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The Effects of Climate Change on Plant Diseases and Possible Means for Their Mitigation

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Abstract. This paper aimed at explaining the possible effects of climate change on the interaction among environment, plant and pathogen, and proposing possible means for mitigating the effects on plant disease. Based on literature review, it is clear that climate change has direct effects on pathogens, on plant-pathogen interactions, and has indirect effects on microbial interactions. Prolonged periods of environmental conditions (temperature, presipitation and relative humidity) that close to the optimal for the development of the pathogen lead to more severe epidemics. Climate change may directly affect several aspects of the biological of the host plants, including their phenology, sugar and starch contents, nitrogen and phenolic contents, root and shoot biomass, number of size leaves, changes in stomatal densities and conductance and root exudation. Any change of these areas may affect infection and colonization by pathogens. Short-term and long-term changes in the abiotic conditions under which plants are grown may influence not only the growth and the productivity of plants but also the populations of microorganisms living on plant surfaces. Mitigating means for climate _s effects can be among the followings: a comprehensive studies on the impact of climate change on the development of plant pests and diseases are needed as to determine appropriate measures which can be adopted by government and farmers. Better understanding by farmers is required as to adjust cultural practices in their farming systems to the climate changes that take place in their localities. Indigenous knowledge which is the bases for arranging the proper planting time in places like Java can be retrieved as traditionally successful pest management. Bio-intensive IPM which optimize the existing bioresources can be applied seriously which require cooperation among goverment, universities, research centers and all components of civil society

Keywords: climate change, effects, plant pathogens, plant diseases, mitigation.

1. Background

Changes in environmental conditions are intimately associated with differences in the levels of crop yield loss caused by a disease because it significantly affects the environment plants, pathogens and their antagonism. The changes were closely related to global warming (for example an increase in temperature, changes in the quantity and pattern of rainfall, increased CO2, ozone levels, drought, etc). That all may affect the incidence and severity of plant diseases and affect the co-evolution of plants and pathogens (Garrett *et al*., 2006). Environmental conditions such as temperature and relative humidity affect development of diseases cause by Phytophthora spp (Duniway, 1983). This paper tries to explain the possible effects of climate change on the interaction among environment, plant and pathogen, and proposing possible means for mitigating the effects on plant disease.

2. Climate Change's Direct Effects on Pathogens

Environmental factors can directly affect several aspects of the biology of a pathogen. More severe epidemics are the result of optimal condition of prolonged periods of environmental conditions. As temperatures increase, many pathogens will spread into new geographic areas, where they will come into contact with new potential hosts. Pathogen survival in the absence of a host can also be influenced by temperature and relative humidity.

The strongest consequences of global warming are believed to take place in tropical countries like Indonesia because tropical species have narrow temperature growth range and are therefore, relatively vurnerable to changes in temperature. According to Ghini *et al*. (2011), many tropical species are living very close to their optimal temperature conditions. According to Caffara *et al.* (2012) epidemics involving

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polycyclic pathogens are strongly affected by the number of generations of the pathogen within a particular time period. Temperature and moisture govern the rate of reproduction of a number of pathogens. The longer growing seasons which will result from global warming will extend the length of time available for pathogen reproduction and dissemination. Climate change may affect the sexual reproduction of the pathogens thereby increasing the evolutionary potential of invidual populations.

From the concept of disease triangle it is clear that climate change which acts as the physical environmental factor affect strongly a disease development process. The effect of climate factor on pathogen can be towards the life cycle of the pathogen, virulence (ability to infect), infection and pathogen reproduction. According to Garret et al. (2006) and Wiyono (2007) climate change affect a disease development through its effect on genom level, celluler, plant physiological process and pathogen.

3. Climate Change's Direct Effects on Plant-Pathogen Interactions

Climate change may directly influence a number of aspects of the biology of host plants, their phenology, the contents of sugar and starch, the contents of ntrogen and phenolic, biomass and composition of wax on leaves, changes in stomatal densities and conductance and root exudation. Any change in any of the areas may affect the infection and colonization by pathogens.

In contrast, several diseases are less severe when the availability of moisture is limited. Drought can reduce root growth, that reduces the chance which roots will come into contact with propagules of soil-borne pathoghens, decreasing the insidence of infection. Factors that influence plant growth, such as elevated levels of CO2, increased temeperature or drought, may lead to changes in the physiology of host species which will deeply alter the colonization of host tissues by biotrophic pathogens. The stress of physical environment may induce the activation of general defence pathways in plants, that increase resistance, buat also increase vurnerablity of the plants to certain pathogens (Wiyono, 1997; 2007).

4. Climate Change's Indirect Effects on Microbial Interactions

Garret *et al*. (2006) reported that increased levels of CO2 in the atmosphere are expected to have major consequences on carbon cycling and the functioning of a number of ecosystems. The increase of CO2 and temperature levels and nitrogen deposition are important factors influencing soil microbial ecosystem. Therefore, these microbial communities are likely to be affected by climate change.

Changes in abiotic conditions under which plants are grown may affect not only the growth and productivity of these plants but also the populations of microorganisms living on plant surfaces. Changes in the populations of microbia in the phyllosphere may, in turn, influence plant growth and the ability of the plants to withstand aggressive attack by pathogens.

5. Possible Means of Mitigating The Effects of Climate Change

Disease development in a crop plantation is the cumulative effect of a number of factors which affect the host and pathogen. A bit of change in microclimatic conditions will affect the outcome of the plant-pathogen interaction. The relationship of plant-pathogen can also be influenced by microbial populations or control agents. Different climate change will have an effect that differ in different plant-pathogen systems.

A comprehensive studies on the impact of climate change on the development of plant and pests and diseases are needed as to determine appropriate measures which can be adopted by government and farmers. Better understanding by farmers is required as to adjust cultural practices in their farming systems to the climate changes that take place in their localities. Indigenous knowledge which is the bases for arranging the proper planting time in places like Java can be retrieved as traditionally successful pest management. Bio-intensive IPM which optimize the existing bioresources can be applied seriously which require cooperation among goverment, universities, research centers and all components of civil society (Wiyono, 2007).

6. Conclusions

Climate change has direct effects on pathogens, on plant and on plant-pathogen interactions, and has indirect effects on microbial interactions. Prolonged periods of environmental conditions (temperature, presipitation and relative humidity) that close to the optimal for the development of the pathogen lead to more severe epidemics. Climate change may directly affect several aspects of the biological of the host plants, including their phenology, sugar and starch contents, nitrogen and phenolic contents, root and shoot biomass, number of size leaves, changes in stomatal densities and conductance and root exudation. Any change of these areas may affect infection and colonization by pathogens. Short-term and long-term changes in the abiotic conditions under which plants are grown may influence not only the growth and the productivity of plants but also the populations of microorganisms living on plant surfaces. Mitigating means for climate _s effects can be among the followings: a comprehensive studies on the impact of climate change on the development of plant and pests and diseases are needed as to determine appropriate measures which can be adopted by government and farmers. Better understanding by farmers is required as to adjust cultural practices in their farming systrems to the climate changes that take place in their localities. Indigenous knowledge which is the bases for arranging the proper planting time in places like Java can be retrieved as traditionally successful pest management. Bio-intensive IPM which optimize the existing bioresources can be applied seriously which require cooperation among goverment, universities, research centers and all components of civil society.

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