Effect of bio-slurry fertilizer and chicken manure on growth and yield of green bean in latosol

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Abstract. In general, latosol soil has a low nutrient content and organic matter, while the productivity of the soil is from moderate to high. The purpose of this study was to determine the growth and production of green beans planted with bio-slurry and chicken manure on latosol soil. This research was conducted at the Screen House of Agrotechnopark, Faculty of Animal Husbandry and Agriculture, Diponegoro University. This study use a completely randomized design with factorial patterns and three replications. The first factor is bio-slurry fertilizer, namely 300 kg ha⁻¹ (P1), 600 kg ha⁻¹ (P2), and 900 kg ha⁻¹ (P3), while the second factor chicken manure is 0 kg ha⁻¹ (A0), 200 kg ha⁻¹ (A1), 400 kg ha⁻¹ (A2) and 600 kg ha⁻¹ (A3). This research using 12 treatment combination, in which each treatment was repeated five times. Therefore, the total experimental unit were 60 units. The results of the analysis of variance showed that the treatment of bio-slurry fertilizer and chicken manure significantly affected the number of leaves, number of pods, pod length, weight of 100 grains and weight of seeds per plant. There was no interaction between the treatment of bio-slurry fertilizer and chicken manure for all observed parameters. The highest number of leaves each was obtained from the treatment of bio-slurry fertilizer 900 kg ha⁻¹ (25.46 strands) and 200 kg ha⁻¹ chicken manure treatment (27.70 strands). The treatment of bio-slurry fertilizer up to a dose of 900 kg ha⁻¹ yield the highest number and length of pods of 16.08 and 13.92 cm respectively. While the highest seed weight per plant of 7.50 g was obtained from bio-slurry fertilizer treatment at a dose of 900 kg ha⁻¹.

1. Introduction

Green beans are one of the legume plants that have high economic value in Indonesia. Because it is classified as high in use in the community then green beans have the level of need is quite high. With relative cultivation and planting techniques easy cultivation of green bean plants have good prospects for being a business opportunity agribusiness sector. According to Rukmana (2004) that the yield of mung beans is still relatively low because it is often planted in less fertile land. Soil fertility plays an important role for green bean plants as a root buffer, a nutrient provider, so that plant growth and development are more optimal. (Rukmana, 2004).

Latosol soil is one type of soil that has the potential to be used as agricultural land for green bean plants. Latosol soil has several problems including soils that contain a lot of iron and aluminum so that it has a pH of 4.5 - 6.5, consequently the soil becomes acidic to slightly acidic, contains low organic matter (3% to 9%) and this soil is already so old that its fertility is low. This soil has good physical properties, but has a low cation exchange capacity so it requires rather frequent fertilization (Hakim, 1986).

Peanut plants including green beans require regular and continuous fertilization, especially on less fertile soils. The main nutrients needed, namely nitrogen, phosphorus, and potassium. Fertilizer given
to green bean plants can be in the form of organic fertilizer, (for example manure) and inorganic fertilizer. If the plant environment does not support, for example, lack of N, P, K nutrients, then it cannot grow properly. To support for optimal growth and yield, plants really need fertilization. There are two types of fertilizers that are often used, namely inorganic fertilizer (chemical) and organic fertilizer. Chemical fertilizers can increase soil productivity in a short time but cause damage soil structure. Organic fertilizer has the advantage of releasing nutrients slowly so that it has a residual effect in the soil and is useful for subsequent crops (Suprapto and Aribi, 2006). Furthermore Astiningrum (2005) states that usage excessive chemical fertilizer can cause the residue which results in damage to the soil so that it will reduce the quality and quantity of agricultural products. In agricultural practices, farmers generally only use inorganic fertilizers. This can occur because inorganic fertilizers are able to provide nutrients in a relatively faster time (Lingga and Marsono, 2001). However, if the application of inorganic fertilizers with excessive doses but rarely using organic fertilizers will result in rapid soil conditions such as compaction, weight gain, and sensitivity to erosion as a result of low organic matter content (Prasetyo et al., 2014). This condition will also result in nutrient impoverishment in the soil so that the provision of organic fertilizer and balanced fertilization is one of the important activities in crop cultivation. Therefore, one of the efforts that can be done to improve the fertility of latosol soil and the growth and production of green bean plants grown in the soil is through the application of bio-slurry organic fertilizer and chicken manure. Bio-slurry fertilizer is the final product of processing waste made from solid and liquid cow manure which is very useful as a source of nutrition for plants. Bio-slurry fertilizer contains 25.58% C-Organic, 18.40 C/N, 2.05% N, 2.70% P2O5, 0.58% K2O and pH between 7.5 - 8. Bio-fertilizer liquid slurry contains 47.99% C-Organic, 15.77% C/N, 2.92% N, 0.21% P2O5, 0.26 K2O. The advantage of bio-slurry fertilizer is that it does not damage the soil and plants although it is often used, can neutralize soils with low pH, add humus as much as 10 - 12%, besides that it can support the activities of developing worms and soil microbes that are beneficial to plants (Arief, 2014). Whereas chicken manure is one of the manures which is widely used among Indonesian farming communities. This happens because chicken manure decomposes more quickly than other types of manure, so the benefits of chicken manure can be directly seen in plants and can directly increase productivity of crop yields. Chicken manure contains 29% organic matter with a C/N ratio of 9 to 11%, 1.5% N2, 1.3% P2O5, 0.8 K2O, and 4.0 CaO. From the content it is known that when compared with other types of manure such as goats and cows, chicken manure has the highest P2O5 and K2O content. That is why chicken manure can increase crop production higher than other types of manure. Based on the description and explanation above, the research on the effect of bio-slurry fertilizer and chicken manure on the growth and yield of mung beans in latosol needs to be done to improve soil fertility and growth and production of green beans on latosol soils. The purpose of this study was to determine the effect of bio-slurry fertilizer and chicken manure on the growth and yield of green beans in latosol.

2. Materials and Methods
2.2. Media Preparation, Fertilization and Planting
Soil samples from 10 to 15 cm deep were collected from farmers' land in the Tembalang village of Semarang, Central Java. After collecting soil samples, unwanted roots and debris are removed and dried in the air for at least 3 days until a constant weight is reached. After air drying the soil sample is filtered by passing a 2 mm filter.

Bio-slurry fertilizer and chicken manure are collected from biogas reactors at the Faculty of Animal and Agriculture Sciences, Diponegoro University, Semarang. After collection, bio-slurry and chicken manure are dried in the air for 3 days and filtered through a 2 mm sieve. Furthermore, the fertilizer ingredients are mixed with the soil according to the level of treatment. Green bean seedlings are planted a day after the soil has been fertilized with bio-slurry and chicken manure. Green bean seeds are planted 3 seeds / polybag, then thinning is carried out at the age of 7 days after planting (HST) and leaving 2 plants / polybags, Harvesting is done in stages when the pods have browned, aged 72 - 77 HST.
2.2. Experimental Design and Data Analysis
This study uses a completely randomized design with factorial patterns and three replications. The first factor is bio-slurry fertilizer, namely 300 kg ha\(^{-1}\) (P1), 600 kg ha\(^{-1}\) (P2), and 900 kg ha\(^{-1}\) (P3), while the second factor chicken manure is 0 kg ha\(^{-1}\) (A0), 200 kg ha\(^{-1}\) (A1), 400 kg ha\(^{-1}\) (A2) and 600 kg ha\(^{-1}\) (A3). The total number was 12 treatment combinations, each treatment was repeated five times so that 60 experimental units were obtained. Parameters observed are plant height, number of leaves, weighted perimeter, length of pods, number of pods / plants, number of seeds/plants, weight of 100 grains, weight of seeds/plants and harvest index.

2.2. Statistical Analysis
Data analysis using variance, if in variance at the level of 5% there is a real effect, followed by DMRT (Duncan Multiple Range Test).

3. Results and Discussion
3.1. Soil Analysis
The results of the analysis of the soil chemical properties carried out before planting green beans showed that the soil was classified as acid with a pH of 4.91 and the soil nutrient status was in the very low category. Soil chemical properties which are classified as very low are N-total, K-dd, Na-dd, CEC, and Al-dd. The P2O5 and Mg-dd contents are classified as very low, while the available Fe, Zn, Cu, and Mn are very high (Table 1). According to Cardona et al. (1982) in Flor & Thung (1989), the critical value for soybean plants is at soil pH 5.0 - 8.1; element P 25.19; K 0.15; Ca 4.5; Mg 2; and Al 1. Based on the results of the analysis of these chemical properties and compared with critical values for mung bean plants, soil pH, elements N, P, K, and Ca can be indicated as a limiting factor for productivity of mung bean plants. In addition, low Al in the soil does not interfere with the growth of green bean plants.

3.2. Plant height, number of leaves and dry weight
The results of the statistical analysis showed that there was no real interaction between the bio-slurry fertilizer and chicken manure (Tabel 2). The application of bio-slurry fertilizer and chicken manure significantly affected the number of leaves of green bean plants. Fertilization of bio-slurry up to a dosage of 900 kg ha\(^{-1}\) resulted in the highest number of leaves of 25.46 strands but the number of leaves was no different from the treatment of bio-slurry powder 600 kg ha\(^{-1}\) (24.03 strands).

Fertilizing 200 kg ha\(^{-1}\) of chicken manure produces the highest number of leaves (27.70 strands) but the number of leaves is no different from plants that are given 400 kg ha\(^{-1}\) of manure (26.86 strands). This is due to bio-slurry fertilizer and chicken manure is able to provide nutrient absorption rate for plants as well as having higher nutrient content compared to without fertilizer application.

The presence of macro elements such as N which has a greater content in chicken manure causes the vegetative growth of green bean plants more rapidly which can be seen from the higher number of leaves produced. This shows that the addition of doses of bio-slurry fertilizer and chicken manure tend to provide a greater amount of nutrients for plants so that the quality and number of leaves increases. According to Suwardjono (2001), that the role of nitrogen for plants is to stimulate overall plant growth specifically for stems, branches and leaves. This leaf formation can take place both at a constant temperature and light intensity, as stated by Oktarina and Purwanto (2009), that the rate of leaf formation or the time interval required per plant leaf that is formed is relatively constant.
Table 1. Chemical properties of latosol soils originating from Tembalang in the 0-20 cm processing layer

| Land Properties | Value | Method | Valuation criteria |
|-----------------|-------|--------|--------------------|
| pH H_2O         | 4.91  | H_2O   | Acid               |
| pH KCl          | 4.02  | KCl    |                    |
| C-organi (%)    | 0.84  | Walkey and Black | Very low         |
| N-total (%)     | 0.04  | Kjeldahl | Very low         |
| P_2O_5 Bray I (ppm) | 5.6 | Bray I   | Very low           |
| K-dd (cmol+/kg) | 0.15  | NH4-asetat 1N | Low              |
| KTK (me/100g)   | 12.7  | N NH_4OAc | Low             |
| Al-dd (cmol+/kg)| 0.41  | KCl 1N   | Low                |
| H-dd (cmol+/kg) | 0.32  | KCl 1N - |                    |
| Fe (ppm)        | 416   | DTPA    | Very high          |
| Zn (ppm)        | 51.4  | DTPA    | Very high          |
| Cu (ppm)        | 2.68  | DTPA    | Very high          |
| Mn (ppm)        | 74.1  | DTPA    | Very high          |

Table 2. Effect of bio-slurry fertilizer and chicken manure on plant height, number of leaves and the weights stover of the green bean plants

| Treatment       | Plant Height | Number of leaves | Weight of stover |
|-----------------|--------------|-----------------|-----------------|
|                 | ----cm------ | ----strands----- | ----g------     |
| Bio-slurry fertilizer |             |                 |                 |
| P1. 300 kg ha\(^{-1}\) | 54,35a       | 22,56b          | 4,25a           |
| P2. 600 kg ha\(^{-1}\) | 56,25a       | 24,03a          | 4,88a           |
| P3. 900 kg ha\(^{-1}\) | 57,75a       | 25,46a          | 5,01a           |
| Chicken manure  |             |                 |                 |
| A0. 0 kg ha\(^{-1}\) | 54,27a       | 23,06b          | 4,11a           |
| A1. 200 kg ha\(^{-1}\) | 56,33a       | 27,70a          | 4,73a           |
| A2. 400 kg ha\(^{-1}\) | 55,40a       | 26,86a          | 4,99a           |
| A3. 600 kg ha\(^{-1}\) | 58,80a       | 24,55b          | 5,19a           |

Note: Different superscripts in the same column show significantly different (p < 0.05)

The treatment of bio-slurry fertilizer and chicken manure can increase the length of pods and the number of pods/green bean plants (Table 3). Giving bio-slurry fertilizer up to a dosage of 900 kg ha\(^{-1}\) produced the highest pod length of 14.92 cm. While all treatments of chicken manure do not differ from the length of the mung bean pods produced. The number of pods/green bean plants at a dosage of 900 kg ha\(^{-1}\) bio-slurry fertilizer was the highest (16.08 pods) not significantly different from the fertilizer dosage of 600 kg ha\(^{-1}\) (15.25 pods). The treatment of chicken manure at a dosage of 600 kg ha\(^{-1}\) produced the highest number of pods/plants of 15.22 pods but was not significantly different from the dosage of 200 kg ha\(^{-1}\) (15.10 pods) and a dosage of 400 kg ha\(^{-1}\) (13.55 pods). The increasing dosage of bio-slurry fertilizer and chicken manure given, the number of pods produced by green beans also increased. That was allegedly because according to the results of the analysis, chicken manure had high N, P, and K contents. This is reinforced by the statement of Widarawati and Harjoso (2011), the formation and filling of pods needed enough N, P, and K elements for protein formation in seeds. The use of manure in the form of manure (chicken and cattle) can increase the P content available in
Table 3. Effect of bio-slurry fertilizer and chicken manure on pod length, number of pods per plant and the number of seeds per green bean plant.

| Treatment                   | Pod length | Number of pods per plant | Number of seeds per plant |
|-----------------------------|------------|--------------------------|---------------------------|
|                             | cm         | pods                     | seeds                     |
| Bio-slurry fertilizer       |            |                          |                           |
| P1. 300 kg ha⁻¹             | 9.92c      | 12.25b                   | 65.11a                    |
| P2. 600 kg ha⁻¹             | 11.92b     | 15.25a                   | 61.32a                    |
| P3. 900 kg ha⁻¹             | 14.92a     | 16.08a                   | 66.48a                    |
| Chicken manure              |            |                          |                           |
| A0. 0 kg ha⁻¹               | 8.25b      | 10.22b                   | 59.83a                    |
| A1. 200 kg ha⁻¹             | 11.33a     | 15.10a                   | 61.33a                    |
| A2. 400 kg ha⁻¹             | 12.44a     | 13.55ab                  | 66.01a                    |
| A3. 600 kg ha⁻¹             | 12.89a     | 15.22a                   | 62.52a                    |

Note: Different superscripts in the same column show significantly different (p < 0.05)

The soil by 65.7% (Hossain et al., 2016). The P element is used to form ATP which is used by plants for energy in the process of photosynthesis so that if ATP is sufficient the photosynthesis process will go well and the results of photosynthesis increase. The existence of P fertilizer is supported by N fertilizer which can be used by plants for material in the process of photosynthesis so that the formation of optimal pods.

The P element becomes important for green beans because of its ability to symbioses with Rhizobium to convert free N from the air into N available for plants. According to Afandi et al., (2015), the provision of organic matter in the form of chicken manure, cow manure and compost significantly increased plant P uptake. According to Kumawat et al. (2009), the application of P fertilizer improves the absorption and translocation of N, P and K nutrients in the reproductive phase. The weight of 100 seeds is related to the quality of seeds produced by plants. Bio-slurry effect fertilizer and chicken manure weighs 100 grains, weight of seeds / plants and green harvest index green bean are listed in Table 4. The weight of 100 seeds that were given bio-slurry fertilizer at a dosage of 900 kg ha⁻¹ was the highest (7.95 g) which was significantly different from the dosage of bio-slurry fertilizer 600 kg ha⁻¹ (6.10 g) and bio-slurry dosage 300 kg ha⁻¹ (6.08 g). The treatment of chicken manure at a dosage of 600 kg ha⁻¹ produced the highest weight of 100 grains (7.00 g) not different from the dosage of 400 kg ha⁻¹ (6.62 g) and a dosage of 200 kg ha⁻¹ (6.13 g). Without chicken manure produces the lowest weight of 100 grains (5.95 g). According to Shukla and Tyagi (2009) that the provision of organic fertilizer increases availability of nutrients needed in seed formation. Organic material in compost, manure, green manure and plant residues can provide nutrition for growth and crop yields, nutrient uptake, seed quality as well soil fertility. Lambers et al., (2008) stated that the weight of 100 grains is influenced by nutrient availability and the ability of plants to absorb, for example phosphorus in the seed filling phase. Phosphorus is an important component of compounds for energy transfer (ATP and other nucleoproteins), for genetic information systems (DNA and RNA), for cell membranes (phospholipids), and phosphoproteins. The application of bio-slurry fertilizer has a significant effect on the weight of seeds/plants of green beans. The highest seed weight/plant yield was given on the application of bio-slurry fertilizer at a dosage of 900 kg ha⁻¹ (7.50 g) which was not significantly different from the treatment dosage of 600 kg / ha. The lowest seed weight / crop was produced in the 300 kg ha⁻¹ bio-slurry fertilizer treatment (Table 4). According to Ali et. al., (2010), that the weight of the seeds of green bean plants is determined by genetic factors, good agronomic practices, and environmental conditions. Furthermore, Hidayat (2008), reported that the supply of phosphorus in plant organs increases metabolism in plants, especially in the seed filling phase can increase seed weight. Furthermore, Syafrina (2009) stated that the function of phosphorus for plants is to stimulate generative growth like formation flowers, fruit formation, and seed filling. Table 4. Effect of bio-slurry fertilizer and chicken manure on weight of 100 grains, seed weight/plant and index of harvest of green bean plants.
**Table 4.** Effect of bio-slurry fertilizer and chicken manure on weight of 100 grains, seed weight/plant and index of harvest of green bean plants

| Treatment                  | Weight of 100 grains | Seed weight/plant | Index of harvest |
|----------------------------|----------------------|-------------------|------------------|
| Bio-slurry fertilizer      |                      |                   |                  |
| P1. 300 kg ha⁻¹            | 6.08b                | 6.53b             | 0.86a            |
| P2. 600 kg ha⁻¹            | 6.10b                | 7.01a             | 0.91a            |
| P3. 900 kg ha⁻¹            | 7.95a                | 7.50a             | 0.88a            |
| Chicken manure             |                      |                   |                  |
| A0. 0 kg ha⁻¹              | 5.95b                | 6.05b             | 0.78a            |
| A1. 200 kg ha⁻¹            | 6.13ab               | 7.21a             | 0.81a            |
| A2. 400 kg ha⁻¹            | 6.62a                | 7.35a             | 0.90a            |
| A3. 600 kg ha⁻¹            | 7.00a                | 7.44a             | 0.85a            |

*Different superscripts in the same column show significantly different (p <0.05).*

4. Conclusion

Based on the results of research that has been done, it can be concluded that bio-slurry fertilizer and chicken manure could increase the growth and production of green bean plants in latosol soil. There was no interaction between the treatment of bio-slurry fertilizer and chicken manure for all observed parameters. The highest number of leaves was obtained from the treatment of bio-slurry fertilizer 900 kg ha⁻¹ (25.46 strands) and 200 kg ha⁻¹ chicken manure treatment (27.70 strands). The treatment of bio-slurry fertilizer up to a dosage of 900 kg ha⁻¹ performed the highest number and length of pods of 16.08 and 13.92 cm respectively.

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References

[1] Afandi F.N, Siswanto B dan Nuraini Y 2015 Pengaruh pemberian berbagai jenis bahan organik terhadap sifat kimia tanah pada pertumbuhan dan produksi tanaman ubi jalar di Entisol Ngrangkah Pawon, Kediri. Jurnal Tanah dan Sumberdaya Lahan 2 (2): 237-244.

[2] Ali, M. A., Abbas, G., Mohy-ud-Din, Q., Ullah, K., Abbas, G., & Aslam, M. 2010. Response of Mungbean (Vigna radiata) to phosphatic fertilizer under arid climate. *Journal of Animal and Plant Sciences*. 20 (2), 83–86. Retrieved from http://thejaps.org.pk/docs/20-2-2010/Abbas et-al.pdf.

[3] Arief Z 2014 Pengelolaan dan Pemanfaatan Bio-Slurry. Revisi Ketiga. Jakarta Revisi Ketiga. Cetak Biru, Jakarta.

[4] Astiningrum M. 2005. Manajemen Persampahan. Majalah Ilmiah Dinamika. Universitas Tida Magelang 15 Agustus 2005. Magelang, 8 hal.

[5] Flor C A, Thung M T 1989 Nutritional Disorders. In H.F. Schwartz and M.A. Pastor-Carrolas. Bean Production Problems in The Tropics. 2nd edt. Colombia (CO): CIAT, Cali.

[6] Hakim dkk 1986 Dasar-Dasar Ilmu Tanah. (Lampung: Penerbit Universitas Lampung)

[7] Hidayat N 2008 Pertumbuhan dan Produksi Kacang Tanah (Arachis hypogea L.) Varietas Lokal Madura Pada Berbagai Jarak Tanam dan Pupuk Fosfor. *Agrovivor* 1(1), 55–64. Retrieved from http://kompetensi.trunojoyo.ac.id/agrovigor/article/viewFile/232/214.

[8] Hossain M S, Hossain A, Sarkar M A R, Jahiruddin M, Teda S J A dan Hossain M. I 2016 Productivity and soil fertility of the rice–wheat system in the High Ganges River Floodplain of Bangladesh is influenced by the inclusion of legumes and manure. *Agriculture, Ecosystems & Environment*. 218 40–52. https://doi.org/10.1016/ J.AGEE.2015.11.017

[9] Kumawat N, Kumar R. dan Sharma O P 2009 Nutrient Uptake and Yield of Mungbean Vigna radiata (L.) Willczek as Influenced by Organic Manures, PSB and Phosphorus Fertilization.
Environment and Ecology. 27(4B), 2002–2005. Retrieved from https://www.researchgate.net/profile/Narendra_Kumawat/publication/258641717_Nutrient_Uptake_and_Yield_of_Mungbean_Vigna_radiata_L_Wilczek_as_Influenced_by_Organic_Manures_PSB_and_Phosporous_Fertilization/links/02e7e528c567001def000000.pdf.

[10] Lambers H, Chapin F S dan Pons T L 2008 Plant Physiological Ecology (New York: NY. Springer New York) https://doi.org/10.1007/978-0-387-78341-3.

[11] Lingga P dan Marsono 2001 Petunjuk Penggunaan Pupuk. (Jakarta: Penebar Swadaya) p 163

[12] Oktarina dan Purwanto E B 2009 Growth and production response of lettuce (lactuna sativa) in hydroponics to concentration and frequency of application of nutrient solution. Agritrop Jurnal Ilmu-ilmu Pertanian. hal:125-132.

[13] Prasetyo A, Utomo W H dan Listyorini E 2014 Hubungan sifat fisik tanah, perakaran dan hasil ubi kayu tahun kedua pada Alfisol Jatikerto akibat pemberian pupuk organik dan anorganik (NPK). Jurnal Tanah dan Sumberdaya Lahan I(1):27-38.

[14] Rukmana R 2004. Kacang Hijau. Budidaya dan Pascapanen. Penerbit Kanisius.

[15] Shukla L dan Tyagi S P 2009 Effect of integrated application of organic manures on soil parameters and growth of mungbean (Vigna radiata ). Indian Journal of Agricultural Sciences. 79(3),174–177

[16] Suwardjono 2001 Pengaruh Beberapa Jenis Pupuk Kandang Terhadap Pertumbuhan dan Produksi Kacang Tanah (Yogyakarta: UPJJ-UT)

[17] Suprapto dan Ariba I B 2006 Pengaruh Residu Beberapa Jenis Pupuk Organik Terhadap Pertumbuhan Dan Hasil Tanaman Kacang Hijau (Vigna radiata L) Di Lahan Kering. http://www.bptp.jatimdenpan.go.id/templates/16. 12 mei 2016.

[18] Syafrina S 2009 Growth Response and Production of Mung Beans (Phaseolus radiatus L.) on Subsoil Media with respect to Provision of Several Types of Organic Materials and Liquid Organic Fertilizer. http: www.google.com: repository.usu.ac.id. Accessed November 11, 2013.

[19] Widarawati R dan T Harjoso 2011 Pengaruh pupuk P dan K terhadap pertumbuhan dan hasil tanaman kacang hijau (Vigna radiata L.) pada media tanah pasir pantai. Jurnal Pembangunan Pedesaan. 11 (1):67-74.

[20] Widowati L R, Widati S, Jaenudin U dan Hartatik W 2005 Pengaruh Kompos Pupuk Organik yang Diperkaya dengan Bahan Mineral dan Pupuk Hayati terhadap Sifat-sifat Tanah, Serapan Hara dan Produksi Sayuran Organik. Laporan Proyek Penelitian Program Pengembangan Agribisnis, Balai Penelitian Tanah, TA 2005 (Tidak dipublikasikan).