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Use of active powder of cassava, on various time applications, to improve carrying capacity of vertisol and alfisol on dry land farming system

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Abstract

Generally, Alfisol has low nutrients content, such as N, P, K, C organic, Mo, Mg, and poisoning of Al, Fe, and Mn. Moreover, Alfisol has medium to high bulk density, less to medium soil of permeability, low of water soil resistance, high sensitivity to erosion, and low content of soil microbiology. Similarly, Vertisol has low content of some nutrients, such as N, P, K, C organic, dominated by clay, and high water saturation. Numerous ways have been practiced to improve the capabilities of Vertisol and Alfisol, such as applying an organic fertilizer. However, some studies showed that those practices resulted in an increasing of soil compaction, and increasing of soil microbiology dormantion. Meanwhile, activities of soil microbiology are needed to improve physical soil characteristic, and improve availability of some soil nutrients. Active powder is an innovation product to improve soil microbiology activity, which finally might improve the availability of soil nutrients. Research had been done to know the effect of various time applications of powder active to improve physical and chemical characteristic of Vertisol and Alfisol ,at dry land farming system, in Kupang, Nusa Tenggara Timur. The research was a factorial research designed as a Randomized Completed Block Design, replicated 4 times. Variables of the research were two type of soil (Vertisol and Alfisol) and various time application of active powder (on planting, 7 days after panting, and 15 days after panting). Parameters

observed were analyzed by analysis of variant and followed by Least Significant Different Test at 0.05 level. Results of the research showed that there was an increasing number of soil bacteria colonies, resulted from the application of powder active, on both of soil type. Similarly, the research showed that application of powder active significantly improved soil porosity, soil bulk density, total N, availability of P, and availability of K, C organic, and pH. Physical and chemical characteristic of Vertisol (total N, availability of P) improved more than Alfisol. Meanwhile, availability of K, C organic, and pH of Alfisol improved significantly better than Vertisol. Moreover, application of powder active on plantation was significantly greater than others time application of powder active. Yield of mungbean was significantly affected by time application of powder active on plantation, in which the yield of mungbean, grown in Alfisol, was higher than yield of mungbean grown in Vertisol

Keywords: *Active powder of cassava, Alfisol, Physical and Chemical characteristic of soil, soil microbiology, Time application, Vertisol*

Introduction

There are two kinds of soil dominate on dry land farming system, in East Nusa Tenggara. They are Alfisol and Vertisol. Generally, both of these soils have low content of some nutrients, such as N, P, K, C organic, dominated by clay, and high water saturation, (Hardjowigeno, 2015; Serangmo, 2015) low to medium soil permeability, low water soil resistance, high sensitivity of erosion, and low content of soil microbiology. These conditions result to decrease the carrying capacity of the soils in supporting growth, development and yield of plants. Some practical technologies have been applied to improve carrying capacity of the soils such as applying an organic fertilizer. However, this practice resulted in an increasing of soil compaction, and an increasing of soil microbiology dormantion as reported in (Abebe, 2002;

Debosz, Petersen, Kure, & Ambus, 2002; Esmaeilzadeh & Ahangar, 2014). Meanwhile, improving soil microbiology is one of the crucial ways to improve the physical and chemical characteristics of soil. Some studies showed that organic fertilizer could improve availability of soil microorganism and could improve the availability of nutrients such as nitrogen, phosphorus, and potassium (Abu-Zahra & Tahboub, 2008; Debosz et al., 2002; Doran & Zeiss, 2000). However, it needs about 10 to 20 t/ha organic fertilizer, which is a significantly problem on dry land farming system practices. This is mainly due to the presence less organic matter sources (variety and quantity) on dry land areas. Application of an organic fertilizer, may reduce use of organic matter resources. However, it is well known that an organic fertilizer application has resulted in negative soil characteristics, such as an increase in soil compactness, increase in bulk density, and an increase in some nutrients toxicity on long term applications. Therefore, there should be an alternative innovation technology found that could minimize use of organic sources, and improve physical and chemical characteristics of soil. Active powder is one innovative product that is available to improve soil microbiology activities which improve availability of some soil nutrients. Physically, active powder may able to increase the use of gamma radiation, to increase the amount of oxygen in the soil. Gamma radiation is able to penetrate into 50 cm soil depth; increase degradation of the H_2O processes, becoming hydrogen (H_2) and oxygen (O_2). An increase in oxygen level, into the soil, will increase activity of soil microorganism and the biomass of microorganism. These processes may stimulate improvement of soil structure, improve soil aeration, improve exchange capacity of anions and cations, and improve availability of nutrients. The positive interaction of active powder application on improvement of soil carrying capacity depends strongly to soil type, dosage application, time application, and crop model plantations.. This is mainly due to the fact that various types of soil have different physical and chemical characteristics as reported by (Esmaeilzadeh & Ahangar,

2014; Hardjowigeno, 2015). Some types of soil have high contents of clay with low nutrient content and others have low content of clay and enough nutrient content. Moreover, interaction process of powder active is significantly affective where it can increase availability of some nutrients required by plant life, to support growth, development and yield. The following study will give detailed information on the application powder active on various soil types, at various time applications.

1. Material and methods

Present research was conducted at Naibonat village (dominated by Vertisol) and Matani village (dominated by Alfisol), district of Kupang, East Nusa Tenggara Province, from May to October 2018. Factorial research was designed on the Randomized Complete Block Design with four replications. Variables of the research were the two type of soil (Vertisol and Alfisol) and various time applications of active powder (on plantation, 7 days before plantation, and 15 days before plantation). Parameters observed in this research was the number of soil bacteria colonies, nutrient content (Nitrogen, Phosphorus, Potassium, C organic), and yield of mungbean. Active powder of cassava was prepared two days before application. All active powder of cassava was mixed with 2 kg ha^{-1} of wheat flour and thereafter mixed with 4 l of water. Mung bean was grown on bed plantings with size 2 x 6 m. The spacing of each mung bean was 20 x 40 cm. Chemical characteristic and number of soil bacteria colonies, of sample soil, was analyzed before plantation and after harvest. Total nitrogen (N) percentages were determined by using the micro Kjeldahl method (Bremner & Mulvaney, 1982). Available phosphorus (P), extracted by 0.5 N NaHCO with pH of 8.5 with Spectrophotometer (Olsen, 1982). Available potassium (K), extracted by 1 N ammonium acetate determined by Flame Photometer (Knudsen, Peterson, & Pratt, 1982). Before

planting, three soil samples were collected at decomposition. 0-20 cm soil depth from each replicate area by using an auger and then these samples were mixed with each other to form a composite sample for each treatment. Each soil sample was mixed, then four replications were taken for measurements and analysis and the average readings were recorded. Also, at the end of the experiment, soil samples were collected in the same manner, as before planting, but replicas of each treatment were not mixed with each other and analysis was done with four replica samples for each replicate, then the average readings were recorded. Yield of mung bean was calculated at the end of the research by harvesting all seeds, per plant per bed, and drying it up. The differences between means of the different treatments were compared by the Least Significant Difference at 5 % significance level.

2. Results and discussion

Soil Bacteria Colonies

Result of the research showed that there were no interaction effects on the type of soil and time of application of powder active. However, there was a single variable type of soil affected significantly to increase the number of soil bacteria colonies. The research showed that the number of soil bacteria colonies, at Vertisol was higher than Alfisol (Table 1).

This is mainly due to percentages of soil porosity and the bulk density of Vertisol being better than Alfisol, which could result in an improvement in soil microorganism activities. An improvement percentage of soil porosity, improving soil aeration, and a decrease in bulk density may able to increase Oxygen content and increase the source of energy which is required by soil microorganism activities. A number of studies reported that availability of soil microorganism depend strongly on the microclimate conditions of the soi,l such as pH, well aeration and drainage, better energy sources (solar radiation and organic matter) and soil management (Habig

& Swanepoel, 2015; Hassink, 1994; Jangid & Williams, 2008; Papadopoulos, Bird, Whitmore, & Mooney, 2006)

Soil porosity

Result of the research showed that there is no significantly effect of interaction and single factor of time applications of active powder, to soil porosity. However, a single type of soil was affected significantly by powder active application. The research showed that the percentage of soil porosity 1of Vertiso increased at a higher percentage than the porosity of Alfisol (Table 2). These result showed that active powder is able to improve oxygen levels of the soil which resulted in increasing soil microorganism activities to improve soil porosities, soil aeration, and decrease the bulk density. Moreover, improved soil porosities of Vertisol was higher than soil porosities of Alfisol mainly due to clay on the top layer of soil, resulting in an increase in soil granulation which resulted in an increased percentage of macro porosity and better soil aeration, as has been reported some studies in (Brian W. Murphy, 2014; Esmaeilzadeh & Ahangar, 2014; Granatstein, Bezdicek, Cochran, Elliott, & Hammel, 1987; Knudsen et al., 1982; P. Soetedjo, 2018)

Total nitrogen content (%)

There was no interaction effect of time applications of powder active and type of soil to Nitrogen content. However, a single variable type of soil was effected significantly by powder application. LSD test at level 5 % showed that powder active application resulted in an increase in the Nitrogen content of both types of soil. The increased Nitrogen content on Vertisol was significantly higher than the Nitrogen content of Alfisol (Table 3).

Improvement in Nitrogen content of Vertisol was much more better than Alfisol because of the physical characteristic of Vertisol. Vertisol is better in supporting gamma radiation penetration into the depths of the soil. This resulted in an improvement to the growth and development of soil microorganism and an increased number of soil microorganism in the depths of soil. These conditions may able to improve soil microorganism activities, improvement of soil porosity, decreasing in soil colloid and improvement of cation exchangeable capacity. A number of studies (Granatstein et al., 1987; I. P. Soetedjo, 2008; Wild, 1993) reported an increase in the activities of soil microorganism as a result of various soil management affects and an improvement in the availability of some nutrients (N, P, and K).

Available phosphorus (ppm)

Results analysis variant showed that there was no interaction effect on the time application of powder active and type of soil to available phosphorus. Similarly to Nitrogen content, it showed that a single variable type soil was affected by application of powder application, on available phosphorus. Further analysis by LSD 5% level, showed that the time application of active powder application resulted in higher content of available phosphorus in Vertisol when compared to Alfisol. (Table 4). These result showed a significantly correlation between improvement of the availability of some nutrients, with increase number of soil microorganism, and improvement of porosities and aeration of soil (Doran & Zeiss, 2000; Esmaeilzadeh & Ahangar, 2014). Interestingly the available of phosphorus in both types of soil decreased significantly after powder active application. This could be closely related to an increasing in Nitrogen content in both types of soil. Some studies reported that increasing soil Nitrogen content could suppress the amount of available phosphorus in the soil (Beja, Mella, & Soetedjo, 2016; P. Soetedjo, 2018).

Potassium content (me/100 g)

Results of the research show that there was no interaction effect of time application of active powder and type of soil on Potassium content. However, a single variable type of soil was affected by application of powder active. Potassium content of Vertisol increased at a higher rate than Alfisol (Table 5). All the result showed that improvement in the physical characteristics of the soil governs the nutrients content of the soil. A better increase in soil porosity results in an increased number of soil microorganism and their activities stimulate an increase in cation exchangeable capacity and availability of nutrients.

Meanwhile, a single variable of time application showed that applications at the same time as plantation resulted in a higher Potassium content (me/100g) compared to application 1 week and 2 weeks before plantation, respectively (Table 6). This might be because an application of powder active improves the physical characteristics of the soil and is much better for the growth and development of soil microorganism It was shown that by improving soil porosity, soil aeration, gamma rays to the depth of soil, and availability of sources of energy, the soil microorganism could increase their activities earlier to improve the quality of some nutrients. Some studies reported that soil microorganism activities increase gradually on soil with good aeration, suitable pH, enough nutrients, enough oxygen, and a high availability of carbon, as a source of energy (Doran & Zeiss, 2000; P. Soetedjo, 2018; Wild, 1993)

Organic content (%)

Results of the research showed that there was no interaction and single factor time application of powder active affect on C organic content. However, a single factor type of soil was affected significantly. The research showed that the increase in C organic content of Alfisol

was higher than Vertisol. This is mainly due to the fact that Vertisol is a high clay textured soil. Nitrogen content was also affected by powder active application and could effect a decrease in C organic content (Table 7). A number of studies have showed that the physical characteristic of soil (texture, structure, aeration, bulk density) and the chemicals characteristics of soil (Total N content) relate closely to C organic content. High clay textured soil, such as Vertisol, has low C organic content; a higher content of N will suppress the organic content (Abu-Zahra & Tahboub, 2008; Knudsen et al., 1982)

Soil pH

Results of the research showed that there was no interaction variables and single variable of time application affected on soil pH. The research showed that powder active is able to be applied on various time applications. The importantly question is when application of powder active could affect a significant improvement of the physical characteristic of soil which result in an increased interception of gamma rays to the depth of soil, increase the availability of oxygen, as well as soil aeration, to stimulate an improvement in soil microorganism activities. All of these things could be strongly dependent on the type of soil and other micro climate conditions. The research showed that the pH of Vertisol tended to decrease after application of powder active (Table 8). Meanwhile, the pH of Alfisol tended to increase after application of powder active. This is mainly due to the ability of Vertisol to expand and contract (Hardjowigeno, 2015; Serangmo, 2015). The results how a high increasing in microorganism activities, and an increase in N content (Table 3). These conditions would increase soil acidity. Meanwhile, a high content of clay in the deep layers of Alfisol could stimulate a decrease in soil acidity and increase pH.

Yield of mung bean (g/6m^2)

Results of the research showed that yield of mungbean was significantly affected by single variable of time application of active powder and the type of soil. Application of powder active at the same time as plantation resulted in a higher yield of mungbean (g/6m^2) compared to application at 1 week and two weeks before plantation. Moreover, yield of mungbean in Vertisol was higher than yield of mung bean in Alfisol. All these result were mainly due to the improvement in physical characteristics and chemical characteristics of the Vertisol after the application of active powder. This result was consistent to yield of mungbean which was affected by various dosage applications of powder active. The research showed that improvement of physical and chemical characteristics of soil directly affect an improvement in the yield of mungbean (Abebe, 2002; Abu-Zahra & Tahboub, 2008; Esmaeilzadeh & Ahangar, 2014; P. Soetedjo, 2018).

Conclusion

It can concluded thatan application of active powder significantly affects an improvement in the physical and chemical characteristics of Vertisol and Alfisol. The research showed that the impact of active powder was much more significant on Vertisol. A yield of mungbean (1.84 kg/6 m^2 and 1.60 kg/6 m^2) was grown in Vertisol and Alfisol. The best time application of powder active is at the same time as plantation, followed by 1 week and then two weeks before plantation.

Table 1..Number of soil bacteria at different soil type affected by powder active applications

Soil type	Number of colony soil bacteria	Changeable of Number of

			colony soil bacteria
	Before	After application	
Vertisol	190	286.42 b	96.41 b
Alfisol	180	243,41 a	63,41 a
LSD 5%	12.49	37,76	26,89

Number followed by same letter at the same column means not significantly different at LSD 5% level

Table 2.Soil porosity at different soil type affected by powder active application

Soil type	Soil porosity affected by active powder application		Changeable of Soil porosity
	Before	After application	
Vertisol	41.78 a	55.49 a	13.64 b
Alfisol	53.39 b	61.26 b	7.86 a
LSD 5%	5.49	6.14	5.86

Number followed by same letter at the same column means not significantly different at LSD 5% level

Table 3. Total Nitrogen content (%) at different soil type affected by powder active application

Soil type	Total Nitrogen Content (%) affected by active powder application		Changeable of total nitrogen
	Before	After application	
Vertisol	0.282 b	0.73 b	0.445 b
Alfisol	0.195 a	0.27 a	0.082 a
LSD 5%	0.025	0.006	0.06

Number followed by same letter at the same column means not significantly different at LSD 5% level

Table 4. Available Phosphorus content (ppm) at different soil type affected by powder active application

Soil type	Available Phosphorus Content (ppm) affected by active powder application		Changeable of available phosphorus
	Before	After application	
Vertisol	22.67 a	21.63 b	-1.04 a
Alfisol	38.05 b	13.32 a	-24.73 b
LSD 5%	6.02	3.23	5.71

Number followed by same letter at the same column means not significantly different at LSD 5% level. Sign(-) showed decrease, sign (+) showed increase

Table 5. Potassium content (me/100g) at different soil type affected by powder active application

Soil type	Available potassium Content (ppm) affected by active powder application		Changeable of potassium content
	Before	After application	
Vertisol	0.84 a	0.94 a	0.103
Alfisol	0.97 b	1.04 b	0.065
LSD 5%	0.123	0.09	0.08

Number followed by same letter at the same column means not significantly different at LSD 5% level. Sign(-) showed decrease, sign (+) showed increase

Table 6. Potassium content (me/100g) affected by various time application of powder active

Time application of powder active	Potassium Content of soil (me/100g)		Changeable of potassium content
	Before	After application	
Same time on plantation	0.91	1.065 b	0.15 b
A week before plantation	0.91	0.965 a	0.05 a

Two weeks before plantation	0.91	0.960 a	0.04 a
LSD 5%	0.15	0.114	0.11

Number followed by same letter at the same column means not significantly different at LSD 5% level. Sign(-) showed decrease, sign (+) showed increase

Table 7. Single Effect of type of soil to C organic content of the soil (%) affected by active powder application

Soil type	Soil organic content (%)affected by active powder application		Exchangable of organic content
	Before application	After application	
Vertisol	1.42 a	1.63 a	0,21 a
Alfisol	1.85 b	2.42 b	0.56 b
LSD 5%	0.37	0.37	0.41

Number followed by same letter at the same column means not significantly different at LSD 5% level. Sign(-) showed decrease, sign (+) showed increase

Table 8. Soil pH at different soil type affected by powder active application

Soil type	Soil pH affected by active powder application		Changeable of soil pH
	Before	After application	
Vertisol	7.89 b	7.39 b	- 0.50 a
Alfisol	6.06 a	6.18 a	+ 0.11 b
LSD 5%	0,39	0.12	0.43

Number followed by same letter at the same column means not significantly different at LSD 5% level. Sign(-) showed decrease, sign (+) showed increase

Table 9. Single Effect time application of active powder and type of soil to yield of mungbean (g/6m^2)

Soil Type	Yield of mungban (kg/ 6 m^2)	Various time application of powder active	Yield of mungban (kg/ 6

			m^2)
Alfisol	1,60 a	Same time on plantation	1.26 b
Vertisol	1.84 b	A week before plantation	1.19 ab
		Two weeks before plantation	1.08 a
LSD5%	0.13		0.17

Number followed by same letter at the same column means not significantly different at LSD 5% level

References

Abebe, G. (2002). *Effect of Manure on Some Physico-chemical Properties of Calcareous Soil, Yield and Quality of Cowpea [Vigna unguiculata (L.) Walp.] Under greenhouse conditions*. University of Jordan.

Abu-Zahra, T. R., & Tahboub, A. B. (2008). Effect of organic matter sources on chemical properties of the soil and yield of strawberry under organic farming conditions. *World Applied Sciences Journal*, *5*(3), 383–388.

Beja, H. D., Mella, W. I. I., & Soetedjo, I. N. P. (2016). Sistem Tebas Bakar dan Pengaruhnya Terhadap Komponen Fisik Kimia Tanah Serta Vegetasi pada Ladang dan Lahan Bera (Studi Kasus di Desa Pruda Kecamatan Waiblama Kabupaten Sikka Provinsi Nusa Tenggara Timur). *Jurnal Keteknikan Pertanian*, *3*(2).

Bremner, J. M., & Mulvaney, C. S. (1982). Nitrogen—Total 1. *Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties*, (methodsofsoilan2), 595–624.

Brian W. Murphy. (2014). *Soil Organic Matter and Soil Function – Review of the Literature and Underlying Data*. Department of the Environment, Canberra, Australia.: a Creative Commons Attribution (CC BY) 4.0 International licence. http://www.ecaf.org/downloads/books/17-soil-organic-matter-and-soil-function-review-of-the-literature-and-underlying-data/file.

Debosz, K., Petersen, S. O., Kure, L. K., & Ambus, P. (2002). Evaluating effects of sewage sludge and household compost on soil physical, chemical and microbiological properties. *Applied Soil Ecology*, *19*(3), 237–248.

Doran, J. W., & Zeiss, M. R. (2000). Soil health and sustainability: managing the biotic component of soil quality. *Applied Soil Ecology*, *15*(1), 3–11.

Esmaeilzadeh, J., & Ahangar, A. G. (2014). Influence of soil organic matter content on soil physical, chemical and biological properties. *IJPAES*, *4*, 244–252.

Granatstein, D. M., Bezdicek, D. F., Cochran, V. L., Elliott, L. E., & Hammel, J. (1987). Long-term tillage and rotation effects on soil microbial biomass, carbon and nitrogen. *Biology and Fertility of Soils*, *5*(3), 265–270.

Habig, J., & Swanepoel, C. (2015). Effects of conservation agriculture and fertilization on soil microbial diversity and activity. *Environments*, *2*(3), 358–384.

Hardjowigeno, S. (2015). *Ilmu Tanah*. Akademika Pressindo.

Hassink, J. (1994). 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 Biology and Biochemistry*, *26*(11), 1573–1581.

Jangid, K., & Williams, M. (2008). a., Franzluebbers AJ, Sanderlin JS, Reeves JH, Jenkins MB, et al. Relative impacts of land-use, management intensity and fertilization upon soil mi-crobial community structure in agricultural systems. *Soil Biol Biochem*, *40*, 2843–2853.

Knudsen, D., Peterson, G. A., & Pratt, P. F. (1982). Lithium, sodium, and potassium. *Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties*, (methodsofsoilan2), 225–246.

Olsen, S. R. (1982). Anion resin extractable phosphorus. *Methods of Soil Analysis*, *2*, 423–424.

Papadopoulos, A., Bird, N. R. A., Whitmore, A. P., & Mooney, S. J. (2006). The effects of organic farming on the soil physical environment. *Aspects of Applied Biology 79, What Will*

Organic Farming Deliver? COR 2006, 263–267.

Serangmo. (2015). *Kajian Beberapa Sifat Fisik Tanah Vertisol dan Alfisol akibat Pemberian Tiga Macam Bahan Dasar pupuk Orga-dec serta Hasil Baby Buncis*. Buletin Leguminosae.

Soetedjo, I. P. (2008). Study The Use of Straw Paddy as Mulch to Improve Water Use Efficiency and Soil Nutrients Content. *Journal of Dry Land Farming System*, *16*, 31–38.

Soetedjo, P. (2018). Use of Active Powder To Improve Carrying Capacity Vertisol and Alfisol on Dry Land Farming System. *4th International Conference on Food, Agriculture and Natural Resources (FANRes 2018)*. Atlantis Press.

Wild, A. (1993). *Soils and the Environment*. Cambridge University Press.