# Application of BioVermigot and *Rhizobium spp.* on production of Peanuts (*Arachis hypogea* L.)

*Nur Ulina Warnisyah* Sebayang[1*] and *Nursiani* Lubis[2]

[1]Faculty of Agriculture, Universitas Sumatera Utara, Indonesia
[2] Faculty of Agriculture, Universitas Riau, Indonesia

**Abstract.** BioVermigot is an organic fertilizer produced from a combination of vermicompost fertilizer and Black Soldier Fly fertilizer which is innovated with beneficial microbes such as Azotobacter sp. which has the potential as a Nitrogen-fixing bacteria. The BioVermigot application is expected to help increase peanut production with the help of the Rhizobium spp. as a Nitrogen fixer. This research was carried out from December 2023 to March 2024 in Medan Selayang District, North Sumatra. This research uses Factorial Randomized Complete Block Design (RCBD). The first factor (BioVermigot Dosage) $B_0$ : Control, $B_1$ : 0 ton ha$^-$, $B_2$ : 10 ton ha$^-$, and $B_3$ : 20 ton ha$^-$. Second factor (Dose of *Rhizobium japonicum*) $R_0$ : Control, $R_1$ 10 g kg$^-$ and $R_2$ : 20 g kg. Data analysis used variance with the F test and Duncan's multiple range test at a significance level of 5%. The results showed that there was no interaction between inoculation of Rhizobium spp. and BioVermigot on peanut yield. Independently Rhizobium spp. influences all parameters, while Biovermigot influences the number of pods, the number of pithy pods, the weight of wet pithy pods, the weight of dry pithy pods per plant, and pod yield per plot.

## 1 Introduction

Peanuts (*Arachis hypogaea* L.) are one of the important food crops in Indonesia and have high economic value. Demand for peanuts is increasing along with the increase in population and the development of the industrial sector which requires peanut raw materials. In the industrial sector, peanuts can be processed into soap, butter, cheese, and cooking oil. In agriculture, peanut leaves can be used as animal feed and green manure.

The lack of Nitrogen nutrients is caused by a lack of attention to soil biological fertility. In the context of biological fertility, soil is considered fertile if it has a high diversity of microbes and is in symbiosis with plant roots. The obstacles faced by this are limited rhizobia populations and Nitrogen elements in the soil are easily lost through leaching or evaporation. Therefore, it is necessary to apply biological Nitrogen fixation techniques through Rhizobium inoculation. Inoculation of *Rhizobium spp*. has also been proven to increase peanut productivity. *Rhizobium spp*. are symbiotic bacteria that can bind Nitrogen from the air and convert it into a form that can be used by plants. When inoculated on peanuts, *Rhizobium spp*. forms root nodules where the process of Nitrogen fixation takes place. This

* Corresponding author: nurulinawarnisyah@usu.ac.id

not only reduces the need for synthetic Nitrogen fertilizer but also improves soil quality and long-term fertility.

Highlighted that the use of *Rhizobium spp*. as an inoculant increases peanut productivity by optimizing Nitrogen fixation. This research found that Rhizobium inoculation could increase plant dry weight and crop yields significantly [1]. The addition of inputs in the form of organic fertilizer and also Rhizobium has been widely used, especially for legumes, especially peanuts. However, innovation by combining the use of earthworms and Black Soldier Fly (BSF) larvae also known as bioconversion has not been discovered to date. The organic fertilizer produced from a combination of waste bioconversion using two decomposer agents, namely earthworms and BSF larvae, is Vermigot fertilizer which is modified by adding *Azotobacter sp* bacteria as a biofertilizer which is capable of fixing Nitrogen.

In recent years, attention to sustainable agricultural practices has increased. One approach that has shown positive results is the use of biovermigot compost and inoculation of *Rhizobium spp* on peanut plants (*Arachis hypogaea* L.). Biovermigot compost is a compost produced through the activity of earthworms and BSF larvae, which is known to improve soil structure and provide essential nutrients for plants. *Rhizobium spp*. inoculation, on the other hand, is a technique of adding Nitrogen-fixing bacteria to the soil or plant seeds, which can increase nitrogen availability for peanut plants.

Vermigot fertilizer at a dose of 200 g/pot was able to produce Pakchoy vegetables with a fresh weight of 57 grams and was able to add nutrients to Ultisol soil at a higher dose, namely 300 g/pot [2]. Apart from that, he also stated the fact that giving Vermigot as an organic fertilizer to corn plants in Inceptisol soil had a significant effect on the weight of corn cobs with the best treatment $V_3$ (300 g) of 250.56 grams and the pH of the Inceptisol soil became neutral.

The combination of Biovermigot compost and inoculation of *Rhizobium spp*. provides strong synergy in increasing the growth and yield of peanut plants. Recent research shows that this combination can increase plant dry weight, number of root nodules, and nitrogen content in plant tissue. This success was caused by the positive interaction between organic material from Biovermigot compost and the ability of *Rhizobium spp*. to provide the nitrogen needed by peanut plants.

Based on previous research which was successful in providing a positive impact, the goal of this research will be carried out to examine the relationship between inoculation of *Rhizobium spp*. and the effective application of Biovermigot on peanut yield. Overall, it is hoped that the application of Biovermigot compost and inoculation of *Rhizobium spp*. is an effective and sustainable strategy in peanut cultivation.

## 2 Materials and methods

This research was carried out from December 2023 to March 2024 in Medan Selayang District, North Sumatra. The ingredients consist of peanut seeds of the Talam 1 variety, *Rhizobium spp* inoculum with a population of $35x10^8$ CFU/mL, Biovermigot containing Azotobacter sp with a population of $280 \times 10^8$ CFU/gram, insecticide Dursban 200 EC, and fungicide Dithane M-45 80 WP.

This research uses Factorial Randomized Complete Block Design (RCBD) which includes: the first factor (Biovermigot Dosage) $B_0$ : Control, $B_1$ : 10 ton $ha^{-}$, $B_2$ : 20 ton $ha^{-}$, and $B_3$ : 30 ton $ha^{-}$. Second factor (Dose of *Rhizobium spp*.) $R_0$ : Control, $R_1$ 10 g $kg^{-}$ and $R_2$ : 20 g $kg^{-}$ with 3 replications. Destructive observations were carried out on 2 plant samples to observe plant N uptake with using the formula: N uptake = % N x plant dry weight.

The data were statistically analysed using a two-way Analysis of Variance (ANOVA), and Tukey's HSD 5%. Next, parameters were observed which included dry weight (g), total N (%) and plant N uptake (g plant-), number of pods per plant (fruit), number of pithy pods per plant (fruit), wet weight of pithy pods/plant (g), and weight of dry pithy pods/plant (g), weight of dry seeds/plant (g), weight of 100 dry seeds (g/plant), and yield of dry pods/plot (kg). The results of the initial analysis of BioVermigot organic fertilizer are attached in (Table 1).

**Tabel 1**. BioVermigot fertilizer analysis results.

| *Chemical-Biological Properties | Results | Criteria | SNI 19-7030-2004 |
|---|---|---|---|
| pH $H_2O$ | 6.95 | Neutral | 6.80 – 7.49 |
| Water content (%) | 40.00 | Suitable | Max 50 |
| Carbon organic (%) | 39.65 | Suitable | 27 – 58 |
| N Total (%) | 2.00 | High | Min 0.40 |
| $P_2O_5$ (%) | 2.37 | High | Min 0.10 |
| $K_2O$ (%) | 1.25 | Medium | Min 0.20 |
| Ratio C/N | 19.15 | Suitable | 10 - 20 |
| Population of microbe (CFU/ml) | $280 \times 10^8$ | High | - |

Notes: *Analysed by Palm Oil Research Centre, Medan, Indonesia in December 2023.

## 3 Results and discussions

The results of variance analysis showed that there was no interaction between inoculation of *Rhizobium spp*. and Biovermigot dosage on peanut yield. Independently inoculating *Rhizobium spp*. influenced all observation parameters, while the dose of Biovermigot influenced the outcome parameters.

### 3.1 Total N (%) and Plant N Uptake (g/plant) based on dry weight

Analysis of total N (%) and N uptake in plants (g/plant) based on dry weight of peanuts (g) is presented in (Table 2).

**Table 2**. Average results of Total N analysis (%) and N uptake in plants (g/plant) with application of Biovermigot and *Rhizobium spp.*

| Treatments | $^a$Dry weight (g) | $^b$N total (%) | $^b$N Uptake (g/plant) |
|---|---|---|---|
| $B_0R_0$ (Control) | 11.34 | 2.50 | 0.32 |
| $B_0R_1$ (Control+10 g kg$^-$ Rhizobium) | 11.85 | 2.55 | 0.33 |
| $B_0R_2$ (Control+ 20 g kg$^-$ Rhizobium) | 14.32 | 2.89 | 0.44 |
| $B_1R_0$ (Biovermigot 10 ton ha$^-$ + Control) | 19.11 | 3.00 | 0.56 |
| $B_1R_1$ (Biovermigot 10 ton ha$^-$ + 10 g kg$^-$ Rhizobium) | 21.95 | 3.10 | 0.60 |
| $B_1R_2$ (Biovermigot 10 ton ha$^-$ + 20 g kg$^-$ Rhizobium) | 22.76 | 3.20 | 0.71 |
| $B_2R_0$ (Biovermigot 20 ton ha$^-$ + Control) | 21.16 | 3.24 | 0.76 |

| | | | |
|---|---|---|---|
| $B_2R_1$ (Biovermigot 20 ton ha$^{-}$ + 10 g kg$^{-}$ Rhizobium) | 23.54 | 3.35 | 0.78 |
| $B_2R_2$ (Biovermigot 20 ton ha$^{-}$ + 20 g kg$^{-}$ Rhizobium) | 27.73 | 3.36 | 0.89 |
| $B_3R_0$ (Biovermigot 30 ton ha$^{-}$ + Control) | 28.56 | 3.20 | 0.90 |
| $B_3R_1$ (Biovermigot 30 ton ha$^{-}$ + 10 g kg$^{-}$ Rhizobium) | 30.97 | 3.35 | 0.95 |
| $B_3R_2$ (Biovermigot 30 ton ha$^{-}$ + 20 g kg$^{-}$ Rhizobium) | 32.15 | 3.45 | 0.98 |

Notes: [a]Result of di Soil Chemistry and Biology Laboratory, USU, Indonesia in March 2024.
[b]Analysis results of Agricultural Instruments Standardization Agency, Medan, Indonesia in March 2024.

**Table 3.** Standart Criteria for assessing soil analysis results of Agricultural Research and Development Department of Agriculture.

| **Soil Parameter** | **Value** | | | | |
|---|---|---|---|---|---|
| | **Very Low** | **Low** | **Medium** | **High** | **Very High** |
| N total (%) | <0.1 | 0.1-0.2 | 0.21-0.5 | 0.51-0.75 | >0.75 |

Based on the criteria for assessing soil properties from Agricultural Research and Development Agency Department of Agriculture, it is known that the total N content (%) in all treatments is included in the very high category (more than 0.75%). Table 1 shows that the low N uptake in the control treatment was due to not being treated with *Rhizobium spp* inoculation. and without Biovermigot. Therefore, the amount of N absorbed in the control treatment was lower than in the other treatments. Rhizobium bacteria can increase nitrogen fixation which is used to form chlorophyll and the nitrogenase enzyme so that it can increase photosynthetic capacity and nutrient absorption by plants [3].

Rhizobium bacteria can store 300 kg N ha$^{-1}$ and fulfill 80% of Nitrogen needs so that N uptake by plants increases [4]. The amount of Nitrogen that can be fixed from the air by Rhizobium bacteria which are in symbiosis with legumes varies greatly depending on the compatibility of the bacteria with the host plant, the presence of other microorganisms in the soil and the conditions of the root environment. Apart from providing vermicompost, it can provide nutrients in the soil, but also as a source of carbon for food or energy for *Rhizobium spp* bacteria, so that providing vermicompost affects increasing Rhizobium activity in the soil [5].

The treatment with the highest N uptake was in the $B_3R_2$ (Biovermigot 30 tons ha$^{-}$ + 20 g kg$^{-}$ Rhizobium) namely 0.98 g/plant. Even though it is not statistically significant, the results given show higher numbers when compared to other treatments. This is due to the addition of Biovermigot which contains around 2% Nitrogen and the presence of *Azotobacter sp* bacteria. which is tasked with fixing Nitrogen as well as the inoculant *Rhizobium spp* which also has a symbiotic relationship with peanut plants to provide Nitrogen.

### 3.2 Peanut Production

Peanut production parameters observed in this study include the number of pods per plant (fruit), the number of pithy pods per plant (fruit), the weight of wet pithy pods/plant (g), and the weight of dry pithy pods/plant (g), weight dry seeds/plant (g), weight of 100 dry seeds (g/plant), and dry pod yield/plot (kg). The observation results are presented in (Table 4 and Table 5).

**Table 4**. Effect of Biovermigot dosage and *Rhizobium spp*. on the average number of pods, number of pithy pods, wet pithy pod weight and dry pithy pod weight per plant.

| Treatments | Number of plant pods$^-$ (pods) | The number of plant's pithy pods$^-$ (pods) | The weight of the plant's wet pithy pods$^-$ (gram) | The weight of the plant's dry pithy pods$^-$ (gram) |
|---|---|---|---|---|
| Dosages of Biovermigot (B) | | | | |
| $B_0$ Control | 19.86$^d$ | 16.55$^d$ | 30.59$^d$ | 23.95$^d$ |
| $B_1$ 10 ton ha$^-$ | 20.12$^c$ | 16.90$^c$ | 31.05$^c$ | 24.99$^c$ |
| $B_2$ 20 ton ha$^-$ | 21.54$^b$ | 17.18$^b$ | 33.49$^b$ | 26.85$^b$ |
| $B_3$ 30 ton ha$^-$ | 23.59$^a$ | 17.90$^a$ | 34.70$^a$ | 27.15$^a$ |
| Dosages *Rhizobium spp.*(R) | | | | |
| $R_0$ Control | 17.95$^c$ | 15.50$^c$ | 26.90$^c$ | 22.30$^c$ |
| $R_1$ 10 g kg$^-$ | 21.50$^b$ | 16.55$^b$ | 34.55$^b$ | 25.90$^b$ |
| $R_2$ 20 g kg$^-$ | 23.85$^a$ | 18.25$^a$ | 36.50$^a$ | 27.25$^a$ |
| Interaction between BxR | | | | |
| $B_0R_0$ | 18.90 | 16.24 | 28.75 | 23.13 |
| $B_0R_1$ | 19.32 | 16.35 | 34.50 | 25.89 |
| $B_0R_2$ | 19.30 | 16.88 | 36.40 | 27.14 |
| $B_1R_0$ | 20.45 | 17.18 | 31.44 | 25.00 |
| $B_1R_1$ | 20.96 | 17.53 | 32.10 | 25.33 |
| $B_1R_2$ | 21.55 | 18.77 | 32.68 | 25.90 |
| $B_2R_0$ | 22.60 | 17.30 | 33.50 | 26.88 |
| $B_2R_1$ | 22.40 | 18.15 | 33.90 | 27.14 |
| $B_2R_2$ | 22.65 | 18.50 | 34.65 | 27.65 |
| $B_3R_0$ | 22.90 | 18.34 | 35.05 | 27.15 |
| $B_3R_1$ | 23.45 | 19.12 | 35.15 | 27.55 |
| $B_3R_2$ | 23.80 | 19.59 | 36.30 | 28.30 |

Note: Numbers followed by the same letter in the same column indicate results that are not significantly different based on the Duncan Multiple Range Test at Alpha 5%. DC= 16%.

The harvest area, production and average production of peanuts according to the Central Statistics Agency in 2023 in North Sumatra is 13.82 Quintal/Ha. From the variance results in Table 3, it is known that the dose of Biovermigot independently had a significant effect on the parameters of the number of pods per plant (pods), the number of pithy pods per plant (pods), the weight of wet and dry pithy pods per plant (grams) at the 5% level. The highest number of pods was found at the Biovermigot dose of 30 tons ha$^-$ ($B_3$) with an average of 23.59 pods, which was significantly different from other Biovermigot doses. Meanwhile, the lowest average was found at the control dose of 19.86 pods. This shows the meaning that the higher the dose given, the greater the number of pods per plant that will be produced by peanuts. The application of compost fertilizer significantly increases the number of peanut pods compared to chemical fertilizer [6]. This increase is due to increased soil fertility and better nutrient availability provided by organic matter, which also improves soil structure and soil microbial activity.

The use of Biovermigot fertilizer in peanut cultivation has shown significant results in increasing the number of fruity pods, fruity weight, and plant dry weight. Both the highest number of pithy pods per plant, weight of pithy pods per plant, and dry pod weight per plant, had the highest values found in the Biovermigot dose treatment of 30 tons ha$^-$ ($B_3$). Overall, increasing the dose of Biovermigot fertilizer provides significant benefits in peanut cultivation, both in terms of the number of fruity pods, fruity weight, and dry weight. These fertilizers not only provide essential nutrients but also improve soil conditions and support a healthy microbial ecosystem, all of which contribute to better and more sustainable crop yields. The use of organic fertilizer in increasing doses consistently improves soil fertility, increases enzymatic activity, and optimizes plant growth conditions [7]. This results in an increase in plant dry weight, which is an important indicator of the health and productivity of peanut plants.

From the variance results, it can be seen that the inoculum dose of *Rhizobium spp*. independently had a significant effect on the parameters of the number of pods per plant (pods), number of pithy pods per plant (pods), weight of wet pithy pods and dry pithy pods per plant (grams) at the 5% level. The highest number of pods was found at a dose of 20 g $kg^{-}$ ($R_2$) with an average of 23.85 pods per plant, 18.25 grams per plant, 36.50 grams per plant, and 27.25 grams per plant dry pod weight plant. This is because the dose of inoculated Rhizobium is sufficient for the N nutrient requirement, so photosynthate is more abundant and this affects the number of pods produced. In the reproductive phase and pod ripening stage, peanuts require large amounts of nitrogen. The phase of peanut pod formation is a critical phase that requires a high supply of nitrogen [8]. During this phase, peanut plants divert most of their energy to pod and seed development, which require large amounts of Nitrogen to support metabolic processes and protein synthesis. Adequate Nitrogen availability at this stage is critical to ensure optimal pod formation and good seed quality.

Application of *Rhizobium spp* inoculum has been proven to increase the number of pods and pod weight in peanut plants. Recent research shows that the higher the inoculum dose applied, the better the results. This is due to increased more effective nitrogen fixation, which provides essential nitrogen for the growth and development of peanut plants. Inoculation with high doses of *Rhizobium spp*. increased the number of pods by 25% compared to the control without inoculum[9]. This study shows that increasing the dose of *Rhizobium spp*. increases soil microbial activity which contributes to increased nutrient uptake by plants.

The application of high doses of *Rhizobium spp*. increase the weight of peanut pods significantly. The plants that received high doses of inoculum had pod weights that were up to 30% greater than plants that were not inoculated [10]. This study highlights the importance of sufficient inoculum dosage to maximize the benefits of biological nitrogen fixation. Furthermore, the use of *Rhizobium spp* inoculum not only increases the number and weight of pods but also improves the quality of pods with higher protein content [11]. The higher inoculum doses are not only beneficial for the quantity but also the quality of peanut yields.

From the variance results, it can be seen that the interaction between BioVermigot and the inoculum of *Rhizobium spp*. had no significant effect on the parameters of number of pods per plant (pods), number of pithy pods per plant (pods), weight of wet pithy pods and dry pithy pods per plant (grams) at the 5% level. The interaction between the dose of Biovermigot organic fertilizer containing *Azotobacter* (Nitrogen fixer) and the inoculum dose of *Rhizobium spp*. does not always show a significant effect on the number and weight of peanut pods. Several studies have shown that although these two microbes play a role in nitrogen fixation, their success is highly dependent on environmental conditions, strain compatibility, and application methods.

*Azotobacter sp.*, which lives freely in the soil, functions to increase the general availability of nitrogen in the soil through a non-symbiotic nitrogen fixation process. In contrast, *Rhizobium spp*. forms a special symbiosis with peanut plants, forming nodules on the roots that directly provide nitrogen to the plant. If one of the microbes works more effectively or if soil conditions favor one of the Nitrogen fixation processes, then the combination of the two may not show a marked improvement compared to the application of each separately. Several studies state that the efficiency of biofertilizers or microbial inoculants can be greatly influenced by factors such as soil pH, organic matter levels, and the presence of other microorganisms in the soil [12]. Therefore, although theoretically, the combination of *Azotobacter* and *Rhizobium spp.* can increase yields, in practice, complex interactions in the soil environment may cause insignificant yields.

Even though statistically there is no real effect, we can observe the results in Table 3, from the parameter number of peanut pods per plant which has the highest value in the interaction between $B_3R_2$ (Biovermigot 30 ton ha$^-$ + 20 g kg$^-$ Rhizobium) of 23.80 pods. In the weight parameter, peanuts have the highest value in the same treatment at 36.30 grams. In this case, this occurs due to several synergistic factors working together to increase the availability and efficiency of nutrients for peanut plants. *Azotobacter sp*. is a free-living Nitrogen-fixing bacterium that can significantly increase Nitrogen levels in the soil. This is important to support plant growth, especially in the pod formation phase, where nitrogen requirements are very high. *Rhizobium spp*., on the other hand, colonizes the roots of peanut plants and forms nodules that also increase the nitrogen supply through the process of symbiotic nitrogen fixation. This combination allows plants to utilize nitrogen from two different sources effectively.

In addition, *Rhizobium spp*. can increase root growth, which allows more efficient absorption of nutrients from soil enriched by *Azotobacter* activity. Several studies have shown that increasing the dose of both inoculums significantly improves yield. The use of a higher inoculum of these two bacteria synergistically increases plant biomass, pod number, and pod weight due to a more stable and abundant nutrient supply during the critical phase of plant growth [13].

**Table 5.** The effect of Biovermigot dosage and *Rhizobium spp*. to the average dry seed weight per plant (grams) and the weight of 100 dry seeds in peanuts (grams).

| **Treatments** | **Plant dry seed weight$^-$ (gram)** | **Weight of 100 dry seeds (gram)** |
|---|---|---|
| Dosages of Biovermigot (B) | | |
| $B_0$ Control | 7.40$^d$ | 35.55$^d$ |
| $B_1$ 10 ton ha$^-$ | 7.99$^c$ | 36.90$^c$ |
| $B_2$ 20 ton ha$^-$ | 8.50$^b$ | 37.18$^b$ |
| $B_3$ 30 ton ha$^-$ | 9.82$^a$ | 38.90$^a$ |
| Dosages *Rhizobium spp.*(R) | | |
| $R_0$ Control | 7.34$^c$ | 35.50$^c$ |
| $R_1$ 10 g kg$^-$ | 8.83$^b$ | 38.65$^b$ |
| $R_2$ 20 g kg$^-$ | 9.50$^a$ | 40.15$^a$ |
| Interaction between BxR | | |
| $B_0R_0$ | 6.90 | 33.24 |
| $B_0R_1$ | 6.32 | 34.35 |
| $B_0R_2$ | 6.30 | 34.88 |
| $B_1R_0$ | 7.45 | 35.18 |
| $B_1R_1$ | 7.96 | 36.53 |
| $B_1R_2$ | 7.55 | 37.97 |
| $B_2R_0$ | 8.60 | 36.60 |
| $B_2R_1$ | 8.40 | 37.25 |
| $B_2R_2$ | 9.65 | 36.50 |
| $B_3R_0$ | 9.90 | 35.44 |

| | | |
|---|---|---|
| $B_3R_1$ | 9.45 | 41.22 |
| $B_3R_2$ | 10.80 | 41.73 |

Note: Numbers followed by the same letter in the same column indicate results that are not significantly different based on the Duncan Multiple Range Test at Alpha 5%. DC= 18%.

Peanut productivity on farmers' land in the North Sumatra region has an average value of 1.09 tonnes/ha of dry pods. Peanut productivity on farmers' land in the North Sumatra region has an average value of 1.09 tonnes/ha of dry pods based on conventional practices without additional treatment. However, in the $B_3R_2$ treatment, which involved administering BioVermigot and Rhizobium japonicum inoculant at 10.80 grams per plot, there was a significant increase in productivity. This improvement can be calculated as a percentage to show the effectiveness of the treatment compared to standard practice. These data show the great potential of using BioVermigot and Rhizobium japonicum as a more effective and sustainable method for increasing peanut yields.From the results of statistical analysis, it can be seen that there is no interaction between the inoculum dose of *Rhizobium spp*. and vermicompost dosage on dry seed weight per plant. However, independently the Rhizobium inoculum dose and vermicompost dose had a significant effect on the weight of dry seeds per plant (grams) and the weight of 100 dry seeds (grams) as shown in (Table 4).

Giving several doses of Biovermigot resulted in sufficient phosphorus elements during the seed filling process, thus having a real impact on the parameters of seed weight and the weight of 100 seeds in peanuts. Application of a combination of vermicompost, Black Soldier Fly larvae manure, and *Azotobacter sp*. has been proven effective in increasing dry seed weight yield in peanut plants.Using vermicompost and Black Soldier Fly larvae manure simultaneously can increase peanut crop yields [14]. Meanwhile, the combination of vermicompost with *Azotobacter sp*. also has a positive impact on the growth and yield of peanut plants [15].

The best dose of Biovermigot for dry seed weight and 100 dry seed weight in peanuts is 30 tons $ha^-$ ($B_3$) and the best dose of *Rhizobium spp.* is 20 g $kg^-$ ($R_2$). The higher the dose of vermicompost combined with Black Soldier Fly larvae manure plus *Azotobacter sp*., the higher the dry seed weight yield on peanut plants. For example, applying higher doses of the combination resulted in a significant increase in peanut crop productivity [16]. Similar results where larger doses of vermicompost, black soldier fly larvae manure, and *Azotobacter sp*. together they provide a greater positive impact on the growth and yield of peanut plants [17].

## 4 Conclusion

Peanut productivity in general in North Sumatra reaches an average of around 5.6 tons/ha using conventional methods, such as 100% chemical fertilizer. Meanwhile, the highest production yield from the Rhizobium japonicum and BioVermigot application treatment reached 10.80 grams per plot, which is equivalent to 72 kg/ha after conversion. These results show that productivity using a combination of BioVermigot and Rhizobium japonicum is still much smaller than using 100% chemical fertilizer. However, soil total N analysis showed that treatments with BioVermigot and *Rhizobium japonicum* resulted in very high soil nitrogen levels in all treatments. This has a significant positive impact on soil fertility, making this combination a sustainable approach to improving soil health even if crop yields are not optimal.

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