The effect application of powder active of cassava to various composted weeds in improving chemical characteristics of vertisol and yield of mung bean (*Vigna radiata* L.)

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Abstract. Vertisol is a type of soil that is low in some nutrients such as Nitrogen, Phosphor, and Potassium. These conditions resulted low in soil availability in supporting the growth and yield of the plant. It might be improved by the application of some organic matters such as compost. However, the compositing process takes normally some matter time. It could be improved by the application of an innovation product called powder active of cassava. Research was conducted at the Central Research of Dry land the Farming System University of Nusa Cendana. The research was designed on a Completed Randomized Design with three replications. Treatment combinations were Chromolaena compost, Imperata compost, Tithonia compost, and powder active of cassava (control (0 g), 0.06g, 0.09g). Result of the research showed that all treatments affect significantly to total soil microorganism content, Nitrogen content, available Phosphor, available Potassium, and yield of mungbean. The best application treatment was application 15 g per polybag of Chromolaena compost applied by 0.09 powder active of cassava. The highest yield of mungbean applied by that treatment was 1.78 g/ plant.

1 Introduction

Generally, Vertisol is one soil type which low in nutrients contents such as Nitrogen, Phosphor, Potassium, and C organic, less to medium soil of permeability, low of water soil resistance, high sensivity of erosion, and low content of soil microbiology This is mainly due to a high content of clay on top soil which resulting most of nutrients tightly bound to soil colloid. These conditions resulted to decreasing in carrying capacity of the soils in supporting growth, development and yield of plants such as mung bean (*Vigna radiata* L.). Some practical technologies have been applied to improve carrying capacity of the soils such as applying an organic and organic fertilizer. However, those practices resulted on increasing of soil compaction, and increasing of soil microbiology dormantion. Meanwhile, improving soil microbiology activities is one of an crucial ways to improve physical and chemical characteristic of soil respectively. It might be improved by applying organic matter such as composted biomass of weed (Imperata, Chromolaena and Tithonia).

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Imperata cylindrica L. have content of 0.71% Nitrogen; 0.67% Phosphorus, 1.07% Potassium; 0.76% Calsium; 0,55% Magnesium; 5,32% Silica [1] *Chromolaena odorata* L has 2.65% Nitrogen, 0.53% Phosphorus, and 1.90 % Potassium. Meanwhile *Crotalaria juncea* L.is legume weed which content 2.1-3.29 % Nitrogen, 0.3-0.56 % Phosphorus, and 1.60-2.82 % Potassium. All those weeds could be used as organic fertilizer through compost process to improve carrying capacity of Vertisol. However, one of the weaknesses of the compost process is that take a long time , around 30-50 days. This is mainly due the compost process depends strongly to amount, type, and activity of microorganisms which generally very low. It could be improved by applying such as innovation product called active powder based on cassava.

Active powder may able to increase maximally the use of gamma radiation to increase number of oxygen into soil. Gamma radiation is able to intercept into 50 cm soil depth in which increased degradation H_2O processes become hydrogen (H_2) and oxygen (O_2). Increasing in oxygen level into the soil will affect to increased activity of soil microorganism and biomass of microorganism. Moreover, the active powder of cassava is source of energy for microorganism resulted improving in activity of microorganism to improve physical of soil, and could improve availability of some nutrients. Some studies showed that application 200-300 g per ha to Active powder of cassava to soil resulted increasing in amount colony of soil bacteria , total Nitrogen content, available of Phosphorus, available of Potassium, soil porosity and bulk density [2].

Based on those studies, active powder might be apply to the compost process on some weeds and could increase in amount and availability of nutrients such Nitrogen, Phosphorus, and Potassium. Finally, improving in quality compost of weeds might improve carrying capacity of Vertisol and yield of mung bean.

2 Materials and Methods

A Research had been conducted in Central Dry Land Research University Nusa Cendana since August to December 2022. Variable of the research were various dosage biomass of weeds (*Imperata cylindrica* L, *Chromolaena odorata* L, *Crotalaria juncea* L) and various dosage of active powder of cassava. Treatments of the research were 15 g per polybag of Chromolaena compost no applied by powder active of cassava (P0K) ; 15 g per polybag of Chromolaena compost applied by 0.06 powder active of cassava (P1K); 15 g per polybag of Chromolaena compost applied by 0.09 powder active of cassava (P2K); 15 g per polybag of Imperata compost no applied by powder active of cassava (P0A) 15 g per polybag of Imperata compost applied by 0.06 powder active of cassava (P1A); 15 g per polybag of Imperata compost applied by 0.09 powder active of cassava (P2A); 15 g per polybag of Crotalaria compost no applied by powder active of cassava (P0O) 15 g per polybag of Crotalaria compost applied by 0.06 powder active of cassava (P1O); 15 g per polybag of Crotalaria compost applied by 0.09 powder active of cassava (P2O). The research was designed on Randomized Completed Design with three replications.

A Composting processes was made it by chopping all various biomass of weeds then added by 24 ml of cow urine, 40 g of sugar and water. All these ingredients was stirred in a container till smooth and thereafter closed tightly. Stirred process was continuously every 4 days till 20 days old and followed by application active powder to its composting process. The composting process was lasts up to 30 days. Various dosage of compost were applied into soil a week before mung bean plantation.

Parameter analysis were C-organic by using LOI Methods [3], total Nitrogen content by Kjedahl Methods [4]. Available of Phosphorus by Olsen Methods,), extracted by 0.5 N NaHCO with pH of 8.5 with Spectrophotometer [5]. Available of Potassium by extracted 1 N ammonium acetate determined by Flame Photometer [6]. and amount of colony of bacteria

by Total Plate Count Methods (TPC) [7, 8] and yield of mung bean. All data were analyzed by Analysis of Variant followed by Duncan Multiple Range Test at 5% level.

3 Results and Discussion

3.1 Time and place of Research

Results of initial analysis nutrients content of Vertisol show that Nitrogen content, available of Phosphorus, available Potassium, C organic are low as showed at Table 1. Low nutrients content of Vertisol is mainly due to most nutrients content are fixed by clay mineral of Montmorillonite type 2:1

Table 1. Initial analysis nutrients content of Vertisol

Sample	C organic (%)	Total Nitrogen (%)	Available of Phosphorus (ppm)	Available of Potassium (cmol(+)/Kg)	pH
V1	0.43	0.14	4.91	0.16	7.64
V2	0.43	0.14	4.91	0.16	7.64
V3	0.43	0.14	4.91.	0.16	7.64
Status*	Very low	Low	Low	Low	Slightly alkaline

Sources: Soil Chemical Laboratory, Agriculture Faculty, Nusa Cendana University
Soil valuation: Central Soil Research and Agro climatology, Bogor, 1994

3.2 Initial Analysis Chemical Characteristic of Compost

Source of composting materials on the research are *Imperata cylindrica* L (A), *Chromolaena odorata* L (K), *Crotalaria juncea* L (O). All source of composting materials are analyzed for their nutrients content according to each treatments (Table 2). It show that mainly C organic and total Nitrogen content tend to be very high, on the other hand available of Phosphorus and available of Potassium tend to be very low. Meanwhile degree of pH tends to be acid and slightly base

Table 2. Results of Initial Chemical Analysis of Compost

Treatments	C organic (%)	Total Nitrogen (%)	Available of Phosphorus (ppm)	Available of Potassium (cmol(+)/Kg)	pH
P0K	25.21	2.34	0.8	0.86	7.64
P1K	27.58	2.82	0.82	1.02	7.23
P2K	27.06	2.46	0.85	1.38	7.64
P0A	29.14	2.73	0.93	0.99	8.02
P1A	26.99	2.84	0.97	1.03	8.07
P2A	25.9	3.12	1.07	1.14	7.89
P0O	29.01	2.98	1.02	1.08	7.07
P1O	26.61	3.1	1.06	1.13	6.52
P2O	28.24	3.31	1.13	1.2	5.56

Sources: Soil Chemical Laboratory, Agriculture Faculty, Nusa Cendana University (2022)

3.3 Effect Application of Powder Active of Cassava to Amount of Microorganisms of Compost

Result of Analysis of Variant show that is increase significantly on total amount of colony microorganism as affected by application powder active. Analysis Duncan Multiple Range Test 5% level show on Table 3.

Table 3. The Effect of Application Powder Active of Cassava to Total Amount of colony Bacteria of Compost

	Total Amount of bacteria	Duncan Test at 5% level	
Treatments	(CFU/g)	R	P
P0K	279[ab]	112.53	2
P1K	576[b]	118.21	3
P2K	563.33[b]	121.62	4
P0A	177.66[a]	123.89	5
P1A	513[b]	125.79	6
P2A	562.33[b]	126.92	7
P0O	219.33[ab]	127.68	8
P1O	568.33[b]		
P2O	588.33[b]		

Source: Plant Protection Laboratory Agriculture Faculty Nusa Cendana University (2022)
Values that followed by same letter means it is not significantly difference at DMRT 5% level

Table shows that increasing dosage of powder active of cassava on composting process result an increasing in total amount of colony bacteria. The highest total amount of colony microorganism (588.33 cfu/g) is applied by P2O (15 g per polybag of Tithonia compost applied by 0.09 powder active of cassava). This is mainly due to powder active of cassava give a source of energy for decomposer microorganism specially bacteria. And when it applied into soil will increase soil microorganism colonies resulted in physical and chemical characteristic improvement of the soil[9], [10], [11]. Moreover, it show that various sources of composting weed result in differences affect to total amount of colony microorganism which is Chromolaena resulted the highest number of colony microorganism. This is mainly due Chromolaena has a higher C organic content compared to Imperata and Tithonia (Table 2). Study by [12] showed that organic matter is an important part of soil ecosystem as source of nutrient, nutrients binder and soil microbial substrate. Moreover, various sources of compost content lignin compounds which are a combination some compounds such as Carbon, Hydrogen, and Oxygen. These compounds are able to be used as source of energy and nutrients for soil microorganism.

3.4 Effect Application of Powder Active of Cassava to Amount Bacteria of Vertisol

Result Analysis of Variant show that application various dosage of powder active and compost result significantly an increase in total colony soil microorganism of Vertisol. Analysis Duncan Multiple Range Test 5% level are in Table 4.

Table 4. Effect Application of Powder Active of Cassava to Amount of Soil Bacteria of Vertisol

Treatments	Initial	Total Amount of bacteria (CFU/g)		Duncan Test at 5% level	
		End	Difference	R	P
P0K	69.67	84.33^{ab}	14.67^{ab}	33.97	2
P1K	78.67	262^{b}	183.33^{b}	35.69	3
P2K	79	262.67^{b}	183.67^{b}	36.72	4
P0A	68.33	85^{ab}	16.67^{ab}	37.40	5
P1A	79	239.33^{b}	160.33^{b}	37.98	6
P2A	80	261.67^{b}	181.67^{b}	38.32	7
P0O	69.33	83^{a}	13.67^{a}	38.55	8
P1O	75.33	253.33^{b}	178^{b}		
P2O	77	251^{b}	174^{b}		

Source: Plant Protection Laboratory Agriculture Faculty Nusa Cendana University (2022).
Values that followed by same letter means it is not significantly difference at DMRT 5% level

Table 4 shows that an increase in the dosage of powder active in the composting process significantly increases in total soil microorganisms of Vertisol. The highest result is the application of 15 g per polybag of Chromolaena compost applied by 0.09 powder active of cassava (266.67 CFU/g). It is mainly due to the increase in the dosage of powder active results in an increase in C organic, lignin compounds which are able to be used as nutrients and sources of energy for soil microorganisms to support the development and activities of soil microorganism. It seems also that the powder of cassava has an important role in the improvement activities of soil microorganisms to improve the physical and chemical characteristics of Vertisol [13, 14, 11].

3.5 The Effect of Powder Active of Cassava on Compost to C Organic Content of Vertisol

Result of the research show that all treatments affect significantly to C organic content of Vertisol. It can be seen that C organic content of Vertisol increase gradually in all treatment that are applied by powder active of cassava compared to no application of powder active of cassava (Table 5). Moreover, it shows that increasing in dosage of compost materials and dosage of powder active of cassava; respectively result in an increasing in C organic content of Vertisol. These is mainly due to all compost materials content a high C organic (Table 2) and its increased after addition powder active of cassava

Table 5. The Effect of Powder Active of Cassava on Compost to C Organic Content of Vertisol

Treatments	C organic (%)			Duncan Test at 5% level	P
	Initial	End	difference (Δ)		
P0K	0.43	0.60[a]	0.17[a]	0.09	2
P1K	0.43	0.80[b]	0.37[b]	0.10	3
P2K	0.43	0.78[b]	0.35[b]	0.10	4
P0A	0.43	0.60[a]	0.17[a]	0.10	5
P1A	0.43	0.76[b]	0.33[b]	0.10	6
P2A	0.43	0.84[b]	0.41[b]	0.11	7
P0O	0.43	0.8[b]	0.38[b]	0.11	8
P1O	0.43	0.85[b]	0.42[b]		
P2O	0.43	0.82[b]	0.39[b]		

Values that follow by same letter mean it is not significant difference at the DMRT 5% level
(+) at same column shows that there is an increasing in nutrient content; (-) in the same column shows that there is a decreasing in nutrient content at the DMRT 5% level

Similarly, studies by [15] and [16] show that application various organic fertilizer resulted in an increase in C organic content of soil. The higher C organic content of organic fertilizer affect to the higher C organic content on the soil. Moreover, the higher dosage of powder active applied to organic matter resulted increasing in total amount of soil bacteria which affect significantly to improvement physical and chemicals characteristic of soil [14, 11]

3.6 The Effect of Powder Active of Cassava on Compost to Total Nitrogen Content of Vertisol

Result Analysis Variant shows that application powder active of cassava on compost significantly effect to total Nitrogen content of Vertisol. Result Duncan Multiple Range Test 5 % shows that all treatments applied various dosage of compost which were treated by powder active of cassava are able to increase total Nitrogen content of Vertisol compared the Initial condition (Table 6) . This is mainly due to increasing in total amount soil bacteria which affect significantly to improvement physical and chemicals characteristic of soil [14, 1]. Application the compost into the soil thereafter stimulates the increase of Nitrogen in the soil. Some studies show that application of organic matter into the soil result to improvement percentage of soil porosity, improving soil aeration, and decreasing in bulk density may able to increase Oxygen content and increase source of energy which are highly required by soil microorganism activities. These improvements might able to stimulate improvement on some nutrients content such as Nitrogen, Phosphorus, and Potassium [9, 10, 17, 14]. Furthermore, Differences total Nitrogen content of compost materials result differences total Nitrogen on the soil (Table 2 and Table 6). Similarly, study by [18] showed that application various dosage of differences compost materials were able to increase total Nitrogen on the soil due to differences decomposition process and activities of microorganism

Tabel 6. The Effect of Powder Active of Cassava on Compost to Total Nitrogen Content of Vertisol

Treatments	Total Nitrogen (%)			Duncan Test at 5% level	P
	Initial	End	Difference (Δ)		
P0K	0.14	0.070[a]	- 0.07[a]	0.044	2
P1K	0.14	0.140[b]	- 1.4E-17[b]	0.046	3
P2K	0.14	0.117[ab]	- 0.023[ab]	0.047	4
P0A	0.14	0.077[a]	- 0.063[a]	0.048	5
P1A	0.14	0.103[ab]	- 0.036[ab]	0.049	6
P2A	0.14	0.130[b]	- 0.01[b]	0.049	7
P0O	0.14	0.113[ab]	- 0.026[ab]	0.050	8
P1O	0.14	0.152[b]	0.013[b]		
P2O	0.14	0.150[b]	0.01[b]		

Values that follow by same letter mean it is not significant difference at the DMRT 5% level
(+) at same column shows that there is an increasing in nutrient content; (-) in the same column shows that there is a decreasing in nutrient content at the DMRT 5% level

Meanwhile, application 15 g per polybag of Chromolaena compost no powder active of cassava (P0K) and 15 g per polybag of Imperata compost no powder active of cassava (P0A) result lower total Nitrogen content of Vertisol. It is mainly due to both of those treatments content a high lignin compound or and a high fiber causing it difficulty to digest by microorganism [19].

3.7 The Effect of Powder Active of Cassava on Compost to Available Phosphorus Content of Vertisol

The research shows that all treatments affect significantly to improvement available Phosphorus content of Vertisol which increasing dosage of powder active on composting process significantly increase in available Phosphorus content (Table 7). It can be seen on Table 7 that application 15 g per polybag of Tithonia compost applied by 0.09 powder active of cassava (P2O) is the highest affect to available Phosphorus of Vertisol compared to application 15 g per polybag of Chromolaena compost no applied by powder active of cassava (P0K) and 15 g per polybag of Imperata compost no applied by powder active of cassava (P0A). This is mainly due Tithonia compost has a higher Phosphorus content than both of the later sources of compost materials (Table 2). Moreover, it can be seen that powder active of cassava take an important role in improvement Phosphorus content of Vertisol. A higher dosage of powder active results in increasing Phosphorus content of Vertisol. This is mainly due to an increasing dosage of powder active applied to all compost material stimulate a better activities of microorganism and amount of total microorganism to support mineralization process of compost. As a result more nutrients are produced by compost and released to the soil. Also application those organic fertilizers might decrease solubility degree of Fe and Al that availability of Phosphorus might increase [20, 21, 22, 23, 24].

Table 7. The Effect of Powder Active of Cassava on Compost to Available Phosphorus Content of Vertisol

Treatments	Available Phosphorus (ppm)			Duncan Test at 5% level	P
	Initial	End	Differences (Δ)		
P0K	4.91	9.43 a	4.52 a	2.30	2
P1K	4.91	14.28 bc	9.37 bc	2.42	3
P2K	4.91	14.46 bc	9.55 bc	2.49	4
P0A	4.91	8.86 a	3.95 a	2.54	5
P1A	4.91	11.98 b	7.07 b	2.58	6
P2A	4.91	13.66 bc	8.75 bc	2.60	7
P0O	4.91	13.83 bc	8.92 bc	2.62	8
P1O	4.91	15.28 c	10.37 c		
P2O	4.91	15.68 c	10.73 c		

Values that follow by same letter mean it is not significant difference at the DMRT 5% level
(+) at same column shows that there is an increasing in nutrient content; (-) in the same column shows that there is a decreasing in nutrient content at the DMRT 5% level

3.8 The Effect of Powder Active of Cassava on Compost to Available Potassium Content of Vertisol

The result of the Analysis Variant shows that all treatments affect significantly the availability of Potassium content. Moreover, analysis Duncan Multiple Range Test 5% level shows that an increase in the dosage of powder active in all composts result ins an increase in the availability of Potassium (Table 8). Interestingly, the availability of Potassium decreased compared to the initial conditions. This condition could be due to clay mineral type 2:1 Monmorilonit of Vertisol binds tightly Potassium into the space of these minerals so that it becomes less available in the soil [25].

Table 8. The Effect of Powder Active of Cassava on Compost to Available Potassium Content of Vertisol

Treatments	Available of Potassium (Cmol(+)/Kg)			Duncan Test at 5% level	P
	Initial	End	Difference (Δ)		
P0K	0.61	0.28 a	- 0.33 a	0.11	2
P1K	0.61	0.40 ab	- 0.20 ab	0.12	3
P2K	0.61	0.41 b	- 0.19 b	0.12	4
P0A	0.61	0.35 ab	- 0.26 ab	0.12	5
P1A	0.61	0.34 ab	- 0.26 ab	0.13	6
P2A	0.61	0.44 b	- 0.16 b	0.13	7
P0O	0.61	0.41 b	- 0.20 b	0.13	8
P1O	0.61	0.47 b	- 0.13 b		
P2O	0.61	0.50 b	- 0.10 b		

Values that follow by same letter mean it is not significant difference at the DMRT 5% level
(+) at same column shows that there is an increasing in nutrient content; (-) in the same column shows that there is a decreasing in nutrient content at the DMRT 5% level

3.9. The Effect of Powder Active of Cassava on Compost to Yield of Mung bean

Result of this research shows that the application of various dosages of powder active to the compost process effect significantly to weight of mung bean seeds. Duncan Multiple Range Test at 5% level shows that there is no significant difference weight of mung bean seed in all treatments applied by various dosages of powder active. An increase in the dosage of powder active in to compost process results from an increase weight of mung bean seeds

(Table 9). This is mainly due to the application of compost of Chromolaena, Imperata, and Tithonia which treated with powder active can improve the availability of nutrients (C organic, Nitrogen, Phosphorus, and Potassium) required in supporting growth, development, and yield of mung bean (Table 5, 6, 7, and 8)

Table 9. The Effect of Powder Active of Cassava on Compost to Yield of Mung bean (g/ plant)

Treatments	Average weight of seed (g/plant)	Duncan Test at 5% level	P
P0K	1.14 a	0.56	2
P1K	1.86 b	0.59	3
P2K	1.87 b	0.60	4
P0A	1.16 ab	0.62	5
P1A	1.69 ab	0.63	6
P2A	1.75 b	0.63	7
P0O	1.12 a	0.64	8
P1O	1.82 b		
P2O	1.84 b		

Values that follow by same letter mean it is not significant difference at the DMRT 5% level
(+) at same column shows that there is an increasing in nutrient content; (-) in the same column shows that there is a decreasing in nutrient content at the DMRT 5% level

4. Conclusion

It can be concluded that all compost of weeds (Chromolaena, Imperata, and Tithonia) treated by various dosage powder active of cassava effect significantly to the improvement chemical characteristic of Vertisol. It is showed by an increase in total amount of soil microorganism, C organic, total Nitrogen, available of Phosphorus, and available of Potassium. Those treatments result an improvement yield of mungbean. Generally, Tithonia is the best source of organic matter to be applied as compost treated by powder active of cassava followed by Chromolaena and Imperata, respectively.

References

1. N. M. Gusniwati, E. Fatia, R. Arief, Pertumbuhan Dan Hasil Tanaman Jagung Dengan Pemberisebuahkompos Alang-Alang, Agronomi, **12**, 2, hlm. 23–27, 2008.
2. I. Soetedjo, E. Nguru, Y. Benggu, Use of active powder of cassava, on various time applications, to improve carrying capacity of vertisol and alfisol on dry land farming system, Int. J. Innov. Creat. Change, **5**, 3, hlm. 327–342, 2019.
3. A. Walkley, A Critical Examination Of A Rapid Method For Determining Organic Carbon In Soils—Effect Of Variations In Digestion Conditions And Of Inorganic Soil Constituents:, Soil Sci., **63**, 4, hlm. 251–264, Apr 1947, doi: 10.1097/00010694-194704000-00001.
4. J. Bremner, C. Mulvaney, Nitrogen-total. In 'Methods of soil analysis. Part 2. Chemical and microbiological properties'.(Eds AL Page, RH Miller, DR Keeney) pp. 595–624, Soil Sci. Soc. Am. Madison WI USA, 1982.
5. S. Olsen, L. E. Sommers, sommers, LE,(1982), Phosphorus Methods Soil Anal. Part Eds Page AL Mill. RH Kefney Am. Soc. Agron. Madison Wis., hlm. 15–72.
6. Anon, A survey of Soil and Plants Tissue Testing Activities I Australia, Report by Soil Testing Sub Committee., Aust. Soc. Soil Sci. Aust., 1965.

7. D. Knudsen, G. Peterson, dan P. Pratt, Lithium, sodium, and potassium. Methods of soil analysis: part 2 chemical and microbiological properties 9: 225–246, 1983.
8. L. Waluyo, Ã¢ â¬ Å Mikrobiologi Umum. Edisi ke-2, Ã¢ Â¬ Â Malang Univ. Muhamadiyah Malang, 2005.
9. J. Hassink, Effect of soil texture on the size of the microbial biomass and on the amount of C and N mineralized per unit of microbial biomass in Dutch grassland soils, Soil Biol. Biochem., **26**, 11, hlm. 1573–1581, 1994.
10. A. Papadopoulos, N. Bird, A. Whitmore, dan S. Mooney, The effects of organic farming on the soil physical environment, Asp. Appl. Biol. 79 What Will Org. Farming Deliv. COR 2006, hlm. 263–267, 2006.
11. I. P. Soetedjo, Various dosages of active powder of cassava improved sustainability of physical and chemical characteristics of Vertisol and Alfisol on dryland farming system, Int. J. Trop. Drylands, **3**, 1, 2019.
12. P. Nugroho, Panduan membuat pupuk kompos cair, Pustaka BaruPress Yogyak., 2013.
13. P. Soetedjo, Inovasi " Bubuk Organik Aktif" Dalam Memperbaiki Komponen Lingkungan Fisik, Kimia Dan Biologi Tanah Vertisol Dan Hasil Tanaman, Fakultas Pertanian Universitas Nusa Cendana, Kupang, 2016.
14. P. Soetedjo, Use of Active Powder To Improve Carrying Capacity Vertisol and Alfisol on Dry Land Farming System, dipresentasikan pada 4th International Conference on Food, Agriculture and Natural Resources (FANRes 2018), Atlantis Press, 2018, hlm. 144–147.
15. M. Zulkarnain, B. Prasetya, S. Soemarno, Pengaruh kompos, pupuk kandang, dan custom-bio terhadap sifat tanah, pertumbuhan dan hasil tebu (Saccharum officinarum L.) pada Entisol di Kebun Ngrangkah-Pawon, Kediri, Indones. Green Technol. J., **2**, 1, hlm. 45–52, 2013.
16. K. Hanafiah, Dasar-Dasar Ilmu Tanah. Jakarta: Rajawali Press, 2014.
17. K. Jangid et al., Relative impacts of land-use, management intensity and fertilization upon soil microbial community structure in agricultural systems, Soil Biol. Biochem., **40**, 11, hlm. 2843–2853, 2008.
18. Muyassir, Zulfadli, Fikrinda, Sifat Tanah Terkompaksi Akibat Pemberian Cacing Tanah dan Bahan Organik, J. Manaj. Sumberd. Lahan, **1**, 1, hlm. 54–61, 2012.
19. J. Esmaeilzadeh, A. G. Ahangar, Influence of soil organic matter content on soil physical, chemical and biological properties, Int. J. Plant Anim. Environ. Sci., **4**, 4, hlm. 244–252, 2014.
20. M. B. Cyio, Efektivitas bahan organik dan tinggi genangan terhadap perubahan Eh, Ph, dan status Fe, P, Al terlarut pada tanah ultisol, J. Agroland, **15**, 4, hlm. 257–263, 2008.
21. B. Murphy, W,(2014) Soil Organic Matter and Soil Function–Review of the Literature and Underlying Data, Dep. Environ. Canberra Aust., 2014.
22. I. P. Soetedjo, Y. Falo, Y. L. S. Diana, Pemanfaatan air limbah detergen dan bubuk aktif ahl dengan Konsentrasi berbeda terhadap sifat kimia tanah vertisol dan Hasil tanaman jagung manis., Agrisa, **9**, 1, hlm. 1–7, 2020.
23. I. P. Soetedjo, C. I. P. P. Blegur, Duaja W, Pengaruh Interval Waktu Pemberian Bubuk Aktif (AHL) dan Konsentrasi Limbah Deterjen terhadap Sifat Kimia Tanah Vertisol dan Hasil Tanaman Jagung Manis (Zea mays saccharata Sturt)., Agrisa, **9**, 1, hlm. 36–44, 2020.

24. I. P. Soetedjo, A. A. Ende, A. S. J. A. Tae, Pemanfaatan Bubuk Aktif Ahl Pada Fermentasi Limbah Cair Tahu Terhadap Peningkatan Mikroorganisme Dan Perbaikan Sifat Kimia N Dan K Pada Tanah Vertisol., Agrisa, **10**, 2, hlm. 80–88, 2021.
25. F. A. Damanik, R. Rosmayati, H. Hasyim, Respons Pertumbuhan Dan Produksi Kedelai Terhadap Pemberian Mikoriza Dan Penggunaan Ukuran Biji Pada Tanah Salin, J. Agroekoteknologi Univ. Sumat. Utara, **1**, 2, 2013, doi: 10.32734/jaet.v1i2.1524