Study of tricho-compost and rice husk biochar applications to development of Phytophthora late blight diseases and yields of potato plants

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Abstract. Increasing crop productivity can do through improved cultivation technology by utilizing agricultural waste. This study aims to determine the development of Phytophthora late blight diseases and yields of potato crops through the applications of tricho-compost and rice husk biochar. Tricho-compost and biochar application on agriculture has benefits to improving soil quality, enhance crop yield, also reduce carbon and mitigate green house gas emission. Potato varieties used are Granola. Beds covered with plastic mulch, fertilizing using NPK according to recommendations, weeding weeds according to conditions, controlling pests and diseases based on Integrated Pest Control. The difference in technological treatment studied was 1) tricho-compost 10 tons/ha, 2) tricho-compost 10 tons/ha + rice husk biochar 1 ton/ha, 3) tricho-compost 10 tons/ha + rice husk biochar 2 tons/ha, and control (farmer technology without tricho-compost and without rice husk biochar). The environmental design used was a Randomized Block Design (RBD) with 7 replications. Data were analyzed by The F test and further tests used with Duncan. Results showed that the intensity of Phytophthora leaf diseases was lower in potato fields with tricho-compost and rice husk biochar applications. Application of tricho-compost + rice husk biochar 2 tons/ha can increase potato productivity to 27 tons/ha (28.6% higher than farmer technology), and improve the quality of potato tubers, especially XL tubers.

1. Introduction
Potatoes (Solanum tuberosum L.) was an important horticultural commodity in Indonesia. Potato commodity was one of the sources of carbohydrates, calories, minerals and proteins in supporting food diversification programs and has the potential as a non-oil export commodity and industrial raw materials. Demand for potatoes tend to continue to increase along with the increase in population, awareness to consume vegetables as a source of nutrition and changes in dietary patterns, especially for the upper middle class. Currently, the potato processing industry was also growing rapidly in line with the increasing welfare of the city and lifestyle changes. These industries required very large quantities of potato raw material [1].

Generally, in potato horticulture commodities, the farmers used high chemical inputs (fertilizers and pesticides) in order to get the best crops. Potatoes required considerable inorganic fertilizers such as Urea 300 kg/ha and Potassium 200 kg/ha for growth and development to obtain maximum production. The use of synthetic fertilizers can indeed increase some types of nutrients but interfere with the absorption of other nutrients and nutrient balance in the soil. This fertilizer also suppressed the growth
of soil microbes which can reduced humus in the soil [2-3]. Organic tools application needed to improve soil quality and the yields of potato plant. Tricho-compost and biochar was organic matters proven by several studies as compromising tools to achieve the purpose [4-5].

Kerinci Regency has the prospect of developing agricultural commodities because it has suitable geographical potential for agricultural commodities, especially for horticulture crops namely vegetables. Kayu Aro District was an area which was suitable for potato cultivation in Kerinci Regency because most of the area have an altitude of > 1.000 m above sea level. This area in agroecosystem was indeed suitable as a center for potato production which was a plateau and was located at an altitude of 1.483 m above sea level with an average rainfall of 1.500-2.000 mm year-1. Soil characteristics were the type of andosol soil with a crumbly and black soil texture, and the soil has normal acidity with a soil pH of 5.5 to 6.5 [6].

Potatoes were the main leading horticultural commodity in Kerinci Regency, Jambi Province. The area of potato cultivation in Kerinci was around 3.451 ha with a production of around 67,896 tons and productivity of around 16.68 tons/ha [7]. The potato plantation area was one of the largest area in Sumatera and was very suitable for the development of this commodity. The majority of farmers in Kayu Aro District were trying potato farming with Granola varieties. This variety was in the Decree of the Minister of Agriculture No. 444/Kpts/TP240/6/1993 which have a production potential reached 26.500 kg/ha. The productivity of potatoes in Jambi Province in 2013 only reached 16.68 tons/ha [8]. The level of production and productivity of potatoes in Kayu Aro District, Kerinci Regency also decreased. Currently, from the results of observations in the field, it was known that potato productivity in Kayu Aro District was below 10 to 15 tons/ha. Potato production was still far from the expected production potential. Potato production can increase significantly if there were no major obstacles faced by potato farmers in Kerinci Regency, such as: lack of location-specific superior seeds, high intensity of disease attacks and pesticide use. Disruption of population suppressive factors for pest populations would also be an increasing factor in the occurrence of plants disturbing organisms attacks.

Field observations and interviews with farmers showed that in addition to the availability of seeds, the soil conditions in the vegetable plantations of Kayu Aro Subdistrict had experienced saturation of fertilizers and pesticides. This condition was due to the application of chemicals through unbalanced fertilization and pesticides, also conservation cultivation patterns that were not carried out by farmers, consequently, the potato productivity decreased and can even cause crop failure. The genetic potential of a plant can appear optimally if the high yielding varieties used were followed by technological innovations in the cultivation and integrated pest management. Phytophthora late blight deseases was the mayor problem at potato production in Kerinci Regency. Diseases control management that was environmentally friendly and environmental recovery with rice husk biochar was expected to increase productivity of potato in KayuAro District, Kerinci Regency. This study was highly needed by the Kerinci Regency Government in increasing potato productivity in Kerinci Regency in general and KayuAro District in particular. The purpose of this study was to determine the development of late blight disease and yield of potato plants that were treated with rice husk biochar.

2. Materials and Methods
The study was conducted on potato plantation at Kayu Aro District, Kerinci Regency, Jambi Province. The research was started from January to December 2016. The materials used were: potato seeds of G3 Granola varieties, Tricho-compost fertilizer, NPK Mutiara fertilizer, as well as organic pesticides and chemical pesticides for pest and plant disease control, and rice husk biochar. The treatments of technology studied were: a. Control (using technology of the farmers' method), b. Tricho-compost(application of 10 tons/ha tricho-compost), c. Application of 10 tons/ha tricho-compost + 1 ton/ha rice husk biochar, d. Application of 10 tons/ha tricho-compost ) + 2 tons/ha rice husk biochar.

The experimental design used was a completely randomized design with 7 replications. The initial tillage was conducted by using a mini tractor, and then the mounds were made by using hoes which in accordance with the treatment. Each experimental unit was represented by a mound unit which was also
a test. Each mound was covered with plastic mulch after the application of all treatments. Tricho-compost fertilizer was given according to the treatment. In each planting hole, one potato seed was planted. The spacing used was 60 cm between rows and 30 cm between seeds in one mound. Fertilizing according to the recommended dosage was given in a circle around the potato seedlings. After giving the basic fertilizer, the potato seeds were covered with topsoil. Weeding was done twice in two months after planting. Pest and disease control was carried out by using biological pesticides and/or vegetable pesticides according to the level of attack, if the attack was very high and passed the economic threshold, recommended pesticides were used.

Observation of the intensity of disease attacks was done by calculating the number of attacked plants divided by the number of plants observed multiplied by 100%. Observations also detected the attack symptoms and types of pests found. Observations to measure the intensity of Phytophthora infestans attacks were carried out by a scoring system 1-9 [9] in table 1.

| Score | Percentage of leaves attacked | Descriptions                          |
|-------|-------------------------------|---------------------------------------|
| 0     | 0                             | No symptoms of an attack               |
| 1     | < 10                          | Attack spots are less than 10% in leaves |
| 2     | 11–25                         | Spots of damage began to appear and reached 25% |
| 3     | 26-40                         | Spots of damage to all leaves reach 40% but the plants are still green |
| 4     | 41-60                         | Maximum damage has reached 60%        |
| 5     | 61-70                         | Maximum damage has reached 70% and the plants changed colour into brown |
| 6     | 71-80                         | Maximum damage has reached 80%, the base of the stem and shoots are attacked and the symptoms of wither and death |
| 7     | 81-90                         | Maximum damage reaches 90%, the green part is only the top of the leaf |
| 8     | > 90                          | The green area is low                 |
| 9     | 100                           | There are no more green leaves, the damage is complete |

The sample plants used were 10 plants in each treatment. Harvesting was done after the plants were 90-100 days old of after planting, with the criterion of dried stems and leaves, and if the potato tubers were rubbed to one another, the tuber skin would not fall. Data collected during this harvest were the number and weight of potato tuber in each treatment. Data collected would be processed and analyzed statistically by using analysis of variance (Analysis of Variance) and followed by further tests using Duncan (DMRT) or other tests at the level of 5% to investigate the differences between treatments.

3. Results and Discussion

3.1. The Attack Intensity of Phytophthora Late Blight Diseases

The application of tricho-compost and rice husk biochar affects the attack intensity of Phytophthora late blight diseases on potato plants. The attack intensity of Phytophthora late blight diseases significantly different and lower than without rice husk biochar application at 4, 8, 10 weeks after planting (Fig. 1). The development of Phytophthora late blight diseases higher at without tricho-compost and rice husk biochar application at 8 weeks after planting (>40%) and 10 week after planting (>80%).
application of tricho-compost and rice husk biochar 2 tons/ha showed the attack intensity of *Phytophthora* late blight diseases lower than other application, but not significantly different from the application of tricho-compost and rice husk biochar 1 ton/ha at 4 and 10 weeks after planting.

**Figure 1.** The attack intensity development of *Phytophthora* late blight diseases on potato plants with the application of tricho-compost and rice husk biochar. Bars followed by the same letters was insignificantly different based on DMRT at significance level of 5%.

This study has shown that the application of tricho-compost and rice husk biochar can reduce the intensity of *Phytophthora* leaf blight disease. The application of coconut shell biochar and biocompost granules and liquid formulations can stimulate soybean plant growth and can reduce the development of wilt disease. This showed biochar was useful for plant resistance against disease attacks [10].

In this study, control of *Phytophthora* leaf blight disease has used chemical control (fungicide use) and based on the level of attack. The frequency of control decreases with the lower intensity of disease attacks, resulting in reduced use of chemicals on the land. Reducing the frequency of spraying with pesticides up to 25% compared to without tricho-compost and rice husk biochar.

3.2. **Yields of Potato Plant**

The application of tricho-compost and rice husk biochar affects the quality of potato tubers (Fig. 2). The application of tricho-compost and rice husk biochar or only tricho-compost produced XL and L potato tubers quality. Without application of tricho-compost and rice husk biochar produced potato tuber with M and S quality. The application of tricho-compost and rice husk biochar 1 and 2 tons/ha showed the number of XL and L potato tubers quality more and significantly different than without tricho-compost.
and rice husk biochar. The S quality potato tubers produced and significantly different from all other applications. These results agree with those reported by Youseef [11] who found that total yield of potato cultivar increased about 31.76 % with increasing biochar application rate at 5 m³ fed⁻¹. Those report showed that yield improvement as well as increased on plant growth (plant height, number of main stems, leaves and tuber, leaf area), also photosynthetic pigments and mineral contents of leaf.

**Figure 2.** Number of Potato tubersat kinds of potato yield quality on several application of tricho-compost and biochar. Bars followed by the same letters was insignificantly different based on DMRT at significance level of 5%. Symbols of S, M, L and XL indicated the tuber quality based on tuber size.

The application of tricho-compost and rice husk biochar 2 tons/ha have produced the highest tuber weight and were significantly different from other applications (tricho-compost and rice husk biochar 1 ton/ha, tricho-compost, without tricho-compost and rice husk biochar). The application of tricho-compost and rice husk biochar 2 tons/ha have produced tuber weights of up to 27 tons/ha (Figure 3). Biochar is an organic material that can increase soil CEC (Cation Exchange Capacity) [12-13] so that it can increase nutrient availability for plants. The mechanism is supported by a high load density on biochar particles and a wider surface of the biochar particles that is capable of absorbing cations [14].

Improvements in soil fertility due to the addition of biochar are evident from several results including increases in soil pH, organic C, N-total, P-available, and K-exchange in ultisol soils [15]. The results of the research by Wibowo [16] show that the application of biochar reduces N-total soil lost due to leaching. This can occur because biochar increases soil water retention. The results of this study indicate an increase in organic C, N, P, and K with the application of biochar as much as 2 tons/ha (Table 2).
Figure 3. Potato productivity (ton/ha) with several tricho-compost and rice husk biochar applications.

Table 2. Results of soil analysis before and after tricho-compost and rice husk biochar application.

| Types of Analysis          | Before of tricho-compost and rice husk biochar applications | After of tricho-compost and rice husk biochar applications |
|----------------------------|-----------------------------------------------------------|----------------------------------------------------------|
|                            | K1                          | K2                          | K3                          | K4                          |
| N-total (%)                | 0.16                        | 0.31                        | 0.31                        | 0.31                        | 0.36                        |
| C-Organic (%)              | 2.68                        | 5.49                        | 5.32                        | 5.84                        | 6.15                        |
| P-available (ppm)          | 51.86                       | 14.71                       | 14.11                       | 15.16                       | 14.71                       |
| K Cmol(+)/Kg               | 1.48                        | 1.45                        | 1.75                        | 2.07                        | 2.62                        |
| pH H2O                     | 4.8                         | 5.1                         | 5.2                         | 5.3                         | 5.9                         |

K1 = without tricho-compost and rice husk biochar, K2 = tricho-compost, K3 = tricho-compost and rice husk biochar 1 ton/ha, K4 = tricho-compost and rice husk biochar 2 tons/ha

Increasing soil fertility with the application of biochar is useful to increase availability of cations on plant root zone. Those results of research by Saputra and Juanda [17] showed that the application of biochar and NPK fertilizer increased the weight of potato tubers.

4. Conclusion
The intensity of Phytophthora late blight diseases lower in the potato fields with tricho-compost and rice husk biochar application. The tricho-compost and rice husk biochar application of 2 tons/ha can increase potato productivity to 27 tons/ha (28.6%), and improve the quality of potato tuber yields (especially XL quality) and soil fertility. Biochar application could reduced chemical inputs on potato cultivation, affected on supporting eco friendly farming.

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