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Relationship of Soil Physicochemical Properties and Existence of *Phytophthora sp.* in Pineapple Plantations

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A B S T R A C T

One of the tropical fruits with high economic value is pineapple. Pineapple plantation has several limitations, especially in cultivating period and diseases caused by *Phytophthora sp.* (called heart rot disease). The spread of *Phytophthora sp.* in pineapple plantation is influenced by physical of soil (called as soil borne pathogen). Here, the purpose of this study was to examine physical properties of soil (compaction), specifically on heart rot disease in pineapple plantation. We used pineaple farm locating in Central Lampung, Indonesia. In this paper, we analyzed the disease impact from the soil compaction point of view. We investigated the difference between soil samples with and without sick plant. The results showed that the disease area were affected by *Phytophthora sp.* area have high soil compaction. Indeed, this soil condition is good for growing *Phytophthora sp.*

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1. INTRODUCTION

Indonesia is the best country for production fruits and vegetable. (Prasetyo, 2016). One of the fruits with a large area and high production in Indonesia is Pineapple (*Ananas comosus* Merr.). This makes pineapple to be the most important economic plants in the tropic area. Pineapple is grown mainly for fresh, canned fruits and juice. This fruit is also the source of bromelain and enzyme used in pharmaceuticals (Pornsuriya *et al.*, 2008).

In the cultivation process, heart rot symptoms are commonly found in the fields and become major losses in pineapple production. Heart rot is caused by *Phytophthora sp.* (Bortholomew, 2003). Soil-borne disease caused by *Phytophthora sp.* species is serious in the tropics because of frequent heavy rainfall favorable to the spread of sporangia and zoospores as well as a lack of cold temperature in the winter to kill the pathogens (Ann, 1994). Some chemical treatments were typically used to control heart rot disease, but they make soil to be getting worse and insustainable for the future. (Muhammed *et al.*, 2014)

As soil-borne pathogens, soil properties influence the existence of *Phytophthora sp.* (Azcón-Aguilar & Barea, 1997) In this experiment, we investigated effect of soil physicochemical properties on *Phytophthora sp.* in the pineapple plantation. The research of this research can give information how to manage and make policy in the cultivation system of pineapple.

2. MATERIALS AND METHODS

The experiment was conducted Pineapple plantation located in Central Lampung, Lampung Province, Indonesia. The experiment was done with the following three steps; First, field survey and take a soil sample (location was indicated an attack by *Phytophthora sp.* and without *Phytophthora sp.*). Second, analysis of the existence of *Phytophthora sp*p. from the soil sample following Postulate Koch in biotechnology laboratory of the University of Lampung. Third, analysis of soil properties (soil compaction) in soil science laboratory of the University of Lampung. The experiment was conducted from December 2015 to February 2016. The data was collected and tested using a T-test.

3. RESULTS AND DISCUSSION

The survey results showed that the soil are classified as the attacked area by *Phytophthora sp.* based on the symptom of heart rot disease. We found pineapple infected by heart rot disease has the average percentage of 26.85%. Furthermore, in the same location, we took soil for sampling, namely a sick plant (soil Phy) and healthy plant (soil No-Phy).

3.1. Disease Identification

The symptom of heart rot disease in this study is identified by the colour of the heart leaves. Leaves changes to yellow or light coppery brown. Later, the that leaves (causing the leaf edges to roll under) turn into brown and eventually die. Once symptom is detected, young leaves are eassly pulled from the plant, and the basal white leaf tissue at the base of the leaves become water-soaked and rotten with a foul smell. This is due to the invasion of secondary organisms. The growing point of the stem becomes yellowish-brown with a draks line between healthy and diseased areas (**Figure 1**).

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The results of the isolation and identification of the disease from infected leaves of pineapple plants by *Phytophthora sp.*are shown in **Figure 2**. As shown in this figure, images of spores of *Phytophthora sp.* was isolated from leaves pineapple. This result is in a good agreement with other report. (Omane *et al.*, 2012)

3.2. Soil Properties

Compaction is rearrangement of aggregates and primary particles into a state of higher bulk density-and lower porosity when a load (or stress, pressure) is applied to a soil (Allmaras *et al.*, 1988; Fox & Kamprath, 1970). The first impact of compaction is the loss of pore space between aggregates (interaggregate pore space) as the soil volume decreased. The loss of interaggregate pore space has a major effect on water infiltration and drainage, gas exchange and aeration (oxygen diffusion), mechanical resistance to root penetration and proliferation, heat movement, and biological activity of both soilborne pathogens and the host organism (Allmaras *et al*., 1988)

Figure 1. Symptom of heart rot disease caused by *Phytophthora sp.* in pineapple plantation in Indonesia. Figure in the left is the low magnification of picture, whereas figure in the right is the high magnification.

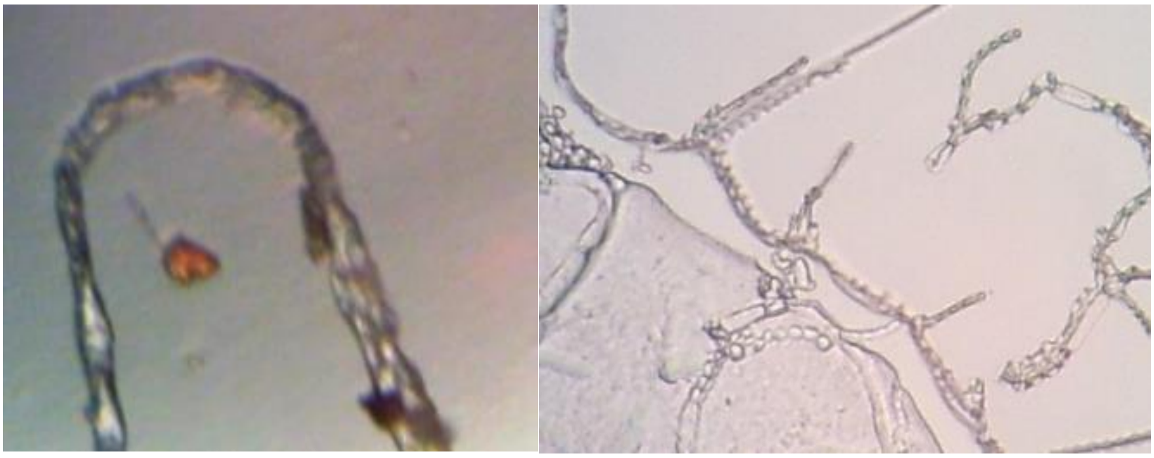

Figure 2. Microscope images of spores (left) and hyphae (right) of *Phytophthora sp.* was isolated from leaves pineapple.

Problems were induced by excessive compaction are runoff, soil erosion, slow infiltration and soil crusting, impaired or delayed internal drainage, decreased soil water storage, shallow and sparse plant rooting, reduced nutrient and water uptake, accelerated denitrification, production of toxic materials due to soil reducing conditions, fewer field days, and more root disease from pathogens such as *Pythium, Phytophtora, Aphanomyces, Fusarium* and *Rhizoctonia* spp. Most of these problems are linked to adverse water relations caused by retarded infiltration, less airfilled pore space, and impeded water movement (Allmaras *et al.*, 1988). Soil compaction alters soil microbial structure and function as a result of the limitation of air permeability and oxygen availability, which has implications for soil nutrition and soil-borne disease (Ishak et. al., 2016).

Results showed that there is an impact from the soil compaction (See **Figure 3**). Soil compaction in a land with an attack by *Phytophthora sp.* is higher than that without *Phytophthora sp.* on T-test. Based on **Figure 3** on T-test, there is no significant difference for the value of the soil compaction at depth 10-50 cm. The tillage is done only to a depth of 50 cm, and the pineapple roots grow to a depth of 50 cm (Gunawan, 2007). However, soil compaction at a depth of 60-70 cm is significantly different. Phy-soil sample has higher soil compaction than that in No-Phy soil sample**.** Thus, when there is a rain, soil in No-Phy condition can infiltrate more water. However, because of soil compaction on soil in Phy-soil, puddle can be promoted. Puddles allow sporangium formation of *Phytophthora sp.* if mycelium soaked by water.

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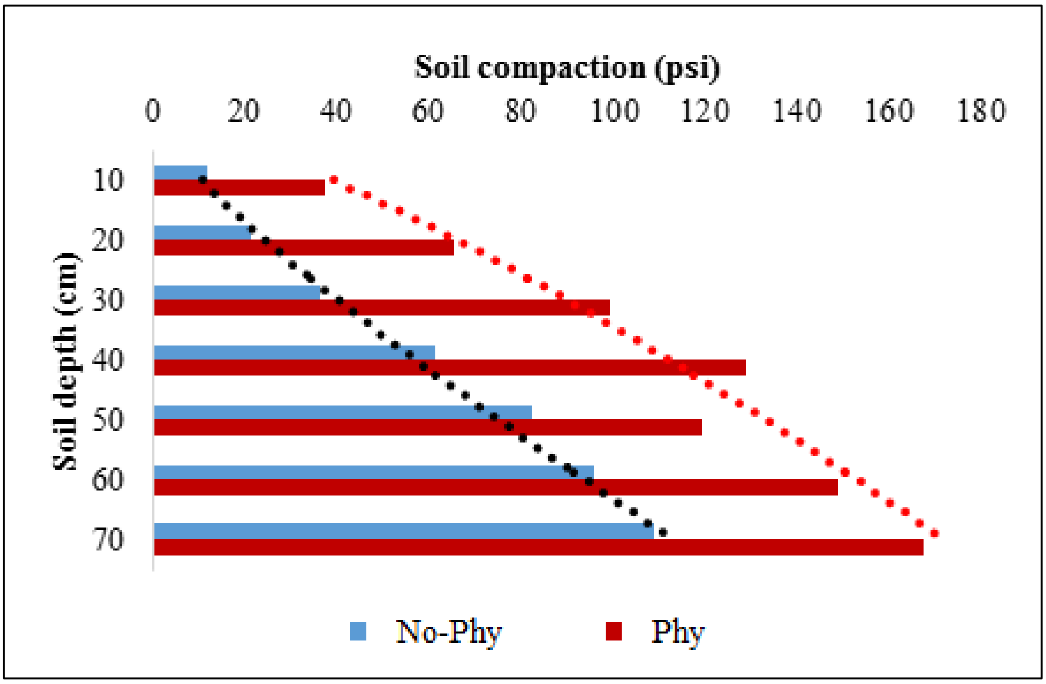

Figure 3. Soil compaction.

Soil No-Phy sample has posibility higher soil porosity than that in Phy-soil sample. Thus, when there is a rain, or irrigation, soil for no-Phy sample can absorb and hold more water than that for Phy-soil sample. Low soil porosity and high soil compaction promote puddle. The rain water will destroy the soil aggregates, while the water will splash the soil particles and are transported by soil surface runoff. This phenomenon is known as erosion (Soepardi, 1983). Erosion carries soil particles or organic materials, which contain structure of *Phytophthora sp.* (Weste & Taylor, 1971). This condition makes *Phytophthora sp.* to spread rapidly in the plantation area. (Weste, 1975)

Excessive soil compaction affects the rate and distribution of root growth, and thus affects the chances of successful host-to-pathogen contact and the dynamics of root-pathogen interactions. For example, poor aeration or axial constraints on root development (such as mechanical resistance) may reduce the rate of root tip advance by as much as 75% and may also induce formation of laterals much closer to the root tip. The result is a more compacted and stressed root system. Exudates produced by elongating and/or stressed roots stimulate dormant fungal pathogen structures (*e.g.* chlamydospores, microsclerotia) to germinate and grow. The overall result is that soilborne pathogens in compacted soils are more likely to intercept young lateral root and obtain sufficient nutrients to infect that root. (Allmaras *et al.*, 1988)

4. CONCLUSIONS

Based on research, we concluded that there is a correlation between soil physicochemical properties and existence of *Phytophthora sp. Phytopthora sp.* can grow with maximum growth rate in high soil compaction. This soil condition support its growth because of its low porosity, low infiltration, and easy to be flooding. This study gives information on how to treat the *Phytophthora sp.* in the plantation.

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6. AUTHORS' NOTE

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article. Authors confirmed that the data and the paper are free of plagiarism.

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