Fruitset Sains, 10 (5) (2022) pp. 339-347

Published by: IOCSCIENCE

Fruitset Sains : Jurnal Pertanian Agroteknologi

Journal homepage: www.iocscience.org/ejournal/index.php/Fruitset

Effect of Humic Acid and Cascing Fertilizer Dosage on the Growth and Yield of Japan Spinach (Spinacia oleraceae L.)

Kania Sari Dewi[1], R Wahyono Widodo[2], Lia Amalia[3]
[1]Mahasiswa Program Studi Magister Agroteknologi Fakultas Pertanian-Universitas Winaya Mukti, Indonesia
[2,3]Dosen Program Studi Magister Agroteknologi Fakultas Pertanian-Universitas Winaya Mukti, Jl. Raya Bandung-Sumedang Km.29 Tanjungsari 45362, Kab. Sumedang, Jawa Barat, Indonesia
E-mail: kaniasaridewi354@gmail.com

Abstract

The experiment was carried out in the experimental garden or practice field belonging to the Lembang Development Agricultural Vocational School, West Bandung Regency which is at an altitude of 1100 m above sea level (ASL) with the Andisol soil order and is planned to be carried out from September to October 2022. The experimental method used was an experiment using a randomized block design (RBD) with a factorial pattern consisting of two treatment factors, namely the dose of humic acid including 4 (four) factor levels, namely a0 = 0, a1 = 3 kg ha-1, a2 = 6 kg ha-1, a3 = 9 kg ha-1 , a4 = 12 kg ha-1 and the dose of vermicompost organic fertilizer includes 4 (four) factor levels, namely k1=0 , k2 = 12.79 tons ha-1, which was repeated three times. Each treatment was placed in each repetition randomly (random). Each replicate was placed in plots (10 plots) with the same size of 1m x 2m spacing of 25 cm x 25 cm, and a population of 32 plants per plot. There was an interaction between the dose of humic acid and vermicompost fertilizer on the height of Japanese spinach plants aged 15 DAP and there was an optimum dose between the dose of humic acid and vermicompost fertilizer on the height of Japanese spinach plants, namely 6 kg. ha-1 and 12.79 tons.ha-1.

Keywords: Humic Acid, Japanese Spinach, Vermicompost

Abstract

Percobaan dilaksanakan di kebun percobaan atau lahan praktik milik SMKN Pertanian Pembangunan Lembang Kabupaten Bandung Barat yang berada pada ketinggian tempat 1100 m di atas permukaan laut (dpl) dengan ordo tanah Andisol dan direncanakan akan dilaksanakan pada bulan September sampai dengan Oktober 2022. Metode percobaan yang digunakan adalah eksperimen menggunakan rancangan percobaan Rancangan Acak Kelompok (RAK) pola faktorial terdiri atas dua faktor perlakuan yaitu dosis asam humat meliputi 4 (empat) taraf factor, yaitu $a_0 = 0$, $a_1 = 3$ kg ha^{-1}, $a_2 = 6$ kg ha^{-1}, $a_3 = 9$ kg ha^{-1} , $a_4 =$ 12 kg ha^{-1} dan dosis pupuk organik kascing meliputi 4 (empat) taraf faktor yaitu k_1=0, k_2 = 12.79 ton ha^{-1}, yang diulang tiga kali. Tiap perlakuan ditempatkan pada tiap ulangan secara acak (random). Setiap ulangan ditempatkan dalam petakan (10 petak) dengan ukuran yang sama 1m x 2m jarak tanam 25 cm x 25 cm, dan populasi 32 tanaman per petak. Terjadi interaksi antara dosis asam humat dan pupuk kascing terhadap tinggi tanaman bayam Jepang umur 15 HST dan Terdapat dosis optimum antara dosis asam humat dan pupuk kascing terhadap tinggi tanaman bayam Jepang, yaitu 6 kg.ha^{-1} dan 12,79 ton.ha^{-1}.

Key words: Asam Humat, Bayam Jepang, Kascing..

1. Introduction

Japanese spinach or often called horenso (Spinancia oleraceae L.), is an annual plant originating from Japan that has entered Indonesia. Japanese spinach has high economic value and is widely cultivated in West Java. Japanese spinach is widely planted in highland land areas, such as in the Lembang, Ciwidey, Cikajang, Pangalengan and Cipanas areas of West Java as highland vegetable centers. The planting area continues to increase so that the yield also increases in line with the increasing demand for Japanese spinach leaf vegetables.

Japanese spinach plants grow well in various types of fertile soil with a loose consistency ranging from sand textured soil, clayey clay to clayey soil in mountainous areas as remnants of volcanic eruptions. Efforts made to increase soil fertility have been widely reported. Adding organic matter to the soil will help increase soil fertility and productivity, thereby increasing plant productivity. This effort was carried out in an effort to intensify land use in addition to land reclamation and rehabilitation efforts. Providing organic materials can include the application of humic acid and organic worm castings (vermicompost) fertilizer. Humic acid (humus) is a compound derived from the remains of animals and plants that have undergone reformation by organisms in the soil layer. Humic acid is dark in color (blackish brown) and has a loose texture (Pettit, 2018).

Japanese spinach is a vegetable plant that requires fertile, loose soil and contains lots of organic material, therefore, apart from inorganic fertilizer, input of organic fertilizer is very necessary to increase the yield of Japanese spinach. Organic fertilizers that are starting to be widely used in Japanese spinach plantings are humic acid and vermicast fertilizer, so that apart from being useful for improving the physical and chemical properties of the soil, it also enriches the soil with effective microorganisms which are expected to support friendly sustainable agriculture. environment.

Increasing the production of Japanese spinach vegetables can be done by providing organic fertilizer. The use of organic fertilizer aims to add soil nutrients to improve soil properties, both physical, chemical and biological, which are important for plant growth (Pranata et al., 2017). One of the uses of organic fertilizer is the use of vermicompost. Vermicompost is an organic fertilizer that comes from earthworm droppings or feces. Applying vermicompost to soil can improve soil properties such as improving structure, porosity, permeability, increasing the ability to hold water. Based on the results of laboratory analysis, the resulting vermicompost has a C/N ratio value that can still be said to meet the minimum quality standards for solid organic fertilizer. Vermicomposting is an alternative for reducing the C/N ratio so that it approaches the C/N ratio of soil so that it can be used as fertilizer that can be absorbed by plants (Sitompul, Wardhana, & Sutrisno, 2017).

2. Materials and Methods

The research method used is a field experiment (experiment design) which is verification in nature with an experimental approach in experimental fields. The experiment was carried out in the experimental garden or practice land belonging to the Lembang Agricultural Development Vocational School, West Bandung Regency, which is at an altitude of 1100 m above sea level (asl) with Andisol soil order and is planned to be carried out from September to October 2022.

The materials to be used include Japanese spinach seeds originating from PT. East West West Java "Cap Panah Merah", humic acid (solid form) produced by PT STEFES Indonesia and worm castings produced by "Bokasi Mandiri Sejahtera Baleendah-Bandung West Java" Tools used include a hoe, 10 L capacity electric knapsack sprayer, bucket , with measuring tools such as digital scales with a capacity of 1 kg, oven, measuring cup, meter, "ATAGO" refractometer, laptop, and treatment sign, as well as stationery.

The experimental approach uses a Randomized Group Design (RAK) factorial pattern consisting of two treatment factors, namely humic acid dose including 4 (four) factor levels, namely a0 = 0, a1 = 3 kg ha-1, a2 = 6 kg ha-1 , a3 = 9 kg ha-1 , a4 = 12 kg ha-1 and the dose of vermicompost organic fertilizer includes 4 (four) factor levels, namely k1 = 0, k2 = 12.79 tons ha-1, which is repeated three times. Each treatment is assigned to each replication randomly (randomly). Each replication was placed in plots (10 plots) with the same size of 1m x 2m, plant spacing of 25 cm x 25 cm, and a population of 32 plants per plot. The plot goes North – South.

Table 1. Combination Treatment Doses of Humic Acid and Vermicompost Fertilizer

Humic Acid	Vermicompost Fertilizer	
	k1	k2
ao	k1a1	k2a1
a1	k1a1	k2a1
a2	k1a2	k2a2
a3	k1a3	k2a3
a4	k1a4	k1a4

Table 2. Operationalization of Independent Variables and Dependent Variables

Variable Type	Sub Variable	Variable Indicator
Variable Free (Treatment)	Aam Humic Dosage (a)	a0 = Humic acid 0 kg ha-1 a1 = Humic acid 3 kg ha-1 a2 = Humic acid 6 kg ha-1 a3 = Humic acid 9 kg ha-1 a4 = Humic acid 15 kg ha-1
	Vermicompost Fertilizer Dosage (k)	k1 = Vermicompost 0.0 ton ha-1 k2 = Vermicompost 12.97 tons ha-1
Variable Bound (Response)	Plant Growth	1. Plant height 2. Number of plant leaves
	Crop yield	1. Plant wet weight (Gross Weight) 2. Plant dry weight (Net Weight) 3. Root loss ratio 4. Fresh weight of plants per plot 5. Total Dissolved Solids (PTT) sugar content

Description: Application of humic acid when plants are -7 dap, 0 dap and 7 dap

Table 4. Types of Randomized Group Design with Factorial Pattern

Variety Source	DB	JK	KT	Fh	F.05
Deuteronomy (r)	2	ΣXi..2 /t – X…2/rt	JKr/2	KTr/KTg	4.26
Treatment (t)	(9)	ΣX.jh2 /r - X…2/rt	JKt/11	KTt/KTg	1.96
Humic Acid (a)	4	ΣX.j.2/cr - X…2/rt	JKa/3	KTa/KTg	2.76
Vermicompost Fertilizer	4	ΣX..h2 /ar-X…2/rt	JKc/2	KTc/KTg	2.76
(c)	9	JKT – JKa – JKc	JKac/	KTac/KTg	2.08
Interaction (pc)	18	JKTot – JKr – JKt	JKg/22	-	
Error (g)					
Total (T)	29	ΣXijh2 – X…2/rt	-	-	

Information: DB = degrees of freedom, JK = sum of squares, KT = middle square, Fh = calculated F, F0.05 = table value of F at the 5% level

3. Results and Discussion

Plant Height

The results of the variance analysis showed that there was an interaction at plant height at 15 HST.

Table 5. Effect of Humic Acid Dosage and Vermicompost Fertilizer on Plant Height at 15 DAP

Humic Acid Dosage	Vermicompost Dosage	
	k1 (Vermicompost 0 kg.ha-1)	k2 (Vermicompost 12.79 kg.ha-1)
a0 (Humic Acid 0 kg.ha-1)	7.13 ab A	7.90 a A
a1 (Humic Acid 3 kg.ha-1)	8.98 c A	7.94 a A
a2 (Humic Acid 6 kg.ha-1)	7.91 a B C A	9.58 b B
a3 (Humic Acid 9 kg.ha-1)	6.68 a A	8.49 ab B
a4 (Humic Acid 12 kg.ha-1)	8.28 BC A	9.04 ab A

Note: The treatment average numbers followed by the same lowercase letters (column direction) and capital letters (row direction) are not significantly different according to Duncan's Multiple Range test at the 5% significance level.

From Table 5 it can be seen that at factor levels a0, a1 and a4 there is no difference in the height of Japanese spinach plants, but in a2 and a3 the use of vermicompost fertilizer (k2) produces plant heights that are higher and significantly different compared to those without vermicompost (k1).

Number of Leaves

The results of the analysis of variance showed that there was no interaction between humic acid and vermicompost fertilizer.

Table 6. Effect of Humic Acid Concentration and Vermicompost Fertilizer on Number of Leaves Age 15 DAP, 20 DAP, 25 DAP, and 30 DAP

Treatment		Number of Leaves (Strands)							
		15 HST		20 HST		25 HST		30 HST	
Factor	Humic Acid								
a0	(0 kg ha-1)	2.21	a	5.92	a	8.42	a	10.79	a
a1	(3 kg ha-1)	3.00	ab	7.63	a	10.88	b	13.25	a
a2	(6 kg ha-1)	2.83	ab	6.50	a	9.08	ab	11.71	a
a3	(9 kg ha-1)	3.46	b	7.04	a	10.17	ab	13.08	a
a4	(12 kg ha-1)	3.33	b	7.38	a	10.29	ab	13.08	a
Factor	Vermicompost								
k1	(0.0 ton ha-1)	2.42	a	7.37	a	10,12	a	12.63	a
k2	(12.79 tons ha-1)	3.52	b	6.42	a	9.42	a	12,13	a

Note: The treatment average numbers followed by the same lowercase letters (column direction) and capital letters (row direction) are not significantly different according to Duncan's Multiple Range test at the five percent significance level.

Based on Table 6, it can be seen that different doses of humic acid have an effect on the number of leaves aged 15 DAP and 25 DAT, while at 20 DAP and 30 DAT there is no effect. At the age of 15 DAT, treatment a0 was not significantly different from a1 and a2 but was significantly different from a3 and a4. Meanwhile, at 25 DAT, treatment a0 was significantly different from a1 but not significantly different from other treatments.

Gross and Net Weight per Plant

The results of the analysis of variance showed that there was no interaction and no significant effect on gross weight and net weight per plant.

Table 7. Effect of Humic Acid Concentration and Vermicompost Fertilizer on Gross and Net Weight per Plant

TREATMENT		Weight per Plant (grams)			
		Dirty		Clean	
Factor	Humic Acid				
a0	(0 kg ha-1)	103.79	a	98.63	A
a1	(3 kg ha-1)	121.46	a	116.25	A
a2	(6 kg ha-1)	99.21	a	93.71	A
a3	(9 kg ha-1)	115.58	a	107.21	A
a4	(12 kg ha-1)	104.71	a	99.46	A
Factor	Vermicompost				
k1	(0.0 ton ha-1)	105.92	a	100.60	A
k2	(12.79 tons ha-1)	111.98	a	105.50	A

Note: The treatment average numbers followed by the same lowercase letters (column direction) and capital letters (row direction) are not significantly different according to Duncan's Multiple Range test at the five percent significance level.

Total Dissolved Solids

The results of the analysis of variance showed that there was no interaction and no significant effect on total dissolved solids.

Table 9. Effect of Humic Acid Concentration and Vermicompost Fertilizer on Total Dissolved Solids

TREATMENT		Total Dissolved Solids (PTT)	
Factor	Humic Acid		
a0	(0 kg ha-1)	4.50	a
a1	(3 kg ha-1)	4.50	a
a2	(6 kg ha-1)	6.28	a
a3	(9 kg ha-1)	4.75	a
a4	(12 kg ha-1)	4.95	a
Factor	Vermicompost		
k1	(0.0 ton ha-1)	4.45	a
k2	(12.79 tons ha-1)	5.54	a

Note: The treatment average numbers followed by the same lowercase letters (column direction) and capital letters (row direction) are not significantly different according to Duncan's Multiple Range test at the five percent significance level.

Planting Dry Weight and Root Loss Ratio

The results of the analysis showed that there was no interaction between vermicompost fertilizer and Humic Acid on plant dry weight and root decay ratio.

Table 10. Effect of Humic Acid Concentration and Vermicompost Fertilizer on Dry Weight and Root Loss Ratio

TREATMENT		BK Extinct (grams)		BK Roots (grams)		NPAs	
Factor	Humic Acid						
a0	(0 kg ha-1)	8.27	a	0.49	a	13.35	a
a1	(3 kg ha-1)	9,10	a	0.44	a	17,19	a
a2	(6 kg ha-1)	8.75	a	0.43	a	12.65	a
a3	(9 kg ha-1)	9.76	a	0.67	a	12.68	a
a4	(12 kg ha-1)	8.42	a	0.43	a	13.94	a
Factor	Vermicompost						
k1	(0.0 ton ha-1)	9.02	a	0.52	a	14.29	a
k2	(12.79 tons ha-1)	8.69	a	0.46	a	13.64	a

Note: The treatment average numbers followed by the same lowercase letters (column direction) and capital letters (row direction) are not significantly different according to Duncan's Multiple Range test at the five percent significance level.

Gross Weight and Net Weight per Plot

The results of the analysis showed that there was no interaction between vermicompost fertilizer and humic acid on gross weight and net weight per plot.

Table 11. Effect of Humic Acid Dosage and Vermicompost Fertilizer on Gross and Net Weight per Plot

TREATMENT		Plant Weight per Plot (Kg)			
		Dirty		Clean	
Factor	Humic Acid				
a0	(0 kg ha-1)	1.59	a	1.44	A
a1	(3 kg ha-1)	2.28	b	1.94	ab
a2	(6 kg ha-1)	1.92	ab	1.71	A
a3	(9 kg ha-1)	2.34	b	2.25	b
a4	(12 kg ha-1)	1.94	ab	1.73	a

Factor	Vermicompost				
k1	(0.0 ton ha-1)	1.84	a	1.68	a
k2	(12.79 tons ha-1)	2.19	b	1.95	a

Note: The average treatment numbers followed by the same letter in each column are not significantly different according to the Least Significant Difference test at the five percent significance level.

Based on the data in Table 11, independently a humic acid dose of 3 kg.ha-1 was able to increase the gross weight and net weight of plants per plot. This is certainly more efficient than using a humic acid dose of 9 kg.ha-1. Meanwhile, 12.79 tons.ha-1 of vermicompost fertilizer was able to increase the gross weight of plants per plot compared to without the addition of vermicompost fertilizer.

Gross and Net Weight per Hectare

The results of the analysis showed that there was no interaction between vermicompost fertilizer and humic acid on gross weight and net weight per hectare.

Table 12. Effect of Humic Acid Concentration and Vermicompost Fertilizer on Gross and Net Weight per Hectare

TREATMENT		Plant weight per hectare (tons/ha)	
		Dirty	Clean
Factor	Humic Acid		
a0	(0 kg ha-1)	3.97	3.60
a1	(3 kg ha-1)	5.70	4.85
a2	(6 kg ha-1)	4.80	4.28
a3	(9 kg ha-1)	5.85	5.62
a4	(12 kg ha-1)	4.84	4.33
Factor	Vermicompost		
k1	(0.0 ton ha-1)	4.59	4.20
k2	(12.79 tons ha-1)	5.47	4.87

Note: The average treatment number followed by the same letter in each column is not significantly different according to the Least Significant Difference test at the five percent significance level.

4. Conclusion

Based on the results of the experiment and discussion, the following conclusions can be drawn: There was an interaction between the dose of humic acid and vermicompost fertilizer on the height of Japanese spinach plants aged 15 HST. There is an optimum dose between the dose of humic acid and vermicompost fertilizer for the height of Japanese spinach plants, namely 6 kg.ha-1 and 12.79 ton.ha-1. To get the optimal height of Japanese spinach plants, you can use a humic acid dose of 6 kg.ha-1 and vermicompost 12.79 tons.ha-1. However, in independent conditions, it is recommended to use 3 kg.ha-1 of humic acid because it is quite effective and efficient.

5. References

Ahmad Ahmad Dailami, Husna Yetti dan Sri Yoseva. 2015. Pengaruh Pemberian Pupuk Kascing dan NPK Terhadap Pertumbuhan dan Produksi Tanaman Jagung Manis (*Zea mays* var *saccharata* Sturt). JOM Faperta Vol. 2.

Anak Agung Oka. 2007. Pengaruh Pemberian Pupuk Kascing Terhadap Pertumbuhan Tanaman Kangkung Darat (*Ipomea reptans* Poir). Jurnal Sains MIPA, Edisi Khusus Tahun 2007, Vol. 13, No. 1, Hal.: 26 – 28.

Arinong R.A., C.D. Lasiwua. 2011. Aplikasi Pupuk Organik Cair terhadap Pertumbuhan dan Produktivitas Tanaman Sawi. Jurnal Agrisistem. 7(1):47.

Badan Penelitian dan Pengembangan Pertanian. 2019. Pupuk NPK dan Asam Humat. *Indonesian Agency for Agricultural Research and Development.* Jl. Ragunan 29 Pasar Minggu Jakarta Selatan 12540, Indonesia. info@litbang.pertanian.go.id. *Diakses Agustus 2022.*

Badan Pusat Statistik. 2022. Statistik Jawa Barat. Jawa Barat Dalam Angka. Bandung : Badan Pusat Statistik.

Bangun, R.A. 2016. Pengaruh Pupuk NPK dan Asam Humat Terhadap pH, C-Organik, N-total, C/N, KTK dan Hasil Pakcoy (*Brassica chinensis*, L) pada Inceptisols Jatinangor

Budiman Siregar. 2017. Analisa Kadar C-Organik dan Perbandingan C/N Tanah di Lahan Tambak Kelurahan Sicanang Kecamatan Medan Belawan. Jurnal Warta Edisi 53.

Eviati dan Sulaeman. 2009. Analisis Kimia Tanah, Tanaman, Air dan Pupuk: Petuntuk Teknis Edisi 2. Balai Penelitian Tanah. Jawa Barat.

Fauziah, I., E. Proklamasiningsih, dan I. Budisantoso. 2019. Pengaruh Asam Humat pada Media Tanam Zeolit terhadap Pertumbuhan dan Kandungan Vitamin C Sawi Hijau (*Brassica juncea*). Bio Eksakta: Jurnal Ilmiah Biologi Unsoed, 1 (2): 17–21

Gaspersz, V. 2004. Teknik Analisis dalam Penelitian Percobaan (Jilid 1 dan 2). Bandung : Penerbit Tarsito.

Gomez, K. A dan AA. Gomez, 1995. Prosedur Statistik untuk Pertanian (Edisi ke-2). Sjamsuddin, E,. J.S. Barhasjah (Penerjemah). Jakarta : Penerbit Universitas Indonesia.

Handayani, W. 2020. Pengaruh Pemberian Pupuk Organik Kascing terhadap Pertumbuhan dan Hasil Sawi Hijau (*Brassica juncea L.*). Jurnal UIN Suska Riau

Hardjowigeno, S. 1995. Klasifikasi Tanah dan Pedogenesis. Jakarta : Akademika Pressindo. 273 p.

Imdad, H.P., dan A.A. Nawangsih. 2010. Sayuran Jepang. Penebar Swadaya, Jakarta.

Irsal, Las. 2010. Program Pemulihan Kesuburan Tanah pada Lahan Sawah Berkelanjutan. Jakarta : Balai Penelitian Tanah, Kementrian Pertanian.

Jalu Lokha, Dwi Purnomo, Bambang Sudarmanto dan Very Tubagus Irianto. 2021. Pengaruh Pupuk Kascing Terhadap Produksi Pakcoy (*Brassica rapa* L.) pada KRPL KWT Melati Kota Malang. Agrihumis Vol. 2, No. 1, pp: 47 – 54.

Karama, A.S., A.R. Marzuki, dan I. Manwan. 1990. Penggunaan Pupuk Organik pada Tanaman Pangan . Prosiding LokakaryaNasional Efisiensi Penggunaan Pupuk. Bogor : Pusat Penelitian Tanah dan Agroklimat. Hal. 395-425.

Komang Melati Nusantari Kusuma Sinda, Ni Luh Kartini dan I Wayan Dana Atmaja. 2015. Pengaruh Dosis Pupuk Kascing Terhadap Hasil Tanaman Sawi (*Brassica juncea* L.), Sifat Kimia dan Biologi pada Tanah Inceptisol Klungkung. E-Jurnal Agroteknologi Tropika, Vol. 4, No. 3, Hal: 170 – 179.

Maulida, A. A. A. (2019). Buku Materi Budidaya Cacing. Malang: CV. RAJ Organik

Pranata, I., D.R. Lukiwati, dan W. Slamet. 2017. Pertumbuhan dan Produksi Okra (Abelmoschus esculentus L.) dengan Berbagai Pemupukan Organik Diperkaya Batuan Fosfat. Jurnal Agro Complex, 1 (2) : 65 - 71.

Radite, S. dan B. H. Simanjuntak. 2020. Penggunaan Asam Humat Sebagai Pelapis Urea Terhadap Pertumbuhan dan hasil tanaman pakcoy (*Brassica rapa* L .). Agriland. 8(1): 72–78.

Rahmadhaini, Satriawan dan Marlina, 2017. Pemberian Pupuk Kascing terhadap Pertumbuhan dan Hasil Tanaman Kedelai (Glycine max L.). Agrotropika Hayati, 4 (3) : 224-234.

Rahhutami, R. · A.S. Handini · D. Astutik. 2021. Respons Pertumbuhan Pakcoy terhadap Asam Humat dan *Trichoderma* dalam Media Tanam Pelepah Kelapa Sawit. Jurnal Kultivasi Vol. 20 (2) Agustus 2021 *97* ISSN: 1412-4718, eISSN: 2581-138x

Rubatzky, V.E. and Yamaguchi, M. 1998. World Vegetables, Principles, Production and Nutritive Values. Chapman Hall (ITP), New York

Salisbury, F.B. dan C.W. Ross. 1995. Fisiologi Tumbuhan (Terjemahan Lukman D.R. dan Sumaryono). Bandung : Penerbit Institut Teknologi Bandung.

Sembiring, J. V., N. Nelvia, dan A. E. Yulia. 2016. Pertumbuhan bibit kelapa sawit (*Elaeis guineensis* Jacq.) di pembibitan utama pada medium sub soil ultisol yang diberi asam humat dan kompos tandan kosong kelapa sawit. J.Agroteknologi. 6(1): 25.

Sharma, R.A., Totawat, K.L., Maloo, S.R., and L.L. Somani. 2004. *Biofertilizer Technology.* Udaipur : Agrotech Publiching Academy. ISBN : 81-85680-90-6.

Simarmata, T. 2011. *Biofertilizer for Sustainable Agriculture Practice In Indonesia.* Paper and Handout for Visiting Lecturer from 17th to 21th of October 2011 at Departemen for Crop Scienc – Crop Production System in The Tropics – Georg-August-University Göttingen- Germany.

Sitompul, E., Wardhana, I. W., & Sutrisno, E. (2017). Studi Identifikasi Rasio C/N Pengolahan Sampah Organik Sayuran Sawi, Daun Singkong, dan Kotoran Kambing dengan Variasi Komposisi Mengggunakan Metode Vermicomposting. Journal of Chemical Information and Modeling.

Sposito, G. 2008. *The Chemistry of Soils*. Second Edition. New York, USA : Oxford University Press, Inc.

Stevenson, F.J. 1982. *Humus Chemistry, Genesis, Composition, Reactions*. New York, Chichester, Brisbane, Toronto, Singapore : A. Willey Interscience Publication, John Wiley and Sons.

Sumarsono, S. Anwar, Widjajanto D. W., Budianto S. 2009. Peranan Pupuk Organik untuk Perbaikan Penampilan dan Produksi Hijauan Rumput Gajah Pada Tanah Masam. Semarang : Fakultas Peternakan, Laporan Penelitian, Universitas Diponegoro.

Suriadikarta, D.A dan R.D.M. Simanungkalit. 2006. Pendahuluan Pupuk Organik dan Pupuk Hayati. Dalam Simanungkalit, R.D.M. Simanungkalit, D.A. Suriadikarta, Rasti Saraswati, Diah Setyorini, dan Wiwik Hartatik (eds.). Pupuk Organik dan Pupuk Hayati. *Organic Fertilizer and Biofertilizer*. Balai Besar Litbang Sumberdaya Lahan Pertanian. Bogor : Badan Penelitian dan Pengembangan Pertanian. Hal. 1-10.

Sutanto, R. 2006. Penerapan Pertanian Organik. Jakarta : Kanisius.

Tioner Purba et al. 2021. Pupuk dan Teknologi Pemupukan. Yayasan Kita Menulis. E-Book.

Yulia Nuraini dan Annisauz. 2020. Pengaruh Asam Humat dan Pupuk NPK Terhadap Serapan Nitrogen, Pertumbuhan Tanaman Padi Di Lahan Sawah. Jurnal Tanah dan Sumberdaya Lahan Vol. 7 No.2: 195