Effect of organic matter of chicken manure with bioactivator application of microbial rhizosphere inoculant to growth and yield of soybean (Glycine max (L.) Merill)

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Abstract. This research was aimed to know effect of organic matter of chicken manure with bioactivator application of microbial rhizosphere inoculant to growth and yield of soybean (Glycine max (L.) Merill). The research was conducted from February 2017 to Mei 2017, located at Panimbang District, Pandeglang Regency, Banten Province, Indonesia. This study used a randomized completely block design one factor that is giving of chicken manure matter with IMR bioactivator application consists of six levels. Thus, there are six treatments and each treatment was replicated four times as a group, so there are 24 experimental units. The results showed that the application of organic waste of chicken manure along with bioactivator application gave a significant effect on the number of leaves of soybean plant age of 5 week after planted and no significant effect on soybean plant height aged 5 and 6 week after planted, leaf number 6 week after planted, number of root nodule, number of pods of contents, number of empty pods, dry weight of seeds per plant, weight of 100 seeds, seed weight per plot and seed yield per hectare.

Keywords: bioactivator, chicken manure matter, microbial rhizosphere inoculant (IMR), soybean

1. Introduction
Soybean (Glycine max (L.) Merill) is a species of legume that plays an important role as the main vegetable protein source for the Indonesian people. According to [1], as a source of vegetable proteins, soybeans are generally consumed in the form of processed products such as tofu, tempeh, soy sauce, tauco, soy milk and various kinds of snacks. The needs of soybean are increasing, while the efforts to improve the production are still far from expectations which results in imports of soybeans.

In 2014, soybean production in Banten Province reached 6,384 tons with a harvested area reaching 4,815 ha and the average soybean productivity was 13.26 ku/ha [2]. Regarding the relatively low productivity of soybeans, there is a need to improve cultivation techniques to increase soybean production to meet market needs.
One effort that can be done to overcome the problem of low soybean production is by the use of organic matters and bioactivators. The admission of fresh or undecomposed organic matters can cause nutrients contained in these organic matters cannot be absorbed by plants and also often contain pathogens, eggs and insects that can harm the plants [3].

Chicken manure is an organic fertilizer derived from solid feces and urine of chickens mixed between the leftover food and the henhouse base [4]. The use of organic chicken manure is due to its abundant availability so that it is easily available and also has a higher nutrient content than other livestock manure. Chicken manure contains the highest nutrients, especially for N, because the urine is mixed with the solid feces [5].

One type of biofertilizers resulted from research conducted by BATAN that has not yet been commercialized is the rhizosphere microbial inoculant (IMR) bioactivator which is a consortia inoculant of the irradiated compost-based plant growth enhancing rhizosphere microbes. The irradiated compost-based inoculants with bioactive content in the form of a combination of Azotobacter sp., Bacillus sp. and Trichoderma sp. This is expected to be a part of efforts to develop microbial inoculants useful to improve health, growth and productivity of plants [6].

The results of the study conducted by [7] showed that the use of rhizosphere microbial inoculant as bioactivator could increase the effectiveness of cocoa pod compost as a nutrient provider for the growth of cacao seedlings and the use of IMR fertilizer as biofertilizers given once a week to better respond to growth of cacao seedlings compared to without IMR fertilizer. The use of rhizosphere microbial consortia inoculants as biofertilizer was able to increase the height, dry weight of plant stover, weight and production of fresh cobs of sweet corn of 23,64%, 63,62%, 29,41% and 29,35% respectively [6].

The purpose of this study was to find out the effect of organic chicken manure with the application of rhizosphere microbial inoculant bioactivator on the growth and yield of soybean plants (G. max (L.) Merill).

2. Methods
This research was carried out from February to May 2017 in the Rice Field of Kampung Pematang Gintung, Mekarjaya Village, Panimbang Sub-District, Pandeglang Regency. The tools used in this study were hoes, sickles, sacks, nameplate, handsprayer, buckets, watering cans, scales, measuring cups, spikes, ruler, meters, scissors, plastic ropes, tarps, cameras and stationery. Furthermore, the materials used were Grobogan-variety soybean seeds, Broiler chicken manure, rhizosphere microbial inoculant bioactivator (IMR), sugar, huck, bran, Sidamethri 50 EC insecticide and water.

This study used the single factor randomized block design. The factor studied was the admission of organic chicken manure with the application of the rhizosphere microbial inoculant bioactivator consisting of 6 levels, namely:
- C1: Control
- C2: Chicken Manure Bokashi
- C3: Chicken Manure Bokashi + IMR watering on plants every week
- C4: Chicken Manure Bokashi + IMR watering on plants every 2 weeks
- C5: Chicken Manure Bokashi + IMR watering on plants every 3 weeks
- C6: Chicken Manure Bokashi + IMR watering on plants every 4 weeks

Each treatment was repeated 4 times so that there were 24 experimental units. Each experimental unit consisted of 35 plants with a spacing of 40 cm x 20 cm, with an area of the experimental plot of 200 cm x 150 cm, the distance between treatment plots of 50 cm and the distance between groups of 100 cm. Each experimental plot was taken 10 plants randomly as sample.

The data obtained from the results of observations were then analyzed using 5% variance. If there is a difference, then a further test is carried out using the Duncan Multiple Range Test (DMRT) at the level of 5%.

The parameters observed in this study included plants aged 5 and 6 weeks, number of leaves aged 5 and 6 weeks, number of nodules, flowering age, number of filled pods, number of empty pods, dry weight of seeds per plant, weight of 100 seeds, seed weight per plot, and seed weight per hectare.
The research processes included land preparation, land processing and plot making, making chicken manure bokashi fertilizer, planting, application of IMR bioactivator, maintenance (planting, thinning, watering, weeding and pest and disease controlling) and harvesting.

3. Results and discussion

3.1. Plant Height

The results showed that at plant height aged 5 and 6 weeks the treatment of organic chicken manure followed by the application of IMR bioactivator in different soybean plants did not have significant effect. The average soybean plant height at the age of 5 and 6 weeks is presented in Table 1.

Table 1. The average soybean plant height at the age of 5 and 6 weeks after the admission of organic chicken manure and IMR bioactivator

| Treatment | 5 Weeks | 6 Weeks |
|-----------|---------|---------|
| C1        | 28.31   | 39.28   |
| C2        | 29.30   | 40.26   |
| C3        | 29.00   | 39.39   |
| C4        | 28.55   | 38.90   |
| C5        | 30.44   | 41.77   |
| C6        | 29.76   | 39.26   |

Table 1 shows that soybean plants treated with organic chicken manure followed by IMR bioactivator watering did not have any effect on plant height. This is presumably because some important nutrients needed by plants are available in the soil. In addition, the nutrient content in bokashi from chicken manure is low and also slow release, so that the effect on soybean plant height is not significant.

Moreover, at the height of plant aged 6 weeks the effects had no significant difference among the treatments. Allegedly, it is because the treated soybean plants have entered the generative phase. According to [9], the reproductive stage of soybean plants starts from the flower formation to pod maturation. The entry to the generative phase results in more carbohydrates produced from photosynthesis for the process of seed forming and filling.

3.2. Number of Leaves

The analysis of number of leaves showed that the admission of organic chicken manure followed by the application of IMR bioactivator had only significant effect on the number of leaves of soybean plants aged 5 weeks and did not have significant effect on the number of leaves of soybean plants aged 6 weeks. The average number of soybean leaves is presented in Table 2.

Table 2. The average number of soybean leaves at the age of 5 and 6 weeks after the admission of organic chicken manure and IMR bioactivator

| Treatment | 5 Weeks | 6 Weeks |
|-----------|---------|---------|
| C2        | 29.30   | 40.26   |
| C3        | 29.00   | 39.39   |
| C4        | 28.55   | 38.90   |
| C5        | 30.44   | 41.77   |
| C6        | 29.76   | 39.26   |

Based on Table 2, the admission of organic chicken manure followed by IMR bioactivator watering increased the number of leaves of soybean plants aged 5 weeks. The average number of leaves was mostly found in the treatment of chicken manure bokashi by IMR watering in every 3 weeks (C5), but not significantly different from the treatment C2, C3, and C4. This is presumably that the chicken manure bokashi applied in addition to improving soil conditions is also capable of supplying nutrients needed by plants even in small amounts. According to [8], the important function of soil organic matter is to provide nutrients through the process of decomposition and mineralization, boosting the activity of microorganisms and land animals and binding of toxic elements to acid soil.
Table 2. The average of number of leaves of soybean plants at the age of 5 and 6 weeks resulted from the admission of organic chicken manure and IMR bioactivator

| Treatments | 5 Weeks | 6 Weeks |
|------------|---------|---------|
| C1         | 12,90 a | 24,55   |
| C2         | 14,45 c | 29,13   |
| C3         | 14,48 c | 28,90   |
| C4         | 14,35 c | 27,78   |
| C5         | 14,50 c | 28,25   |
| C6         | 13,90 b | 27,43   |

Information: The numbers followed by the same lowercase letter on the same column showed insignificant difference in the DMRT test of 5%.

3.3. Number of Nodules
The results of analysis of variance of the variable number of nodules showed that the treatment of the admission organic chicken manure followed by the application of the IMR bioactivator on soybean plants has no significant difference. The average number of nodules of soybean plants can be seen in Table 3.

Based on Table 3, the effect of organic matter of chicken manure followed by IMR bioactivator watering on the number of nodules of soybean plants has no significant difference. Legume plants have a symbiotic relationship with bacteria from the genus *Rhizobium*. In their root nodules, bacteria fix the atmospheric nitrogen to ammonia, which plants assimilate into amino acids [10].

Rhizosphere microbial inoculant bioactivator (IMR) is a rhizospheric microbial consortia inoculant which enhances the growth of plants based on irradiated compost with bioactive content in the form of *Azotobacter* sp., *Bacillus* sp. and *Trichoderma* sp [11]. *Azotobacter* is an N$_2$ fixing bacteria that is able to produce stimulating substances to grow gibberellins, cytokines and indole acetic acid, so that the utilization can stimulate root growth. Azotobacter are found in almost all soils and grow well in soils with a pH between 6-7, which is mineral rich and lacks of N [10].

3.3. Flowering Age
The results of analysis of variance of variable flowering age showed that the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator on soybean plants was not significantly different. The average age of flowering of soybean plants can be seen in Table 3.

Based on table 3, the administration of bokashi followed by bioactivator watering has no significant effect on the flowering age of soybean plants. This is presumably because the flowering age is more influenced by genetic factors. It is in accordance with the opinion of [12] that the pattern of flowering of soybean plants depends on the variety.

3.4. Number of filled pods
The results of analysis of variance in the number of filled pods showed that the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator in soybean plants has no significant difference. The average number of soybean pods can be seen in Table 3.
Table 3. The average of the number of nodules, flowering age, number of filled and empty pods of soybean plant after the admission of organic chicken manure and IMR bioactivator

| Treatments | Number of Nodules | Flowering Age (days) | Number of filled pods | Number of empty pods |
|------------|-------------------|----------------------|-----------------------|---------------------|
| C1         | 46,95             | 36,25                | 59,18                 | 8,45                |
| C2         | 45,90             | 36,00                | 63,25                 | 7,38                |
| C3         | 45,10             | 36,25                | 58,48                 | 7,83                |
| C4         | 48,08             | 36,25                | 55,83                 | 5,73                |
| C5         | 44,45             | 36,00                | 58,98                 | 6,90                |
| C6         | 39,65             | 36,00                | 59,98                 | 7,40                |

Based on Table 3, the effect of organic matter of chicken manure followed by IMR bioactivator watering on the number of nodules of filled pods has no significant difference. This is presumably because the high nutrient content in the soil causes the chicken manure bokashi has not given any significant effect. In addition, the bioactivator watering is also not optimal because of the occurrence of leaching due to high rainfall. High rainfall causes inhibition of mineralization (the release of organic nutrients into nutrients available to plants) in the process of decomposition of organic matter which results in disrupted growth and development of plants because they do not get the necessary nutrients [13].

3.5. Number of Empty Pods
The results of analysis of variance in the number of empty pods showed that the treatment of organic chicken manure followed by the application of IMR bioactivator on soybean plants has no significant difference. The average number of soybean pods can be seen in Table 3.

Based on Table 3, the effect of organic matter of chicken manure followed by IMR bioactivator watering on the number of nodules of empty pods has no significant difference. The number of pods per plant that is not followed by sufficient source capacity will cause the photosynthetic distribution to fill the pods unevenly so that many empty pods will be produced. In addition, pest and disease attacks can also increase the percentage of empty pods. High rainfall causes greater leaf rust attack. According to [14], rust can reduce photosynthesis so that when the attack is heavy many pods are not fulfilled.

3.6. Dry Weight of Seeds per Plants
The results of analysis of variance of variable dry weight of seeds per plant showed that the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator on soybean plants has no significance difference. The average dry weight of seeds per soybean plant can be seen in Table 4.

Based on Table 4, the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator shows that the different watering intervals of IMR bioactivators tend to make difference in the dry weight of seeds per plants. The lowest average of dry weight of seeds was found in the treatment without chicken manure bokashi and IMR bioactivator watering (C1) which equals to 22.25 g, but the difference is not significant in all treatments. This is presumably because chicken manure bokashi can improve soil conditions and supply nutrients needed by plants even in small amounts. According to [15] chicken manure applied through soil media can help in fulfilling the soil nutrient availability and improving soil structure so that it can be a good growing medium for plants. However, if the soil has enough N, P and K, the plants are no longer responsive to the admission of chicken manure bokashi.
3.7. Weight of 100 Seeds

The results of analysis of variance of variable weight of 100 seeds showed that the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator on soybean plants has no significance difference. The average weight of 100 soybean seeds can be seen in Table 4.

**Table 4.** The average of dry weight of seeds per plant, weight of 100 seeds, weight of seeds per plot and weight of yield per hectare resulted from the admission of organic chicken manure and IMR bioactivator.

| Treatment | Dry weight of seeds per plant (g) | Weight of 100 seeds (g) | Weight of seeds per plot (g) | Weight of yield per hectare (ton/ha) |
|-----------|----------------------------------|-------------------------|-----------------------------|-------------------------------------|
| C1        | 22.25                            | 16.00                   | 700.00                      | 2.33                                |
| C2        | 24.85                            | 16.25                   | 735.00                      | 2.45                                |
| C3        | 23.05                            | 17.00                   | 700.25                      | 2.34                                |
| C4        | 22.58                            | 16.75                   | 721.25                      | 2.41                                |
| C5        | 23.15                            | 16.00                   | 751.25                      | 2.51                                |
| C6        | 23.73                            | 16.50                   | 687.25                      | 2.30                                |

Based on Table 4, the effect of the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator to the weight of 100 seeds has no significant difference. This is presumably because the initial growth conditions of the soil have been optimal for the growth and development of soybean plants. This is supported by the results of the initial soil analysis which showed that the soil pH has neutral reaction (7.44). According to [14], the value of soil pH that is suitable for soybean crops ranges from 5.8–7.0. Soil pH determines whether the nutrients are absorbed by plants and by plant roots in general at neutral pH around 5.

3.8. Weight of Seeds per Plot

The results of analysis of variance of variable weight of seeds per plot showed that the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator on soybean plants has no significance difference. The average weight of seeds per plot can be seen in Table 4.

Based on Table 4 the effect of treatment of organic chicken manure followed by the application of IMR bioactivator showed that the different watering intervals of IMR bioactivators tend to give different weight yields of seeds per plot. According to [16] the increase in seed weight both dry seed weight per experimental plot and the weight of 100 dried seeds are closely related to photosynthetic matter which is translocated to the pods and seeds. The greater the photosynthesize translocated, the higher the filling of seeds. The absence of a significant response to the weight of seed yield per plot is suspected because the land used has very high levels of organic C so that soybean plants are not responsive to the administration of chicken manure bokashi fertilizer and IMR bioactivator. In addition, the land used is also used for rice cultivation which still contains a lot of nutrients N, P and K due to the residue of the fertilizer left before.

3.9. Weight of Yield per Hectare

The results of analysis of variance of variable weight of seeds per hectare showed that the treatment of the admission of organic chicken manure followed by the application of IMR bioactivator on soybean plants has no significant difference. The average weight of seeds per hectare can be seen in Table 4.

Based on Table 8, the effect of organic chicken manure followed by the application of IMR bioactivator on weight of seeds per hectare has no significant difference. It is allegedly because some of the important nutrients needed by plants are already available in the soil and high rainfall results in leaching so that the IMR bioactivator watering is ineffective and inefficient. In addition, the attack of rats in the filling phase until pod maturation caused a considerable decrease in yield.
4. Conclusion
Based on the results of the research, it can be concluded that the admission of organic chicken manure followed by IMR bioactivator watering every 3 weeks has only good effect on the number of leaves aged 5 weeks (14.50 leaves). Meanwhile, there is no effect found in the plant height is at the age of 5 and 6 weeks, number of leaves aged 6 weeks, number of nodules, number of filled pods, number of empty pods, dry weight of seeds per plant, weight of 100 seeds, weight of seeds per plot, and yield of seeds per hectare.

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