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Popular Article

Effect of climate changes on Plant Diseases

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Introduction

Climate change is a major concern for agricultural communities worldwide. The last decade of the 20th Century and the beginning of the 21st have been the warmest period in the entire global temperature record. It is now recognized that climate change will affect plant diseases together with other components of global change, i.e. anthropogenic processes such as air, water and soil pollution, long-distance introduction of exotic species and urbanization (Regniere, 2012). Climate change is affecting plants in natural and agricultural ecosystems throughout the world (Stern, 2007). Climate change directly affect crops, as well as their interactions with microbial pests (Rosenzweig *et al.*, 2000). Changing weather can induce severe plant disease epidemics (Chakraborty, 2005; Bosch *et al.*, 2007), which threaten food security if they affect staple crops (Anderson *et al.*, 2004) and can damage landscapes if they affect amenity species (Bergot *et al.*,2004).

Effect of climate change on plant diseases

The agricultural process of disease development consists of three main parts: **virulent pathogen**, **susceptible host**, and **favourable environmental conditions**. When these three factors coincide with each other, successful disease development will occur. So, climate change has great effect on all these factors. Climate change is just one of the many ways in which the environment can move in the long term from disease-suppressive to disease-conducive or vice versa (Fuhrer, 2003; Perkins *et al.*, 2011). Longterm datasets on plant disease development under changing environmental conditions are rare (Scherm, 2004), but, when available, can demonstrate the key importance of environmental change for plant health (Fabre *et al*., 2011). Changes in climatic parameters greatly affect crop pests and disease susceptibility which affects crop health, and these changes cause deviations in farming practices to handle this changing situation and to prevent a reduction in productivity.

Diseases are responsible for losses of at least 10% of global food production, representing a threat to food security (Strange & Scott, 2005). It is highly possible that climate change will affect food security at the global, regional, and local levels. Plant health is predicted to generally suffer under climate change through a variety of mechanisms, from accelerated pathogen evolution and shorter incubation periods to enhanced abiotic stress due to mismatches between ecosystems and their climate and the more frequent occurrence of extreme weather events (Sutherst *et al*., 2011).

A major example for the devastating effects of climate change is **flood** caused by rising of sea level. Due to flood many low land areas become disappear under water which leads to major crop losses. Besides this, **drought** or **insufficiencies in water** levels in the soil cause malfunction in plants due to disturbance in their biological functions and even become more susceptible to diseases and pests.

Increases in **temperatures** affecting the occurrence of bacterial diseases such as *Ralstonia solanacearum, Acidovorax avenae* and *Burkholderia glumea*. Thus, bacteria could proliferate in areas where temperature-dependent diseases have not been previously observed (Kudela, 2009). Temperature has potential impacts on plant disease through both the host plant and the pathogen. As for example, wheat and oats become more susceptible to rust diseases with increased temperature; but some forage species become more resistant to fungi with increased temperature (Coakley *et al*., 1999). Many mathematical models that have been useful for forecasting plant disease epidemics are based on increases in pathogen growth and infection within specified temperature ranges.

Changes in temperature, rainfall and other atmospheric conditions, along with predominantly increased CO2 concentration may accelerate the reproduction time of several plant pathogens, thereby increasing their infection pressure on crop plants (Boonekamp, 2012). The geographical distribution of hosts and pathogens will change (Mina *et. al*., 2012) and also modify host–pathogen relationships (Garrett *et.al.*, 2006; Gregory *et al*., 2009; Pedapati *et al*., 2016). Elevated carbon dioxide (ECO2) in association with climate change has the potential to accelerate plant pathogen evolution, which may, in turn, affect virulence. Kobayashi *et.al*., 2006, reported that both rice blast and sheath blight increased when CO2 increased from 365 ppm to 550 ppm. In addition to high disease incidence and

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severity due to changes in host, reproduction and spread of the pathogens has also been reported to increase at high CO_2 levels in barley powdery mildew and anthracnose (Chakraborty *et. al*., 2000)

Forest Plant Diseases and Climate Change

Forest plant diseases are strongly influenced by climate change. Extreme weather, i.e., drought or typhoons, can kill large number of trees directly. Patterns and rates of wood decay, caused by forest fungi, are also change, which will influence forest carbon cycles. Warming, changes in precipitation, and weather extremes are already influencing forest plant diseases in western North America.

As for example, Earlier snow melt exposes shallow fine roots to colder temperatures and results in spring freeze injury that is killing millions of yellow-cedar (*Chamaecyparis nootkatensis*) in Alaska (Hennon and D'Amore, 2007).

In California and Oregon, sudden oak death mortality rates abruptly increase and then subside. The pattern is driven by heavy rains and extended wet weather during warm periods which create optimal infection conditions. Infected trees suffer a reduced capacity to manage water, but survive until high temperatures and extended dry periods overwhelm their vascular capability, resulting in death. Two cycles of this pattern have been noted in California: 1998-2001 and 2005-2008 (Frankel, 2007).

Impact of Climate Change on Disease Management Practices

Change in climate cause alteration in host resistance, efficacy of the pesticides and also change the host-pathogen interaction. Fungicide and bactericide efficacy may change with increased CO_2, moisture, and temperature. The more frequent rainfall events predicted by climate change models could result in farmers finding it difficult to keep residues of contact fungicides on plants, triggering more frequent applications. So, there is a need to integrate findings and insights from the physical and social sciences with knowledge from local farmers and land managers to provide guidance and suggestions to decision-makers for promotion of strategies, including cooperation of both public and private sectors. Besides this, farmers will have to adapt to changing climates in the coming decades by applying a variety of agronomical techniques that already work well under current climates, such as adjusting the timing of planting and harvesting operations, substituting cultivars and wherever necessary modifying or changing altogether their cropping systems. Exclusion of pathogens and quarantines through regulatory means may become more difficult for authorities as unexpected pathogens might appear more frequently on imported crops. Changes in plant growth and development can alter the period of higher susceptibility to pathogens that can determine a new fungicide application (Coakley *et al*., 1999; Chakraborty and Pangga, 2004; Pritchard and Amthor, 2005).

Therefore, some important mitigation strategies for managing plant diseases in respect of climate change include:

• Selection of resistant cultivars/varieties at elevated temperature.

• New molecules with higher efficacy at increased temperature for disease management.

• New forecasting model for prediction of appearance of diseases.

• Change of date of sowing to avoid cause of epidemic.

• Selection of bio-agents having wide range of temperature adoptability.

• Disease management through integration of all the existing technologies.

• Efficient tillage practices for disease management

Conclusion

Changing disease scenarios due to global climate change have highlighted the need for better agricultural practices and use of eco-friendly methods in disease management i.e. shift in seasons, choice of crop management practices based on the existing situation is essential. Integrated disease management strategies should be developed to decrease dependence on fungicides (Gautam and Bhardwaj, 2011). Also, monitoring and early warning systems for forecasting disease epidemics should be developed for important host-pathogens which have a direct bearing on the earnings of farmers and food security at large (Boonekamp, 2012). Use of botanical pesticides and plant-derived soil amendments help in mitigation of climate change, because they help in the reduction of nitrous oxide emission by nitrification inhibitors such as nitrapyrin and dicyandiamide (Pathak *et al*., 2010).

Effect of climate change on plant diseases under field conditions or disease management under climate change is still under research. However, some assessments are now available for a few countries, regions, crops and particular pathogens which concern with food security. There is need to evaluate under climate change the efficacy of current physical, chemical and biological control strategies, including disease-resistant varieties, and to include future climate scenarios in all research aimed at developing new tools and methods. Disease risk analyses based on host–pathogen interactions should be managed and research on host response and adaptation should be conducted to understand how an imminent change in the climate could affect plant diseases.

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