Indonesian Journal of Agricultural Research Vol. 01, No. 01, 2018 | 78 – 86

talenta PUBLISHER

InJAR
Indonesian Journal of Agricultural Research

Effect of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure on the Growth and Production of Chinese Kale *(Brassica oleracea L.)*

Wan Arfiani Barus, Sri Utami, and Erna Pan Azmi

Department of Agrotechnology, Faculty of Agriculture, Universitas Muhammadiyah Sumatera Utara, Indonesia

Abstract. The purpose of this research was to find out the effect of Azolla Bokashi and liquid organic fertilizer of goat manure on the growth and production of *Chinese kale*. This study used a Factorial Randomized Block Design. The factors studied were Azolla Bokashi Fertilizer (B) with 3 levels (B_0 = without treatment/control, B_1 = 5 tons (1.14 kg/plot), B_2 = 10 tons (2.28 kg/plot) and liquid organic fertilizer of goat manure (K) (K_0 = without treatment, K_1 = 100 ml/liter of water, K_2 = 200 ml/liter of water, and K_3 = 300 ml/liter of water. The parameters observed were the plant height, number of leaves, amount of chlorophyll, stem diameter, plant's wet weight, plant's dry weight and harvest index.

Keywords: Azolla, bokashi, *Chinese kale*, goat manure, liquid organic fertilizer

Received 24 February 2018 | Revised 29 March 2018 | Accepted 29 March 2018

1. Introduction

Chinese kale (*Brassica oleracea L.*) is a leaf vegetable that has high nutrient content such as protein, minerals, and vitamins whose leaves and stems taste sweet. *Chinese kale* (*Brassica oleracea L.*) or kale belongs to the same species with such other vegetables as cabbage. In addition, *chinese kale* belongs to seasonal and short-lived vegetables. *Chinese kale* should be harvested before it becomes too old because its leaves and stems will be so tough that it is no longer good to eat. *Chinese kale* harvested in its early age is called baby *chinese kale*. Baby *chinese kale* is more desirable because of its better and crunchier taste than old *chinese kale*. The success of cultivating *chinese kale* is influenced by environmental factors, and one of the important factors that can affect the growth and production of this plant is fertilization. Nitrogen fertilization for leafy vegetables plays a role in protein synthesis, an integral part of the chlorophyll molecule, and the application of N in sufficient quantities is expected to provide good vegetative growth and fresh green color [1].

*Corresponding author at: Department of Agrotechnology, Faculty of Agriculture, Universitas Muhammadiyah Sumatera Utara, Jl. Kapten Muchtar Basri No. 108-112, Medan, Sumatera Utara, Indonesia

E-mail address: wanarfrianibarus@umsu.ac.id

Journal Homepage: https://talenta.usu.ac.id/InJAR

Organic fertilizers are provided gradually for plants because they have to undergo various changes before they are absorbed by the plants. Generally, the residual effect of organic fertilizer will provide nutrient reserves that can be used for the next period of planting. The use of organic material in plants does not only provide the elements needed by plants, but also can improve the soil structure both the soil physical properties and the soil biological properties. Administering liquid organic fertilizer should consider the concentration or the dose applied to the plants. Some research results indicate that the administration of liquid organic fertilizer through the leaves provides better growth and yield than the administration through the soil. The higher the dose of fertilizer is administered the higher the nutrient content is received by the plant; similarly, the more frequent the administration of leaf fertilizer is conducted to the plant, the higher the content of the nutrients is. Nevertheless, administering in excessive doses leads to the emergence of symptoms of malignancy in the plants [2].

Nitrogen content produced by *Azolla pinnata* has high values in the agricultural sector. Fasakin [3] conducted a study on Azolla in Nigeria and found a potential source of protein for fishery activities. In addition to fish feed in fishery activities, Azolla plant can also be applied to agricultural activities as natural organic fertilizer and to livestock activities as animal feed [4]. Nevertheless, some of the potential of Azolla plant is still not optimally utilized.

The content of macro- and micronutrient of animal dung is complete enough according to the quality standard of organic fertilizer of animal manure issued by the Ministry of Agriculture [5]. Such condition is one of the weaknesses of organic fertilizer from animal dung. Therefore, the manufacture of organic fertilizer from animal dung should be added with other materials, such as fruit waste, vegetable waste and so forth, which can improve the macronutrient content in the fertilizer. The results of heavy metal measurements are still in a non-hazardous condition, so it can be said that such fertilizer deserves to be used as an organic fertilizer. The heavy metal is important to be measured and studied because it causes health effects for humans depending on which part of the heavy metal is bound in the human's body. Its toxicity will work as an enzyme work barrier, so that the body's metabolic process is disturbed. Furthermore, this heavy metal will act as the cause of allergies, mutagens, teratogens or carcinogens for humans. It comes into human's body through skin, breathing and digestion. Therefore, the manufacture of fertilizer will be related to the plant [6].

Bokashi fertilizer is one of the alternatives in the application of sustainable environmentally sound organic agricultural technology. Bokashi has a good prospect for organic fertilizer because it has a quite high nutrient [7].

2. Materials and Method

This research was conducted from January to March 2017 in Pasaribu Percut Sei Tuan Village, Deli Serdang Regency, North Sumatra Province, Indonesia, the area is located 20 meters above sea level.

The materials used in this research were *chinese kale* seeds, Azolla bokashi fertilizer, liquid organic fertilizer of goat manure, Sevin 85 S insecticide, ordinary bran, fresh Azolla, molasses, goat dung, drums/vat, Em4, *tapai* (fermented tuber) yeast and water as well as other materials deemed necessary to conduct this research. The tools used were machetes, hoe rakes, *gembor* (big kettle), scales, meter, raffia rope, chlorophyll meter (SPAD), S-caliper, stationery and a calculator.

This research used a Factorial Randomized Block Design with 2 (two) treatment factors, they are: Azolla Bokashi Fertilizer, consisting of: B0 = Without treatment/control; B1= 5 tons (1.14 kg/plot); B2= 10 tons (2.28 kg/plot). Liquid Organic Fertilizer of Goat Manure, consisting of: K0 = without treatment/control; K1 = 100 ml/liter of water; K2 = 200 ml/liter of water; K3 = 300 ml/liter of water.

3. Results and Discussion

3.1. Plant Height (cm)

The data were obtained from the observation on the *chinese kale* plant height treated with Azolla bokashi and liquid organic fertilizer of goat manure on the growth and production of 1-5 weeks old *chinese kale*. The result of variance analysis with a Randomized Block Design showed that the treatment using Azolla bokashi had a significant effect on the plant height at 4 weeks after planting (WAP), but the treatment using liquid organic fertilizer of goat manure had no significant effect on the growth and production of *chinese kale*. The height of 4 week old *chinese kale* administered with Azolla bokashi and liquid organic fertilizer of goat manure can be seen in Table 1.

Table 1. Plant Height (cm) of *Chinese kale* at 4 WAP on Application of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure

Treatment	K_0	K_1	K_2	K_3	Mean
B_0	16.39	17.06	20.50	21.11	18.76c
B_1	22.61	20.22	22.78	20.28	21.47a
B_2	20.56	21.89	22.22	19.56	21.06b
Mean	19.85	19.72	21.83	20.31	20.43

Description: The numbers followed by different letters in the same colomn are significantly different based on the 5% DMRT test

Table 1 explains that the highest *chinese kale* plant height after 4 weeks of planting is found in the B_1 treatment with the average height of 21.47 cm, and the lowest is found in the B_0

treatment with the average height of 18.76 cm. It is suspected that bokashi fertilizer is able to provide nutrients for the plant, despite its small amounts, to increase the plant height growth. Bokashi fertilizer belongs to compost fertilizer that can improve the physical, chemical and biological properties of the soil which, therefore, can increase plant production and maintain the stability of production, resulting in quality and quantity of environmentally sound agricultural products [8]. The correlation between the *chinese kale* plant height and Azolla bokashi treatment can be seen in Figure 1.

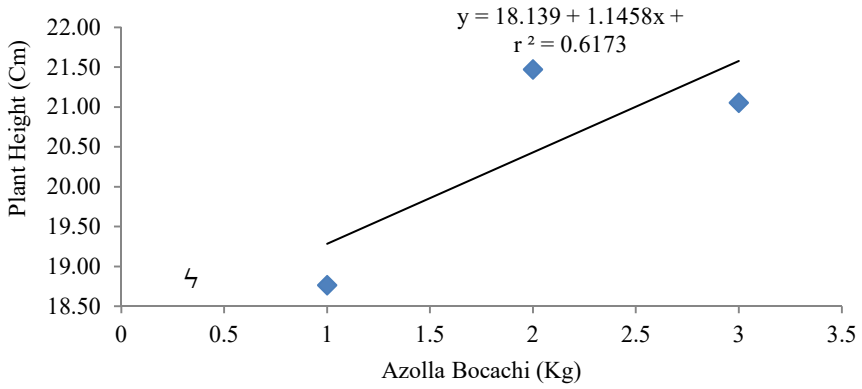

Figure 1. The Correlation between *Chinese kale* Plant Height and Azolla Bokashi Treatment after 4 Weeks of Planting

Figure 1 shows that the plant height increases after being given Azolla bokashi treatment with a high dose showing a quadratic linear relationship with the regression equation of y = 18.139 + 1.1458x + r^2 = 0.6173.

3.2. The Number of Leaves

The data were obtained from the observation on the number of leaves of 1-5 week old *chinese kale* treated with Azolla bokashi and liquid organic fertilizer of goat manure. The result of variance analysis with a Randomized Block Design showed that the treatment using Azolla bokashi and liquid organic fertilizer of goat manure had no significant effect on the growth and production of 1-5 week old *chinese kale* in terms of the number of leaves. The number of leaves of the 5 week old *chinese kale* administered with Azolla Bokashi and liquid organic fertilizer of goat manure can be seen in Table 2.

Table 2. Number of Leaves of *Chinese kale* at 5 WAP on Application of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure

Treatment	K_0	K_1	K_2	K_3	Mean
B_0	8.22	9.22	9.44	8.33	8.81
B_1	8.89	8.67	8.78	8.89	8.81
B_2	9.11	9.00	9.56	8.78	9.11
Mean	8.74	8.96	9.26	8.67	8.91

Table 2 shows the number of leaves of *chinese kale* treated with Azolla bokashi and liquid organic fertilizer of goat manure after 1-5 weeks of planting. The result of variance analysis using a Randomized Block Design showed that the treatment of Azolla bokashi and liquid organic fertilizer of goat manure had no significant effect on the growth and production of *chinese kale* in terms of the number of leaves after 1-5 weeks of planting. In addition to administering nutrients through the soil, nutrients are also generally administered through the leaves. Liquid organic fertilizers are substances or elements administered through the leaves by spraying or watering the leaves of the plant for direct absorption to meet its need for growth and development [2].

3.3. The Amount of Chlorophyll

The data were obtained from the observation on the amount of chlorophyll of the *chinese kale* treated with Azolla bokashi and liquid organic fertilizer of goat manure on the growth and production of 1-5 week old *chinese kale*. The result of variance analysis with a Randomized Block Design showed that the treatment using Azolla bokashi had a significant effect on the growth and production of 4-5 week old *chinese kale* in terms of the amount of chlorophyll. Table 3 presents the amount of chlorophylls per plot.

Table 3. Number of Chlorophyll (unit) of *Chinese kale* at 5 WAP on Application of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure

Treatment	K_0	K_1	K_2	K_3	Mean
B_0	50.30	47.51	56.52	50.81	51.29c
B_1	53.06	58.29	55.56	54.92	55.46b
B_2	59.04	53.02	60.89	62.29	58.81a
Mean	54.13	52.94	57.66	56.01	55.18

Description: The numbers followed by different letters in the same row are significantly different based on the 5% DMRT test.

The result of the data analysis presented in Table 3 shows that the highest quantity of chlorophyll of *chinese kale* treated using Azolla bokashi and liquid organic fertilizer of goat manure is found in the B_2 treatment (58.81 grains/mm^2) which is significantly different from the B_1 treatment (55.46 grains/mm^2), B0 (55.46 grains/mm^2). This result is in line with the research done by Musnamar [9] reporting that manure contains complete nutrients that plants need for growth. In addition to containing macro-elements such as nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg) and sulfur (S). The phosphorus element in manure is largely from solid wastes, while the nitrogen and potassium elements are derived from the liquid wastes. Based on the results of the variance analysis, it was found that the parameter of chlorophyll quantity of *chinese kale* using Azolla bokashi treatment had a significant effect on the growth and production of *chinese kale*. Meanwhile, the parameter of chlorophyll quantity of *chinese kale* using liquid organic fertilizer of goat manure had no significant effect. From the results of research, it was found that the observation on the parameter of chlorophyll quantity of

plants showed significantly different results. It is suspected that organic fertilizer administration is not counterbalanced by other fertilization so that the plant lacks of nutrients. This finding is in line with the Hasibuan [10] opinion arguing that the plant growth will not be achieved higher than what the plant growing in the most minimum conditional factors can achieve.

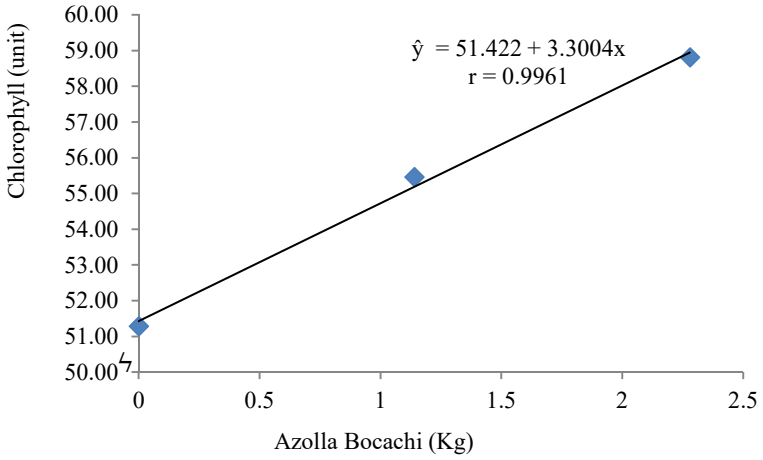

Figure 2. The Correlation between the Number of Chlorophylls of *Chinese kale* and Azolla Bokashi Treatment after 5 Weeks of Treatment

Figure 2 shows that the plant height gain corresponds to the administration of Azolla bokashi at high doses. Linear relationship is counted using a regression equation of $\hat{y} = 51.422 + 3.3004$ x r = 0.9961.

3.4. Stem Diameter

The data were obtained from the observation on the stem diameter of *chinese kale* treated with Azolla bokashi and liquid organic fertilizer of goat manure on the growth and production of 1-5 week old *chinese kale*. The results of variance analysis using a Factorial Randomized Block Design showed that the treatment using Azolla bokashi and liquid organic fertilizer of goat manure and its interaction on the growth and production of *chinese kale* had no significant effect. Table 4 shows the observed stem diameter of *chinese kale*.

Table 4. Stem Diameter (cm) of *Chinese kale* at 5 WAP on Application of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure

Treatment	K_0	K_1	K_2	K_3	Mean
B_0	4.03	4.19	4.50	5.28	4.50
B_1	5.76	4.44	5.38	6.05	5.41
B_2	5.68	4.18	5.53	5.71	5.27
Mean	5.16	4.27	5.13	5.68	5.06

The data presented in Table 4 shows that administering Azolla bokashi and liquid organic fertilizer of goat manure had no significant effect on the stem diameter of *chinese kale*. It is suspected that the administration of liquid organic fertilizer of goat manure and Azolla bokashi

has not yet been able to meet the needs of *chinese kale*. This is in line with Edhi [11] opinion arguing that fertilization is one of the soil fertility management efforts. By relying only on the availability of nutrients from the original soil, without the addition of nutrients, agricultural products will further continue declining. This is due to the imbalance between the nutrient supply and the plant's demand. Nutrients in soil will gradually diminish as they are transported along with yields, leaching, surface runoff, erosion or evaporation.

3.5. Plant's Wet Weight

The data were obtained from the observation on the wet weight of *chinese kale* treated with Azolla bokashi and liquid organic fertilizer of goat manure and its variance. The result of variance analysis using a Factorial Randomized Block Design showed that the treatment using Azolla bokashi and liquid organic fertilizer of goat manure had no significant effect on the wet weight and its interaction. Table 5 presents the data of plant's wet weight.

Table 5. Wet Weight (gram) of *Chinese kale* on Application of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure

Treatment	K_0	K_1	K_2	K_3	Mean
B_0	100.28	81.50	153.51	111.49	111.70
B_1	98.19	104.21	102.64	122.91	106.98
B_2	129.36	96.07	121.24	99.76	111.60
Mean	109.27	93.92	125.79	111.38	110.09

The data presented in Table 5 shows that the administration of Azolla bokashi and liquid organic fertilizer of goat manure has no significant effect on the wet weight of *chinese kale*. It is suspected that the treatment using Azolla bokashi and liquid organic fertilizer of goat manure has not yet been able to meet the nutrient needs of *chinese kale* so that the plant cannot grow optimally. It is suspected that when the liquid organic fertilizer was administered, the nutrient availability in the plant was so little that it affects the weight of its biomass. This is in line with Sunarto [12] opinion stating that the availability of nutrients plays an important role as an energy source so that the level of nutrient adequacy plays a role in affecting the biomass of a plant, and the plant growth can be disturbed if no additional nutrients are derived from fertilizers resulting in lower biomass.

3.6. Dry Weight

The data were obtained from the observation on the plant's dry weight and its variance. The result of variance analysis using a Factorial Randomized Block Design showed that administering Azolla bokashi and liquid organic fertilizer of goat manure and its interaction did not have a significant effect. Table 6 shows the dry weight of 100 plants.

Table 6. Dry Weight of *Chinese kale* on Application of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure

Treatment	K0	K1	K2	K3	Mean
B0	26.76	8.95	7.24	18.36	15.32
B1	15.81	16.94	21.89	17.45	18.02
B2	11.52	15.01	13.38	20.50	15.10
Mean	18.03	13.63	14.17	18.77	16.14

The data presented in Table 6 shows that the administration of Azolla bokashi and liquid organic fertilizer of goat manure has no significant effect on the dry weight of *chinese kale*. It is suspected that the treatment using Azolla bokashi and liquid organic fertilizer of goat manure has not yet been able to meet the nutrient that the kalian needs so that they cannot grow optimally. According to Lakitan [13], plants through photosynthesis can increase the amount of chlorophyll that supports the dry weight gain. The fewer nutrients are absorbed by the plant roots the smaller the amount of photosynthesis results will be, and vice versa, the more nutrients are absorbed by the plant roots the larger the amount of photosynthesis results.

3.7. Harvest Index

The data were obtained from the observation on the harvest index and its variance. The result of variance analysis using a Factorial Randomized Block Design showed that administering Azolla bokashi and liquid organic fertilizer of goat manure and its interaction did not have a significant effect on the plant's dry weight. Table 7 shows the data of the crop harvest index.

Table 7. Harvest Index of *Chinese kale* on Application of Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure

Treatment	K_0	K_1	K_2	K_3	Mean
B_0	43.92	29.06	12.98	27.44	28.35
B_1	29.60	30.34	40.52	29.04	32.37
B_2	26.94	34.68	24.41	39.97	31.50
Mean	33.49	31.36	25.97	32.15	30.74

The data presented in Table 7 shows that the administration of Azolla bokashi and liquid organic fertilizer of goat manure has no significant effect on the dry weight of *chinese kale*. It is suspected that the treatment using Azolla bokashi and liquid organic fertilizer of goat manure has not yet been able to meet the nutrient needs of the *chinese kale* so that they cannot grow optimally. This finding is in line with the research done by Murbandono [14] who found that the nutrients contained in organic fertilizer are slowly available for the plant growth; nevertheless, by using organic fertilizer the soil improvement will continue.

4. Conclusion

1. The administration of Azolla bokashi had an effect on the plant height and the chlorophyll quantity, with the highest value of 32.67 cm and 58.81 grains/mm2 at the dose of 2.28 kg/plot (B2).
2. Liquid Organic Fertilizer of Goat Manure does not affect the growth and production of the chinese kale.
3. There was no interaction of treatment between Azolla Bokashi and Liquid Organic Fertilizer of Goat Manure on the growth and production of chinese kale.

REFERENCES

[1] Samadi, *Budidaya Intensif Chinese Kale Secara Organik dan Anorganik*. Jakarta: Pustaka Mina, 2013.

[2] M. D. Duaja. Pengaruh jenis pupuk cair terhadap pertumbuhan dan hasil duavar selada (Lactuca sativa L). *Jurnal Bioplantae.* 2012. [Online]. Available: http://omline-journal.unja.ac.id/index.php/bioplantae.

[3] E. A. Fasakin, "Nutrient quality of leaf protein concentrates produced from water fern (Azolla africana Desv) and duckweed (Spirodela polyrrhiza L Schleiden)," *Bioresource Technology,* vol. 69, no. 2, pp. 185-187, 1999.

[4] Z. Arifin, *Azolla: pembudidayaan dan pemanfaatan pada tanaman padi*. Jakarta: Penebar Swadaya, 2003.

[5] Indonesia Departemen Pertanian, *Pemupukan berimbang proyek pengembangan penyuluhan pertanian pusat.* Jakarta: Departemen Pertanian, 1996.

[6] Suhendrayatna, *Bioremoval logam berat dengan menggunakan microorganisme: suatu kajian kepustakaan, Institute for Science and Technology Studies (ISTEC 5)– Chapter Japan Department of Applied Chemistry and Chemical Engineering Faculty of Engineering.* Kagoshima University 1-21-40 Korimoto, Kagoshima 890-0065, Japan, 2010.

[7] F. H. Tola, Dahlan, and Kaharuddin, "Pengaruh peggunaan dosis pupuk bokashi kotoran sapi terhadap pertumbuhan dan produksi tanama jagung," *Jurnal Agrisistem*, vol. 3, no. 1, 2007.

[8] Anonim, *Effective Microorganisme 4*. Jakarta: Indonesia Kyusei Nature Farming, 1995

[9] E. I. Musnamar, *Pupuk Organik Cair dan Padat, Pembuatan, Aplikasi*. Jakarta: Penebar Swadaya, 2009.

[10] B. E. Hasibuan, *Kesuburan Tanah dan Pemupukan (II.Pemupukan).* Medan: Fakultas Pertanian Universitas Sumatera Utara, 2012.

[11] Edhi, *Pupuk Akar dan Jenis Aplikasi*. Jakarta: Penebar Swadaya, 2012.

[12] L. Sunarto. "Pupuk kandang," 2002. [Online]. Available: http://balittanah.litbang.deptan.pupuk-kandang-sapi.pdf.

[13] Lakitan. "Fotosintesis," 2000. [Online]. Available: http://digilib.unila.ac.id/12081/11/Pembahasan.pdf.

[14] L. Murbandono, *Membuat Kompos*. Jakarta: Penerbit Swadaya, 2000.