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CLIMATE CHANGE, ENVIRONMENT AND PLANT DISEASES DEVELOPMENT

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ABSTRACT

Climate changes such as global temperature increase has become the topic of international conferences as well as regional scientific meetings including for Indonesian perspective. Climate changes affect environmental conditions in agricultural system, hence affect plant pests and diseases development. Weather components namely air temperature, humidity, soil temperature, rainy spell, wind, irrigation etc do affect the disease development in the plantations. The effect of weather components on its own or in togetherness can be negative in the form of pests and diseases outbreaking at a time of the year. Such effect can be the result of short term, middle term or even long term postponement. Globally, negative impact of climate changes namely weakening the ecosystem components that regulate the balance of plant pests and diseases, weakening the plant resistance and the formation of environmental condition that support the plant pests and diseases development in general.

Keywords: climate changes; environment; plant disease development;

INTRODUCTION

Plant diseases are among the important plant pests which affect the plant production in Indonesia especially for food, horticulture and estate crops. Plant diseases that cause physiological disturbance for plants are namely caused by fungies, bacteria, phytoplasm, virus, viroid, nematod and certain plant specieses. The development of the diseases that are specifically caused by certain pathogen is closely related to climate changes. Not surprising if during rainy seasons the problems of plant diseases can make farmers busy. In paddy plantation, for instance, blast disease is quite common disease. In chilly plantation, antractnose disease is widely found.

Recently, climate changes such as global temperature increase has become the topic of international conferences as well as regional scientific meetings including for Indonesian perspective. Based on the data provided by NASA Goddar Institute for Space Studies (GISS) it was clease that the temperature changes of land surfaces in Indonesia between 1951 and 1980 have increased between 0.5 to 1 Centigrate (Kompas 4 January 2006; Wiyono, 2007). A number of studies tried to prove the relationship of climate changes, environment and the development of plant diseases. For instance, Nurhayati (2009) clearly stated that high temperature at day times affect the insidence of leaf fall disease of rubber tree in the seedling nursery. Rain day pattern and number of rain days also affected the severity of rubber leaf fall diseases as reported by Nurhayati and Situmorang (2008).

Physical environmental factors that influence plant diseases such as previously mentioned including temperature, solar radiation, humidity, irrigation and wind. Each of these factors individually or collectively influence the development of a disease (Table 1).

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Table 1 shows that the factors of temperature, humidity and leaf wetness are very important factors in influencing the development of pathogens and plant diseases. Temperature has an important role in the development of plant diseases in general. Temperature affects plant disease because there are minimum, optimum and maximum temperatures. Disease will experience the fastest growth occurs at optimum temperature, but below or above this temperature becomes hampered its development.

If the temperature minimum, optimum and maximum temperatures for the pathogen with its host plant, then the effect of temperature on the pathogen makes it a very active compared to its host. So even though its host is at its optimum growth conditions remains a serious disorder. This is because the condition is still more active for pathogens in order to survive (Semangun, 2000).

In certain cases a particular disease develops at temperatures below the optimum temperature of the host or pathogen. For example, black root rot disease on tobacco plants caused by *Thielaviosis basicola.* The disease is progressing optimally at temperatures of 17 to 23 ^{o}C, while the optimal temperature for tobacco is 28-29 ^{o}C and for the pathogen is 22-28 ^{o}C. Because tobacco is very weak growth at temperatures far below the optimum, so that pathogens can still attack the plant.

Table 1. Influence of weather factors on the development phase pathogen and plant diseases

Weather factor	phase
Free leaf moisture from rain, dew / fog, irrigation, long a certain temperature in the period	Infection and germination
Old air temperature appropriate and inappropriate, leaf temperature Free leaf moisture, high relative humidity, temperature, light and radiation	Incubation, latent period, and the development of symptoms
Wind speed, temperature, relative humidity, moisture-free leaves, rain or splashes of rain water	Sporulation The spread of spores
Temperature, relative humidity, radiation (UV)	Survival of spores

Source: Rapidly, 1983 *in* Friesland and Schrodter, 1988. Nurhayati. 2006.

Other pathogens are also growing rapidly at temperatures below the optimum temperature of the host and the pathogen. An example of this is on the corn root rot disease by Gibberella zeae. In yet another case of wheat. This disease actually develops a maximum at temperatures above the optimum temperature and pathogen of wheat. In that context, given the corn grow better at high temperatures and the wheat grow better at lower temperatures, the difference in the effect of temperature on the same disease on different host plants was due to host factors. This paper is further aimed at understanding the relationship of climates changes and the development of a number of plant diseases.

RESULT AND DISCUSSION

Climate Changes and Diseases Progression

In Indonesia a real difference in temperature between the lowlands there are only a higher temperature and a temperature plateau is lower where each location has a pattern of disease progression are usually different. As an example of the severity of leaf fall disease of rubber Corynespora. In the rubber plantation is located in a higher temperature lower, despite having an abortion, but attacks are rare plant leaves. State of lower temperature is a factor suspected of

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inhibiting the development of pathogens. Several observations indicate that the weather is humid and cloudy with rainfall evenly distributed throughout the day and 26-29 °C air temperature will help the progression of the disease Corynespora autumn leaves in the field, whereas at temperatures, 30 and 35 °C will be hampered its development. Infection can occur in the temperature range 20-35 °C with optimum temperature 25 ^{o}C. If the air is saturated, the infection can occur without the presence of water (Pawirosoemardjo and Purwantara, 1987; Chee, 1988; Semangun, 2000).

In addition to air temperature, soil temperature was instrumental in the development of disease pathogens live in the soil (soil-borne pathogens). That is why the fungus Rhizoctonia solani and Meloydogyne incognita nematodes invade the host at a critical soil temperature and amount of inoculum lot.

Other environmental physical factors are irrigation. Irrigation affects the progression of the disease through a variety of things. The presence of irrigation can affect the progression of a disease either directly or indirectly. Direct irrigation will cause the plants more susceptible to pathogens. For example infestan Phytophthora fungi attack will be very heavy on the condition of waterlogged crop irrigation. Indirectly the irrigation can lower temperatures and increasing humidity around the plant, allowing more rapid progression of a disease.

Humidity affects the progression of the disease, in the process of infection / penetration, spore germination and dispersion / spread of spores. The source of this moisture may come from rain, irrigation and air relative humidity. Humidity is very influential on the development of disease, because pathogens generally require the presence of a layer of water or moisture to be able to perform certain infection or penetration of the host. Some diseases caused by fungi are in need of a layer of water or kelembababn for sporulation and germination spores, fungi and even some need to release spores.

The presence of free water or relative humidity is dependent on the pathogen needs. Some pathogens require free water / air relative humidity throughout his life but there is also only need it at the beginning of infection and even a few pathogens are not so require wet conditions for its development. Pathogens require free water and high humidity throughout their life cycle include Phytophthora infestan causes late blight disease in potato crops. Some bacteria such as Erwinia and Pseudomonas require wet and humidity is quite high, but there is also a pathogen that requires only the free water and high humidity during the initial penetration only. Soil pathogens such as Rhizoctonia, Sclerotium also require adequate soil moisture is high even though the fungus is not require inundation.

Moisture, either as a relative air humidity as well as free water on leaf surfaces of plants, plays a very important role in plant disease epidemics in general. High humidity will cause the host plant to be succulent and susceptible to pathogens. Humidity greatly affects mainly spore germination and host penetration by germ tubes. Old and level of humidity and leaf wetness affecting spore production, spore germination, growth, and survival of pathogens that would expand the level of pathogen attack (Agrios, 1996).

Some pathogens will result in more severe damage in areas which are quite wet or damp. In such circumstances the development of pathogen race faster. Humidity is very influential on the development biology of C. cassiicola. The release of conidia maximum takes place at about 86% humidity during the day (Radziah et al, 1996). Optimum moisture for germination of spores was> 96-100% or wet leaves, while low humidity <90% will inhibit the germination (Pawirosoemardjo and Purwantara, 1987). According to Liamage (1987) maximum germination takes place at humidity 100%, while the humidity is 50% germination of conidia occurred after 24 hours. Pathogen mycelia grow better in humidity> 95% and its growth will be depressed at humidity <80% (Darwin, 1984). Weather cloudy and humid at night followed by bright sunshine in the morning may stimulate the

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formation of large amounts of conidia on infected leaves of fungi or other pathogens. This situation occurs when continuously can lead to epidemics (Soepena, 1990).

The rain has an important role in the development of epidemic disease epidemic disease generally occurs in the early rainy season due to airborne pathogens require high humidity and leaf wetness for its development. Rain may help to release or spread of pathogens through rain splash and wash the spores of pathogens from plant and soil surfaces. But the rain continued so that the soil becomes too moist can kill or suppress the development of pathogens and vice versa in the dry season the soil becomes dry so that pathogens become dead (Situmorang, 1998; Agrios, 1997). In cases in which spores are on the surface of plants such as leaves, release and spread of the pathogen conidia usually occurs after a rain and no wind, spread much less in the rainy season than dry season (Chee, 1988; Radziah et al., 1996).

Rain is an important factor in influencing the onset of pathogen attack. As in the case of epidemic occurrence of autumn leaves corynespora rubber caused by *C. cassiicola*. In South Sumatra and Lampung in 2004. In the rubber plantations in Lampung Sembawa and autumn leaves Corynespora epidemic will occur if somewhat humid weather conditions (it rained continuously heat).

In areas that have evenly distributed rainfall throughout the year or in areas where the limit of the rainy season and dry season is not so clear, *C. cassiicola* cause severe damage and the plant will molt throughout the year. But in areas with rainy and dry seasons limits clearer pathogen attack also occurred but the plant suffered no damage and no leaves throughout the year. Plants are capable of forming leaves up after a severe attack (Situmorang and Budiman, 1984).

The occurrence of Colletotrichum leaf blast disease in Sumatra in 1973-1974, 1984-1985 Kalimantan, Sumatra and Kalimantan in 1989 and 1993 and 1996/1997 in Southern Sumatra as a result of the long rainy season (Table 2). It generally occurs in young leaf formation period is critical for the pathogen, the presence of persistent rain which led to high humidity or leaf wetness that is in accordance with disease progression.

Light effect on the infection process, sporulation, spore release, as well as the spread of spores. Many pathogens that require a light with certain wave to sporulate and to release spores. Radiation and light have a role for the development of epidemics and biological pathogens. Pathogen life cycle may change with the light and dark period. Infectivity of conidia some pathogens are influenced by light intensity. Ultraviolet (UV) can suppress the development of pathogens within a certain time and can lead to the formation of spores of pathogens.

Wind plays an important role to assist the release and dissemination of conidia. With the wind currents or turbulence pressure conidia are released from the conidiophores. Furthermore, with the wind flow will conidia transported to a distant and dispersed to a wide area. It can be seen that these pathogens are spread across Indonesia and even in different countries around the world. In addition to rotating wind currents or turbulence conidia found on rubber plants are vulnerable or the surface soil can be transported to the plant canopy whose height can reach 13-15 feet.

Wind effect on disease progression through its role in the spread of inoculum. Unleash the wind can spread the fungus spores and insect vectors to great distances, can be up to inter-regional, inter-provincial, inter-country and even between continents. Pathogen spores contained in the air is very dependent on wind speed and direction to be able to find its host. Strong winds can also cause mechanical injury favorable wound pathogens and water borne diseases to infect its host.

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Table 2. Relationship between the occurrence of epidemics of *Colletotrichum gloeosporiodes* with climatic conditions on rubber plantations in South Sumatra from 1970 till 1998

Year	Type of season	Attack conditio
1970-1971	normal	
1972	dry	
1973	wet	Epidemic
1974	wet	Epidemic
1985	wet	Epidemic
1986	wet	Epidemic
1987	normal	
1988	dry	
1989	dry	
1990	wet	Epidemic
1991	normal	
1992	dry	
1993-1994	normal	
1995	dry	
1996	normal	
1997	wet	Epidemic
1998	dry	

Source: Winarso (1992). Situmorang and Budiman (1990).

Gusts of wind are very favorable for pathogens such as fungi that produce spores rather dry where lies its sporophore protrude. The existence of turbulent gusts of wind that can blow the spores spores reach the host plant. Example conidiosphore *Helmintosporium maydis* causes corn leaf blight disease. However, gusts of wind that is too tight is also known to accelerate the drying of plant surfaces so that if there are pathogens that are in the process of infection can derail the process.

Other physical factors that influence the development of a disease is mulching. Effect of mulch is generally against micro climate, and also against pests, diseases and weeds. Organic mulch can reduce soil temperatur during summer in the sub-tropical climates, and raising it during the winter. Such circumstances will be able to influence the progression of a disease. In addition to well known types of organic mulch plastic mulch is colored either black or transparent. Plastic mulch commonly used by farmers in the area of Java to increase the temperature so it is as a means of solarization of soil pathogen-borne pathogens.

CONCLUSION

Climate changes affect environmental conditions in agricultural system, hence affect plant pests and diseases development. Weather components namely air temperature, humidity, soil temperature, rainy spell, wind, irrigation etc do affect the disease development in the plantations. The effect of weather components on its own or in togetherness can be negative in the form of pests and diseases outbreaking at a time of the year. Such effect can be the result of short term, middle term or even long term postponement. Globally, negative impact of climate changes namely weakening the ecosystem components that regulate the balance of plant pests and diseases, weakening the plant resistance and the formation of environmental condition that support the plant pests and diseases development in general.

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