Improving The Carrying Capacity of Vertisol nd Alfisol on Dryland Ecosystem by Applying Active Powder of Cassava

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Abstract. Alfisol and Vertisol have low nutrients content. Improving the carrying capacity of the soils applying an organic and organic fertilizer resulted in increasing of soil compaction and increasing of soil microbiology. Research had been done to know the effect of various dosages and time applications of powder active to improve the carrying capacity of Vertisol and Alfisol at the germinating land Ecosystem in East Nusa Tenggara. Factorial research designed as Randomized Completed Block Design replicated four times. Variables of the research were a various dosage of active powder (0, 100, 200, and 300 g/ha), and various time application active powder of cassava (on planting, seven days after panting, and 15 days after planting). The result showed that the active powder applied to cassava significantly increase the colony number of soil bacteria, improving in soil porosity, soil bulk density, total N, availability of P and K, C organic, and soil pH. Application active powder of cassava by 200-300 g/ha was able to improve the physical and chemical characteristics of Vertisol and Alfisol.

1. Introduction
There are two kinds of soil dominated on the dryland farming system in East Nusa Tenggara. They are Alfisol and Vertisol. Both of soils have low content of some nutrients such as N, P, K, C organic, dominated by clay, high saturated water as in Hardjowigeno [1], and Serangmo [2] less to medium soil of permeability, low of water soil resistance, high sensitivity of erosion, and low content of soil microbiology. These conditions resulted in a decrease in the carrying capacity of the soils in supporting the growth, development, and yield of plants. Some technologies have been applied to improve the carrying capacity of the soils, such as applying inorganic and organic fertilizer. However, those practices resulted in increasing soil compaction and increasing of soil microbiology dormant [3, 4, 5].

Meanwhile, improving soil microbiology activities is one of the crucial ways to improve the physical and chemical characteristics of soil, respectively. Some studies showed that organic fertilizer could improve the availability of soil microorganisms and could improve the chemical characteristic of the soil [6, 3, 7]. However, it needs a massive amount of biomass (10 to 20 t/ha) to produce organic fertilizer in dryland areas. Meanwhile, the application of an organic fertilizer resulted in some soil environmental impacts, such as increasing soil compactness, increasing bulk density, and increasing some nutrients toxicity on long term application. Therefore it could be found an alternative innovation technology that could minimize the use of organic sources, but, it could improve the physical and chemical characteristics of the soil.
The active powder is one of the innovative products that are available to improve soil microbiology activities, which improve the availability of some soil nutrients. Physically, an active powder may be able to increase the use of gamma radiation maximally to increase the number of oxygen into the soil. Gamma radiation can intercept into 50 cm soil depth in which increase degradation H$_2$O processes become hydrogen (H$_2$) and oxygen (O$_2$). Increasing oxygen level into the soil will affect to increased activity of soil microorganisms and biomass of microorganisms. These processes may stimulate the improvement of soil structure, improve soil aeration, improve the exchange capacity of anions and cations, and improve the availability of nutrients. Positive interaction active powder application on the improvement of soil carrying capacity depends strongly on soil type, dosage application, time application, and crop model plantations. The application mainly due to various types of soil has different physical and chemical characteristics [5,1]. Some soil has high contents of clay with low some nutrients content, and others have a low content of clay and enough nutrients content. Moreover, the interaction process of powder active is significantly useful when it could increase the availability of some nutrients required by the plant to support growth, development, and yield. Based on those studies, it will give some details information, if application powder active examined at various soil types, various dosages, and various time applications.

2. Methods

2.1. Materials

The research 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 designed on Randomized Complete Block Design with four replications. Variable of the research was a various dosage of active powder (0, 100, 200, and 300 g/ha), and various time application of active powder (on the plantation, seven days before plantation, and 15 days before plantation). Parameters observed of the research were some colony soil bacteria, nutrients content (Nitrogen, Phosphorus, Potassium, C organic), and yield of mungbean.

2.2. Procedure

Active powder of cassava was prepared two days before application into the soil. All active powder of cassava mixed with 2 kg ha$^{-1}$ of wheat flour and after that mixed it with 4 l of water. Mung bean was grown on bed planting with size 2 x 6 m, and the spacing of mung bean was 20 x 40 cm. Chemical characteristics and the number of colony soil bacteria of sample soil were analyzed before plantation and after harvest. Total nitrogen (N) percentage, determined by using the micro Kjeldahl method [8]. Available phosphorus (P), extracted by 0.5 N NaHCO with pH of 8.5 with Spectrophotometer [9]. Available potassium (K), extracted by 1 N ammonium acetate determined by Flame Photometer [10].

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

3. Result and Discussion

3.1. Colony Soil Bacteria
The result of the research showed that there was no interaction effect of the treatments. However, a single factor of dosage applications showed that an increase in the dosage application of active powder up to 300 g/ha. These resulted in an increase of colony soil bacteria (Table 1) on both soil type (Vertisol and Alfisol). There this is mainly due to those soils that have content of clay, low of soil porosity, and high bulk density. These conditions result in low Oxygen content that is highly required by soil microorganism activities. By application active-powder up to 300 g/ha, more oxygen may able to increase the number and activities of soil microorganisms. Result in improvement soil porosity, improve soil aeration, decreasing in bulk density, and improvement of exchangeable cation capacity. Some studies reported that availability of soil microorganism depends strongly to microclimate condition of the soil such as pH, aeration, energy sources and soil management [11, 12, 13].

| Dosage (g/ha) | Number of colony soil bacteria Before | After application | Changeable |
|--------------|--------------------------------------|-------------------|------------|
| 0            | 236.5                                | 233.50 a          | 3          |
| 100          | 236.5                                | 271.37 b          | 34.8       |
| 200          | 236.5                                | 285.25 bc         | 48.7       |
| 300          | 236.5                                | 292.87 c          | 53.3       |
| LSD 5%       | 15.23                                | 15.23             |            |

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

Moreover, It showed that improvement number colony of soil bacteria at Vertisol was higher than Alfisol (Table 2)

| Soil type | Number of colony soil bacteria Before | After application | Changeable of Number of colony soil bacteria |
|-----------|--------------------------------------|-------------------|---------------------------------------------|
| Vertisol  | 190                                  | 286.42 b          | 96.41 b                                     |
| Alfisol   | 180                                  | 243.41 a          | 63.41 a                                     |
| LSD 5%    | 12.49                                | 37.76             | 26.89                                       |

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

There are mainly due to percentages of soil porosity, and bulk density of Vertisol is better than Alfisol, which could result in an improvement in soil microorganism activities. An improvement percentage of soil porosity, improving soil aeration, and decreasing in bulk density, may able to increase Oxygen content and increase the source of energy, which is highly required by soil microorganism activities. Several studies reported that the availability of soil microorganism depends strongly to the microclimate condition of the soil, such as pH, well aeration and drainage, better energy sources (solar radiation and organic matter), and soil management in [11, 12, 13].

3.2. Soil porosity
The result of the research showed that there no significant effect of interaction treatments and a single factor of time application of active powder application to soil porosity. It showed that 100 – 300 g/ha active powder
applications increased soil porosity of Vertisol and Alfisol compared to no application of active powder (Table 3). These results showed that active powder could improve the oxygen level on the soil. The increasing of the soil microorganism activities to improve soil porosities, soil aeration, and decrease bulk density.

Moreover, the improvement of soil porosities of Vertisol was more significant than soil porosities of Alfisol (Table 4). Moreover, improvement soil porosities of Vertisol was higher than soil porosities of Alfisol mainly due to dominated clay on top layer of soil resulted an increasing in soil granulation which resulted an increasing in percentage of macroporosity and better soil aeration as had been reported some studies in [10, 5, 14, 15].

Table 3. The effect of various dosage of active powder application to soil porosity

| Dosage (g/ha) | Soil porosity affected by active powder application | Changeable
|---------------|--------------------------------------------------|-------|
| 0             | Before 59.65 After 58.8 a                         | -0.84 a |
| 100           | Before 59.65 After 62.9 b                         | 3.32 b |
| 200           | Before 59.65 After 63.0 b                         | 3.41 b |
| 300           | Before 59.65 After 64.9 b                         | 5.32 b |
| LSD 5%        | Before 3.39 After 3.39                            | 3.39   |

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

Table 4. Soil porosity at different soil type affected by powder active application

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

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

3.3. Total nitrogen content (%)

There was no interaction effect of treatments on Nitrogen content. However, a single variable of dosage affected significantly to Nitrogen content. LSD test at level 5% showed that active powder application to 300 g/ha increased the Nitrogen content of both type of soil, which an increasing Nitrogen content on Vertisol significantly higher than Nitrogen content on Alfisol (Table 5 and 6).

An increasing the Nitrogen content at 300 g/ha of actual powder application. Its mainly due to an increasing number of microorganisms resulted in the improvement of soil micro bacteria activities, improvement of soil porosity of the soil, decreasing soil colloid, and improvement of exchangeable cation capacity. Moreover, the improvement Nitrogen content of Vertisol is much better than Alfisol could be related to the physical characteristic of Vertisol is better in supporting gamma radiation interception into the depth of the soil resulted in improved growth and development of micro soil organism and increasing in the number of soil microorganism on the depth of soil. Some studies as in [15, 16, 17] reported that increase in number and activities of soil microorganism as result of various soil management affect to the improvement of availability of some nutrients (N, P, and K).
Table 5. Single Effect of various active powder application to total nitrogen content (%)

| Dosage (g/ha) | Before application | After application | Changeable |
|---------------|--------------------|------------------|------------|
| 0             | 0,067              | 0,57 a           | 0,51 a     |
| 100           | 0,067              | 0,65 bc          | 0,58 ab    |
| 200           | 0,067              | 0,66 c           | 0,59 b     |
| 300           | 0,067              | 0,71 c           | 0,64 b     |
| LSD 5%        |                    | 0,07             | 0,08       |

The number followed by the same letter at the same column means not significantly different at LSD 5% level.

Table 6. 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 application | 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 |

The number followed by the same letter at the same column means not significantly different at LSD 5% level.

3.4. Available phosphorus (ppm)

The result analysis variant showed that there was an interaction effect of dosage and type of soil to available phosphorus. Further analysis by LSD 5% level showed that all dosage active powder application on Alfisol resulted in a higher content of available phosphorus compare to Vertisol. (Table 7). There are mainly due to a higher content of Nitrogen on Vertisol suppress the amount of phosphorus in the Vertisol, instead of low content of nitrogen increase available phosphorus on Alfisol. Meanwhile, both types of soils have a high content of available Phosphorus applied by 300 g/ha of powder active. These results showed that there is a significant correlation between improving the availability of some nutrients with the increased number of soil microorganism, and improvement of porosities and aeration of soil [10, 13].

Table 7. The Effect of dosage active powder application interacted type of soil on available Phosphorus content (ppm)

| Type of soil/ dosage (g/ha) | 300 | 200 | 100 | 0    |
|-----------------------------|-----|-----|-----|------|
| Vertisol                    | 16,09 b | 15,88 ab | 15,422 ab | 14,81 a |
| Alfisol                     | 22,71 b | 21,64 ab | 20,38 ab | 19,427 a |

The number that followed by the same small letter at the same row and capital letter at the same columns means not significantly different at LSD 5% level.

3.5. Potassium content (me/100 g)

The result of the research showed that there was no interaction effect of the treatments. However, the application of 200 – 300 g/ha of active powder increased the Potassium content of both types of soil significantly. Meanwhile, the Potassium content of Vertisol increased higher than Alfisol (Table 8). All the results showed that improvement of the physical characteristic of the soil governs directly to nutrients content of the soil. A better soil porosity provides an increased in the number of soil-microorganism. Their activities stimulate an increase in exchangeable cation capacity and availability of nutrients.
Table 8. Single Effect of active powder application and type of soil to the Potassium content of the soil (me/100g)

| Dosage (g/ha) | Before application | After application | Exchangeable |
|---------------|--------------------|-------------------|--------------|
|               | 0.66               | 0.69 a            | 0.0 a        |
| 0             |                    |                   |              |
| 100           | 0.66               | 0.99 b            | 0.3 a        |
| 200           | 0.66               | 1.07 bc           | 0.4 b        |
| 300           | 0.66               | 1.16 c            | 0.5 b        |
| LSD 5%        |                    | 0.11              | 0.11         |
| Vertisol      | 1.21               | 1.20 b            | -0.02a       |
| Alfisol       | 0.11               | 0.75 a            | 0.65 b       |
| LSD 5%        |                    | 0.08              | 0.05         |

The number followed by the same letter at the same column at the different single variable of dosage and type of soil means not significantly different at LSD 5% level.

Table 9. Potassium content (me/100g) affected by various time application of powder active

| Time application of powder | Potassium Content of soil (me/100g) | Changeable of potassium content |
|----------------------------|-------------------------------------|---------------------------------|
| Same time on the plantation| 0.91                                | 1.065 b                         |
| A week before plantation   | 0.91                                | 0.965 a                         |
| Two weeks before plantation| 0.91                                | 0.960 a                         |
| LSD 5%                     | 0.15                                | 0.114                           |

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

Meanwhile, a single variable of time application showed that the application same time on plantation resulted in a higher Potassium content (me/100g) compared to other time applications of powder active (Table 9). It showed that early application of active powder might early improve soil environmental conditions resulted in improvements in soil microorganism activities, physical and chemical characteristics of the soil.

Some studies reported that soil microorganism activities increase gradually on well soil aeration, suitable pH, enough some nutrients, enough oxygen, and well available of carbon as a source of their energy [17, 6, 14].

3.6. Organic content (%)

The result of the research showed that there was no interaction effect on C organic content. However, a single factor type of soil affected significantly to C organic content. It showed that increasing in C organic content of Alfisol was higher than Vertisol. It is mainly due to Vertisol has a high clay textured soil than Alfisol. Also, increasing in Nitrogen content affected by active powder application could effect to decreasing in C organic content (Table 10). Several studies showed that physical characteristics of soil (texture, structure, aeration, bulk density) and chemicals characteristics of soil (Total N content) relate closely to C organic content. High clay textured soil such as Vertisol has a low C organic content, and a high content of N on Vertisol will suppress the organic content as reported by [7, 10].
Table 10. 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 | Exchangeable of organic content |
|-----------|---------------------------------------------------------------|--------------------------------|
|           | Before application                                            | After application              |
| Vertisol  | 1.42 a                                                        | 1.63 a                         |
| Alfisol   | 1.85 b                                                        | 2.42 b                         |
| LSD 5%    | 0.37                                                          | 0.37                           |

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

3.7. The yield of mungbean (g/6m$^2$)

The result of the research showed that the yield of mungbean was significantly affected by a single factor of the dosage application of active powder (Table 11). Application of 200-300 g/ha active powder provided a higher yield of mungbean (g/6m$^2$) compared to no application of active powder. Application active powder on the same age plantation resulted in a higher yield of mungbean (g/6m$^2$) compared to application a week and two weeks before plantation. Moreover, the yield of mungbean on Vertisol was higher than the yield of mungbean on Alfisol. All these results mainly due improvement of physical characteristic and chemical characteristic of the Vertisol after application of active powder better than Alfisol as reported by [4, 5, 7, 14].

Table 11. Single Effect of active powder application and type of soil to yield of mungbean (g/6m$^2$)

| Dosage (g/ha) | Before application | After application of active powder |
|--------------|--------------------|-----------------------------------|
| 0            | 0                  | 166.38 a                          |
| 100          | 0                  | 170.50 ab                         |
| 200          | 0                  | 201.88 b                          |
| 300          | 0                  | 225.38 b                          |
| LSD 5%       |                    | 35.19                             |

The number followed by the same letter at the same column means not significantly different at LSD 5% level.

Table 12. Single Effect time application of active powder and type of soil to yield of mungbean (g/6m$^2$)

| Soil Type | Yield of mungbean (g/6 m$^2$) | Various time application of powder active | The yield of mungbean (g/6 m$^2$) |
|-----------|--------------------------------|------------------------------------------|-----------------------------------|
| Alfisol   | 160 a                          | Same time on the plantation              | 126 b                             |
| Vertisol  | 184 b                          | A week before plantation                 | 119 ab                            |
| LSD5%     | 0.13                           | Two weeks before plantation              | 108 a                             |

The number followed by the same letter at the same column means not significantly different at LSD 5% level.

4. Conclusion

It can be concluded that the application of active powder significantly affects the improvement of the physical and chemical characteristics of Vertisol and Alfisol. Application 300 g/ha of active powder resulted in a better physical and chemical characteristic of Vertisol and Alfisol in which Vertisol is much more better than Alfisol. Moreover, The best time application of powder active is on the same time plantation followed by a week and two weeks before plantation.
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