	29,20	29.80	28.80
Average	27.94a	28.04a	28.84ab	29.74b	

Note: Numbers followed by letters that are not the same in the same treatment group are significantly different based on the Duncan test at the 5% level.

Table 1 shows that the biological fertilizer treatment did not have a significant effect on soybean plant height at 4 WAP, where the highest average plant height was in the H_1 (10 cc/l water) treatment, namely 28.80 .

NPK fertilizer treatment had a significant effect on soybean plant height at 4 WAP. The highest plants were obtained in treatment N_3 (60 g/plot), namely 29.74, which was significantly different from treatment N_2 (40 g/plot), namely 28.84 , treatment N_1 (20 g/plot), namely 28.04, and treatment N_0 (Control) is 27.94.

The relationship between NPK fertilizer application and soybean plant height is linear with the equation $\hat{Y} = 0.031x + 27.71$ where the correlation is r = 0.9152. This can be seen in Figure 1.

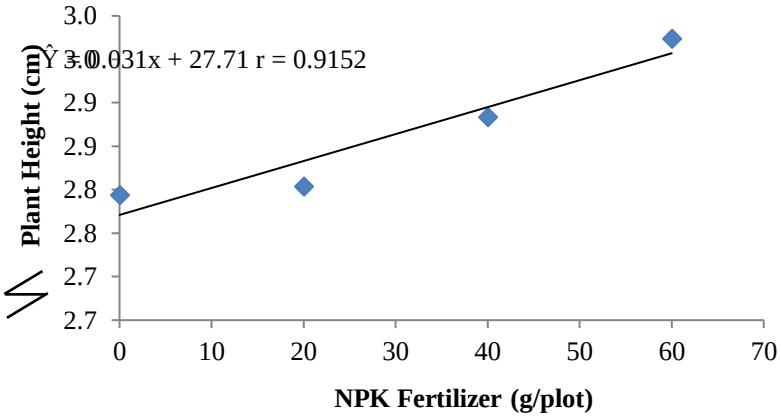

Figure 1. Relationship between plant height (cm) of soybeans at 4 WAP and NPK fertilizer (g/plot).

The interaction between the two treatments had no significant effect on soybean plant height at 4 WAP. The highest plant was obtained in the H_1N_3 treatment combination, namely 29.80 , while the lowest plant was obtained in the H_0N_0 treatment combination , namely 27.67.

2. Number of Branches per Plant

The results of the analysis of variance showed that NPK fertilizer treatment had a significant effect on the number of branches of soybean plants at 4 WAP , but the interaction between the two had no significant effect. The results of statistical analysis of the number of branches of soybean plants treated with biological fertilizer and NPK fertilizer are presented in Table 2.

Table 2. Average Number of Branches of Soybean Plants at 4 WAP Age with Biological Fertilizer and NPK Fertilizer Treatment.

Organic fertiliser	NPK Fertilizer				Average
	N_0	N_1	N_2	N_3	
H_0	3.33	3.73	4.47	4.67	4.05a
H_1	4.27	4.20	4.73	5.00	4.55b
Average	3.80a	3.97a	4.60ab	4.83b	

Note: Numbers followed by letters that are not the same in the same treatment group are significantly different based on the Duncan test at the 5% level.

Table 2 shows that biological fertilizer treatment has a significant effect on the number of branches of soybean plants at 4 WAP. The highest number of branches was obtained in the treatment H_1 (10 cc/l water), namely 4.55, which was significantly different from the H_0 (Control) treatment, namely 4.05.

NPK fertilizer treatment had a significant effect on the number of branches of soybean plants at 4 WAP. The highest number of branches was obtained in the N_3 (60 g/plot) treatment, namely 4.83, which was significantly different from the N_2 (40 g/plot) treatment, namely 4.60, N_1 (20 g/plot), namely 3.97 and N_0. (Control) namely 3.80.

The relationship between the application of biological fertilizer and the number of soybean plant branches is linear with the equation $\hat{Y} = 0.05x + 4.05$ where the correlation r = 1. This can be seen in Figure 2.

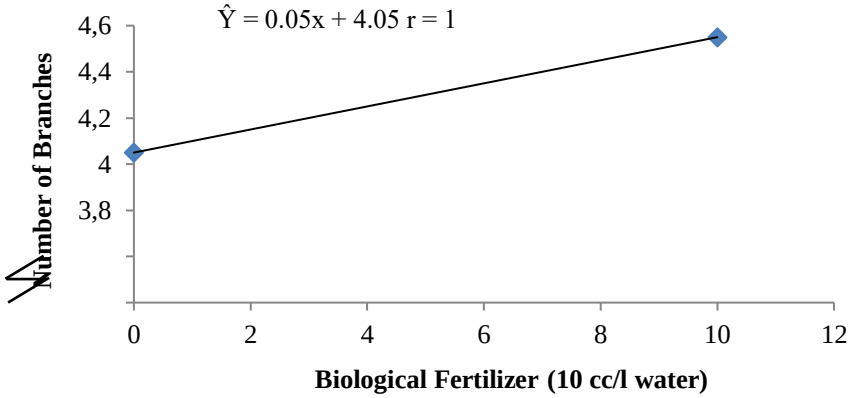

Figure 2. Relationship between the number of branches of soybean plants at the age of 4 WAP with the provision of biological fertilizer (cc/l water).

the number of soybean plant branches is linear with the equation $\hat{Y} = 0.0186x + 3.742$ where the correlation r = 0.9481 . This can be seen in Figure 3 .

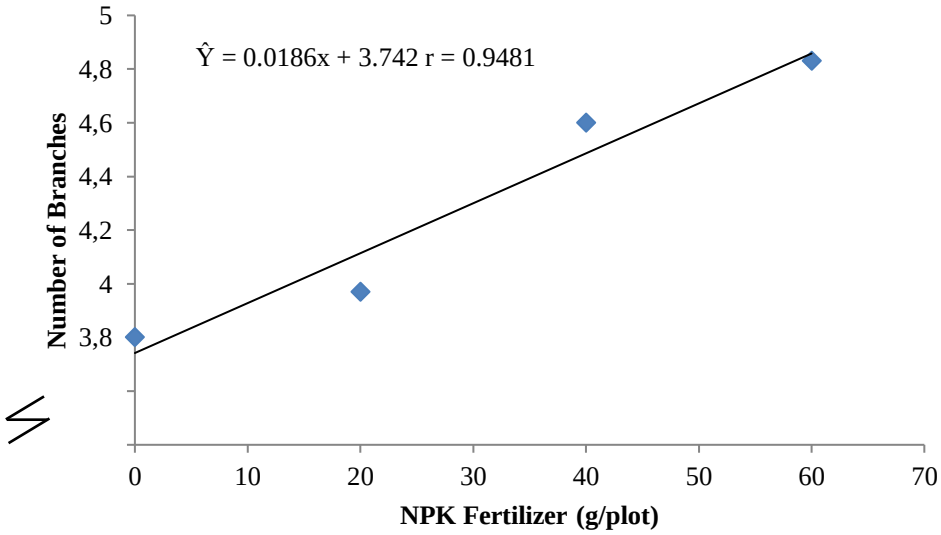

Figure 3. Relationship between the number of branches of soybean plants at the age of 4 WAP with the provision of NPK fertilizer (g/plot).

The interaction between the two treatments had no significant effect on the number of branches of soybean plants at 4 WAP. The highest number of branches was obtained in the $H_1 N_3$ treatment combination (10 cc/l water bio-quality biofertilizer and 60 g NPK fertilizer/plot), namely 5.00 , while the lowest number of plant branches was found in the $H_0 N_0$ (Control) treatment combination. namely 3.33.

3. Number of Root Nodules (nodules)

The results of the analysis of variance showed that biological fertilizer treatment had no significant effect on the number of root nodules in soybean plants. The results of the analysis of variance also showed that the NPK fertilizer treatment and the two treatment interactions had no significant effect on the number of root nodules in soybean plants. The results of statistical analysis

of the number of branches of soybean plants treated with biological fertilizer and NPK fertilizer are presented in Table 3.

Table 3. Average Number of Root Nodules on Soybean Plants with Biological Fertilizer and NPK Fertilizer Treatment.

Organic fertiliser	NPK Fertilizer				Average
	N_0	N_1	N_2	N_3	
H_0	10.60	11.07	11,13	11.33	11.03
H_1	10.47	10.80	11.47	12.40	11.28
Average	10.53	10.93	11.30	11.87	

Note: Numbers followed by letters that are not the same in the same treatment group are significantly different based on the Duncan test at the 5% level.

Table 3 shows that biological fertilizer treatment had no significant effect on the number of root nodules in soybean plants. The highest number of root nodules was obtained in the treatment H_1 (Bio quality 10 cc/l water biological fertilizer), namely 11.28 .

NPK fertilizer treatment had no significant effect on the number of root nodules in soybean plants. The highest number of root nodules was obtained in the treatment N_3 (60 g NPK fertilizer/plot), namely 11.87 .

The interaction between the two treatments had no significant effect on the number of root nodules in soybean plants. The highest number of root nodules was obtained in the combination of H_1N_3 treatment (10 cc/l water biological fertilizer and 60 g NPK fertilizer/plot) , namely 12.40 , while the lowest number of root nodules was obtained in the H_1N_0 treatment combination (Bio biological fertilizer quality 10 cc/l water and control) namely 10.47.

Discussion

1. Soybean Plant Growth Response to Biological Fertilizer Application

The biological fertilizer treatment had a significant effect on the number of branches per plant, but had no significant effect on plant height and number of root nodules.

Regarding plant height parameters, the application of biological fertilizer does not have a significant effect on plant height. The amount of nutrients, especially nitrogen, as the main factor in cell division or in plants, is not in large quantities. Apart from forming young cells such as plant height, it also forms other vegetative parts such as roots and leaves, resulting in the available nutrients being divided into several parts of the plant's vegetative growth in line with research conducted by Ardhani (2014) regarding the provision of non-symbiotic N-fixing biological fertilizer. (*azotobacter spp* and *azospirillum sp.*) in soybean plants, it was found that increasing the dose of biological fertilizer given did not result in significantly different plant heights.

On the parameter of the number of branches of soybean plants, the application of biological fertilizer has a significant effect. This is because the availability of biological fertilizer in the soil is sufficient, as is known, besides containing several important microbes, this biological fertilizer also contains a number of nutrients N, P and K so that the function of N is to stimulate overall growth, especially stems, branches and leaves . . Apart from that, nitrogen also plays an important role in the formation of green leaves which is very useful in the photosynthesis process. Meanwhile, the nutrient element phosphorus (P) functions to stimulate root growth. The nutrient potassium (K) functions to help form proteins and carbohydrates and also plays a role in maintaining plant turgor and opening leaf pores.

On the parameter of the number of root nodules in soybean plants, the application of biological fertilizer has no significant effect on the number of root nodules. This is because the development of root nodules is influenced by environmental factors, namely nutrient content and light, where the biological fertilizer given is less able to provide the nutrients needed for root nodule growth.

2. Soybean Plant Growth Response to NPK Fertilizer Application

Applying NPK fertilizer has a significant effect on plant height, but does not have a significant effect on the number of branches per plant and the number of root nodules.

In this study, the treatment used for NPK fertilizer consisted of 4 levels, namely N_0 (Control), N_1 (20 g/plot), N_2 (40 g/plot) and N_3 (60 g/plot). From the NPK fertilizer treatment used, the N_3 (60 g/plot) treatment had a better effect than the N_0 (Control), N_1 (20 g/plot) and N_2 (40 g/plot) treatments. NPK fertilizer treatment had a significant effect in increasing the growth of soybeans.

Providing NPK fertilizer has a significant effect on plant height because NPK fertilizer contains the element N. Plant height growth is the result of the activity of meristematic cells which undergo division and elongation. This defense and elongation requires amino acid compounds which are formed in the presence of the element N (Kartasaputra, 2005).

The application of NPK fertilizer had no significant effect on the number of branches per plant and the number of root nodules. In the vegetative phase, soybean growth can increase rapidly, namely at 28-35 HST and growth slows down when the plants start to flower, namely at 35 HST. Plants do not respond to the nutrients provided, this is because the nutrients in the soil are not yet able to supply the nutrients according to the plant's needs, especially to accelerate plant growth. Lack of efficiency of some nutrients in plants can also occur if there is a lack or excess of nutrients (Palobo *et al* . 2016).

Fertilization treatments do not always have a real effect on plant growth. This is thought to be because the nutrients in the soil have been able to provide a nutrient supply according to the plant's needs. Different fertilizer treatments did not provide a significant response to plant growth, this could be due to the availability of sufficient nutrients in the soil before planting. Another factor that can cause no effect on fertilizer treatment is thought to be because soil fertility is sufficient (Fitriesa *et al* . 2017).

3. Effect of the interaction of biological fertilizer and NPK fertilizer on the growth of soybean plants

The results of the analysis showed that the interaction between biological fertilizer and NPK fertilizer had no significant effect on plant height, number of branches per plant and number of root nodules. The combination of the two treatments had no effect because the two factors covered each other in carrying out their activities.

Even though it was not significantly different, increasing the combination of doses of biological fertilizer and NPK fertilizer increased the growth of soybean plants. Biological fertilizer is very effective in improving the nutrient cycle and soil fertility, enriched with macro and micro elements needed by plants, while NPK fertilizer is a macro nutrient needed by plants which, if available in sufficient quantities, will increase plant growth, especially in the generative. Plants have a linear response to the application of both fertilizers, so the plant response has the same tendency

CONCLUSION

Treatment had a significant effect on the number of branches per plant, but had no significant effect on plant height and number of root nodules. The best application of biological fertilizer was obtained in the $H_{1\ \text{treatment}}$ (10 cc/l water). The application of NPK fertilizer had a significant effect on plant height and number of branches per plant, but had no significant effect on the number of root nodules. The best application of NPK fertilizer was obtained in the $N_{3\ \text{treatment}}$ (60 g/plot). The interaction between biological fertilizer and NPK fertilizer had no significant effect on plant height, number of branches per plant, and number of root nodules .

REFERENCES

Anonim. 2007. Bangkit Kedelai, Departemen Pertanian Republik Indonesia, Jakarta.

Anonim. 2010. Brosur Pupuk NPK 16 : 16 : 16. CV. Bumi Agro Fertilizer Indonesia.

Departemen Pertanian. 2006. Usaha Pengembangan Kedelai. Balai Penelitian dan Pengembangan Pertanian, Departemen Pertanian.

Fitriesa S, Sari M, Suhartanto M. R. 2017. Pengaruh pemupukan N, P, dan K pada dua varietas benih kedelai (*Glycine max* (L) Merr.) terhadap kandungan antosianin dan hubungannya dengan vigor benih. *Bul.Agrohorti*. 5(1): 117–125

Kartasaputra. 2005. Bertananam Kedelai. Penebar Swadaya. Jakarta. 74 hal.

Novizan. 2007. Petunjuk Pemupukan Yang Efektif. PT. Agromedia Pustaka. Jakarta.

Palobo F, Ayakeding E, Nunuela M, Marwoto. 2016. Pengaruh waktu aplikasi pupuk npk phonska terhadap pertumbuhan dan hasil kedelai. Prosiding Seminar Hasil Penelitian Tanaman Aneka Kacang dan Umbi: 198–206.

Petrokimia Gresik, 2013. Petro Biofertil. http://www.petrokimia-gresik.com [12 Desember 2017]