Utilization of \textit{Trichoderma viride} as organic fertilizer to induce the resistance of banana seeds on \textit{Fusarium oxysporum f.sp cubense} (FOC)

S H Wahyuni* and D P Y Nasution

Department of Agricultural, Universitas Graha Nusantara Padangsidimpuan
Kampus I Tor Simarsayang Padangsidimpuan 22712.

Email: *sitihardiantiw@yahoo.com

Abstract. Utilization of Trichoderma viride as Organic Fertilizer to Induce the Resistance of Banana Seeds to \textit{Fusarium oxysporum f.sp cubense} (Foc). This study aimed to find out the type of organic material that is able to suppress Foc. and knowing the macronutrient value of organic matter decomposed by \textit{Trichoderma viride}. This research was carried out on the field of the Faculty of Agriculture, Graha Nusantara Padangsidimpuan University, from February to August 2018. The treatment of research are control, Cow manure without decomposition by T. viride, Cow manure was decomposed by T. viride, Chicken manure without decomposition by T. viride, and Chicken manure was decomposed by T. viride. The results showed that compost with the addition of decomposer Trichoderma viride can suppress Foc growth and can increase the nutrient value of N, P, K compost organic matter.

1. Introduction

Banana fruit is popular with many people, because it tastes good, and can be used as Indonesia's mainstay commodity. But in reality, the high production of bananas cannot be part of the source of state revenue. This was demonstrated in 2014, the export volume of banana reached 5.177 million tons and after that it decreased to 0.14 million tons in 2015 [1].

One of the obstacles that must be faced in the effort to increase banana production in Indonesia is the disturbance of plant pest organisms. One of the important pests in banana plants is \textit{Fusarium oxysporum f.sp cubense} (Foc) [2]. This fungus is one of the pathogens that are soil-borne, this pathogen can cause fusarium wilt in banana plants. Foc infects through lateral roots or short root branches, then penetrates the transport network and develops broadly in the xylem. Fusarium wilt caused by Foc fungus is fatal and attacks plants at various stages of growth, both when the plants are still in the form of seeds or near the time of harvest. Once attacked, infected plants cannot be saved again, and belong to a very detrimental group [3].

This fungus is naturally a parasite that attacks many types of fungi that cause plant diseases (broad control spectrum). Trichoderma spp. can be hyperparasite in some types of fungi that cause plant diseases, its growth is very fast and does not become a disease for high-level plants. Mechanism of Trichoderma spp. towards the host, namely in the form of competition for life, parasitism, antibiosis, and lysis [4].
Some results of previous studies prove that *Trichoderma* isolates have different abilities in suppressing the growth of pathogenic fungi [2]. A total of 33 *Trichoderma* spp isolates from banana plant rhizosphere in several production centers in West Sumatra, three isolates were effective in suppressing Foc growth both in vitro and in planta. The three isolates were able to increase chitinase enzyme activity in the roots and leaves of banana seedlings and have the potential to be developed for the control of *Fusarium* wilt disease in banana plants. Furthermore, reported that *Trichoderma viride* was able to colonize banana roots and is endophytic in banana root tissue and could reduce the rate of *Fusarium* wilt disease by 93.33%. *Trichoderma* spp antagonism mechanism against pathogenic fungi carried out by removing toxins in the form of the enzyme β-1,3 glucanase, chitinase, and cellulase which can inhibit growth and even kill pathogens. *Trichoderma* spp antagonistic properties can be used as an alternative in controlling pathogens that are environmentally friendly [2-4].

2. Materials and Methods

2.1. Experimental design

This research was carried out in the field of the Faculty of Agriculture, University of Graha Nusantara Padangsidimpuan. This research starts from February to July 2018. The treatment of research are control, Cow manure without decomposition by *T. viride*, Cow manure was decomposed by *T. viride*, Chicken manure without decomposition by *T. viride*, and Chicken manure was decomposed by *T. viride*. Procedure research was Isolation of *Trichoderma viride*, Propagation inoculum of *Fusarium oxysporum* f.sp cubense (Foc), Organic Material Preparation, Composting (*T.viride* decomposition with chicken and cow dung), Soil sterilization and application of organic matter decomposed by *Trichoderma viride*, Planting banana seeds, and Inoculation of *Fusarium oxysporum* f.sp cubense (Foc).

2.2. Percentage of affected leaves

The percentage of stricken leaves was observed by counting the number of symptomatic leaves. Observations began 1 day after Foc inoculation. The percentage of affected leaves is calculated by:

\[ Pd = \frac{c}{d} \times 100 \]  

Information:
- \( Pd \) = Percentage of affected leaves
- \( c \) = Number of plant symptomatic leaves
- \( d \) = The total number of leaves of the crop

2.3. Macro nutrient testing

Nutrient testing was conducted at the Laboratory of Soil Science, Faculty of Agriculture, Andalas University, Padang, West Sumatra.

3. Results and Discussion

3.1. Percentage of affected leaves

The results of the analysis of variance in the percentage of infected leaves in banana seedlings treated with various types of decomposed organic matter *T. viride* can be seen in the results of further tests in Table 1.

Table 1 shows that the lowest percentage of banana infected with Foc was found in compost treatment of cow manure which was decomposed by *T. viride* which was 62.51%. While the highest percentage of infected leaves was 72.43% control and showed no significant different with other treatments.

Compost of cow manure decomposed by decomposition by *T. viride* was also able to reduce the percentage of infected leaves in banana seedlings (Table 1), but it was not able to suppress the damage
of hump. The lack of ability of\textit{T. viride} in reducing the percentage of infected leaves and damage to the hump in banana seedlings is due to the low population of \textit{T. viride} after being applied to the rhizosphere of banana seeds. Nutrients and pH of organic matter are very influential on the development of \textit{T. viride} in organic matter and soil. Nutrients contained in organic matter, environmental conditions and the presence of competition between microorganisms in the soil affect the growth of microorganisms to obtain nutrients and energy. Each microbe has a different ability to obtain nutrients. Various soil factors such as soil type (soil texture, cation exchange capacity, organic matter content, pH), soil moisture content and presence of soil microflora affected the persistence of fungi in the soil [1].

Table 1. Percentage of leaves attacked by Fusarium oxysporum f.sp.cubense in banana seedlings treated with organic matter

| Treatment                                      | Percentage of leaves Attacked (%) |
|------------------------------------------------|----------------------------------|
| Control                                        | 72.43 a*                         |
| Cow manure without decomposition by \textit{T. viride} | 72.43 a*                         |
| Cow manure is decomposed by \textit{T. viride}   | 67.63 ab*                        |
| Chicken manure without decomposition by \textit{T. viride} | 63.67 ab*                        |
| Chicken manure was decomposed by \textit{T. viride} | 62.51 ab*                        |

*The numbers followed by the same lowercase letters in the same column show no significant difference between the treatments at the 5% level according to the Tukey test

3.2. Macro nutrient testing
Nutrients in compost determine the quality of compost. The results of the analysis of compost nutrient content analyzed in the laboratory include N-total, total P, total K, and C/N ratio (Table 1).

3.3. N, P, K total

Table 2. Result of parameters in each treatment

| Parameter       | Unit | SNI   | Control | A1\textsuperscript{a} | A2\textsuperscript{b} | A3\textsuperscript{c} | A4\textsuperscript{d} |
|-----------------|------|-------|---------|-----------------------|-----------------------|-----------------------|-----------------------|
| C-Organic       | %    | 9.80-32 | 29.83   | 30.18                 | 45.12                 | 45.57                 | 45.70                 |
| B-Organic       | %    | 27-58  | 95.64   | 77.36                 | 90.14                 | 90.90                 | 91.03                 |
| C/N ratio       | %    | 10-20  | 27.79   | 13.32                 | 12.36                 | 15.54                 | 11.13                 |
| N-Total         | %    | 0.40   | 2.53    | 2.37                  | 2.60                  | 3.16                  | 3.55                  |
| P-Total         | %    | 0.10   | 2.61    | 2.37                  | 3.20                  | 3.18                  | 3.46                  |
| K-Total         | %    | 0.20   | 1.18    | 1.13                  | 1.29                  | 1.13                  | 1.58                  |

\textsuperscript{a}A1 = Cow manure without decomposition by \textit{T. viride}
\textsuperscript{b}A2 = Cow manure is decomposed by \textit{T. viride}
\textsuperscript{c}A3 = Chicken manure without decomposition by \textit{T. viride}
\textsuperscript{d}A4 = Chicken manure was decomposed by \textit{T. viride}
From the results of laboratory tests it was obtained the results that the treatments of A1, A2, A3 and A4 have good nutrient content. However, when compared with the SNI compost standard, A1, A2 and A3 compost treatments meet the SNI compost standard for all parameters while the A1 treatment does not meet the standard for N, P, K Total parameters while for Organic B, C-Organic and C/N ratio meet SNI standards (Table 2).

The treatment of A1, A2, A3, A4 with decomposer and without decomposition of T.viride has the largest N content, namely in the treatment that is equal to 3.55%, while A1 has an N content of 2.37%. Based on this value, the compost produced has fulfilled the N content according to SNI compost which is > 0.40%. The treatment of A4 has a higher P content, which is 3.46% while A1 has a content of 2.37%. Based on this value, the compost produced has met the P content according to SNI compost, namely > 0.10%. This is presumably because chicken manure and cow dung have been decomposed in advance so that microorganisms in the compost work optimally compared to controls or those without decomposed T.viride. Control and treatment without decomposing organic matter showed no increase in N, P, K because T. viride had not developed well in the organic material, because the organic material used was not sterilized and it was thought that the organic matter had been colonized by microorganisms in organic matter so that T. viride is less able to grow and develop on the organic material used.

The results showed that the organic matter of chicken manure could increase N, P, K compared to cow dung. This happens because chicken manure is relatively decomposed faster and has sufficient nutrient levels compared to the same number of units as other manure. The results of the study also state that the use of Trichoderma sp as a biological agent that helps degrade organic matter so that more nutrients are available for plant growth. The potential of Trichoderma sp with chicken manure has the highest value in producing plant height. Selanjuntnya, the biological agent Trichoderma sp can decompose lignin, cellulose, and kithin from organic matter into nutrients that are readily absorbed by plants [3,5,6].

The treatment of A4 has a higher K content, which is 1.58 ppm, while A1 has a K content of 0.13 ppm. Based on this value, the compost produced does not meet the K content according to SNI compost which is > 0.20%. This is presumably the provision of compost Trichoderma sp. has not been able to increase the nutrients contained in compost. Increased compost storage time will cause higher nutrient content in compost. These nutrients will be used by plants to carry out their lives, including photosynthesis and respiration.

The response of Trichoderma sp at the beginning of decomposition of compost requires time to multiply itself in organic fertilizer, as well as to act as a decomposer of organic material in providing nutrients for plants. The longer storage of compost and the more microorganisms present in organic fertilizers can help metabolize the soil so that the soil is better able to provide nutrients needed by plants [6,7].

3.4. C/N Ratio
Table 1 shows that the value of the C/N ratio in control is 26.77%, this shows that it still requires a long time to get quality compost. While after composting using decomposer T. viride the value of the C/N ratio has begun to show a decrease in accordance with the storage time, the constituent value has also been in accordance with the SNI standard of 10-20%. If the C/N ratio is high, the biological activity of microorganisms will decrease, it takes several cycles of microorganisms to degrade compost so that it takes a long time for composting and results in lower quality. A high C/N ratio of a material is slower to be converted into compost. Conversely, a low C/N ratio will speed up the composting process [7].

The composting process aims to reduce the value of the organic material C/N ratio, the good C/N value is the C/N compost value which approaches the C/N value of the soil. The principle of composting is to reduce the C/N ratio of organic matter to equal to C/N soil (<20). With the higher C/N material, the composting process will be longer because C/N must be lowered [4]. The C/N ratio is the most important factor in the composting process. This is because the composting process
depends on the activities of microorganisms that require carbon as an energy source and forming cells, and nitrogen to form cells [4]. If the C/N ratio is high, the biological activity of microorganisms will decrease. In addition, several cycles of microorganisms are needed to complete the degradation of compost material so that the composting time will be longer and the resulting compost will have low quality. If the C/N ratio is too low (less 30), the excess nitrogen (N) used by microorganisms cannot be assimilated and will be lost through volatility as ammonia. Plants can not directly use the organic material because the C/N ratio in the material is relatively high or not equal to C/N soil. The value of C/N is the result of a comparison between carbohydrates and nitrogen. The principle of composting is to reduce the C/N ratio of organic matter to the same as C/N soil (<20), the higher the C/N material the composting process will be, the longer it will be due to C/N must be lowered [6].

3.5. C-Organic.
The results showed that C. organic compost from all treatments showed good organic organism in the range A1 = 30.18, A2 = 45.12, A3 = 45.57 and A4 = 45.70. Of the four C. organic treatments that were best found in A4 treatment, which was 45.70 and the lowest was in treatment A1 = 32.18. C-Organic content in all treatment results is high, this is presumably because the material used for compost is the litter that contains lots of organic material where the source of C-Organic is organic material.

The treatment of A4, namely by adding decomposer T. viride with a storage time of 4 weeks is the best among all treatments, this is due to the working power of the fungi in the yeast which decompose organic matter so that it can increase C-organic. Organic materials which are renewable, recyclable, remodeled by soil bacteria become elements that can be used by plants without polluting the soil and water [8]. Organic matter is a collection of various complex organic compounds which are or have undergone a decomposition process, both in the form of humification humus and organic compounds resulting from mineralization and including microbes and muscle-fibers involved and present in them[2].

3.6. Organic matter
The role of organic matter in the availability of nutrients in the soil is inseparable from the process of mineralization which is the final stage of the process of changing organic matter. In the process of mineralization, complete plant nutrients will be released (N, P, K, Ca, Mg and S, and micronutrients) in uncertain quantities and are relatively small. Nutrients N, P and S are nutrients that are relatively more to be released and can be used by plants[5].

Organic matter is a source of energy for macro and soil micro-fauna. The addition of organic matter in the soil will increase the activity and microbiological population in the soil, especially those related to decomposition and mineralization of organic matter. Some microorganisms that play a role in the decomposition of organic matter are fungi, bacteria and actinomycetes[6].

4. Conclusions
Compost with the addition of decomposer Trichoderma viride can suppress Foc growth. Application of organic matter decomposed by T. viride can increase the nutrient value of compost.

References
[1] Arwiyanto 2003 Rustic effects of Tricho-compost of rice straw on growth and production of mustard greens (Brassica juncea. L) (Riau, Laboratory of Soil Science Faculty of Agriculture UNRI) 7
[2] Agus C 2012 Organic Material Management: Role in Life and Environment (Yogyakarta: KP4 and BPFE Press.)
[3] Hartatik and Widowati 2006 Fertilizer Enclosure in: Manure Organic Fertilizer and Biofertilizer (Bogor, Center for Agricultural Land Resources Research and Development Agricultural Research and Development Agency) pp 59-82
Acknowledgments
Authors wishing to acknowledge assistance or encouragement from colleagues, special work by technical staff or financial support from organizations should do so in an unnumbered Acknowledgments section immediately following the last numbered section of the paper.