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Potential impacts of climate change on plant pathogens and plant diseases management

Sushila Choudhary1*, Rekha choudhary[2], Vijay Laxmi Yadav[2] and Dilip Chaurasiya[3]

[1]Assistant Professor, RNT College of Agriculture, Kapasan (Raj.)

[2]Research Scholar, RARI, Durgapura (SKNAU, Jobner)-Raj.

[3]Research Scholar, DRPCAU, Pusa, Samistipur (Bihar)

**Corresponding e-mail: scpath16220@gmail.com*

Abstract

Human activities have had a significant impact on climate and ecosystems, resulting in higher temperatures, changes in precipitation quantity and pattern, increasing CO2 and ozone levels, drought, and other issues. Plant diseases are caused by interactions between a susceptible plant, a virulent pathogen, and the environment, hence any change in ecosystems can affect them. The occurrence, prevalence, and severity of plant diseases are all influenced by climate change. Pathogen development and survival rates are projected to be affected by predicted environmental changes, as well as host sensitivity, resulting in changes in the impact of illnesses on crops. Resulting in changes in the geographical distribution of pathogens and their hosts, that decrease the selection and efficacy of the pathogen to crop disease losses IPM is an analytical method used to analyze the agro-ecosystem and its different elements in order to optimally manage these elements to control and minimize pests while protecting the environment and the economic health. Interactions with global change drivers influence the prediction and control of climate change effects on plant health. Under various forms of climate change, plant disease models can evolve, necessitating different management techniques based on more participatory approaches and multidisciplinary knowledge. All of these initiatives and collaborations will result in successful crop protection techniques that employ novel technology as appropriate instruments for adapting to changing climate conditions.

Keywords: Climate change, Plant pathogen and Disease management

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Introduction

The environment (defined as the combination of temperature, humidity, precipitation, UV-rays, and water, air and soil, etc.) is one of the three sides of the disease triangle in plant pathology, and it can have a significant impact on the appearance and severity of plant diseases. Human activities have had a significant impact on climate and ecosystems during the 'Anthropocene' era, the most recent period in Earth's history, resulting in increased temperature, changes in the quantity and pattern of precipitation, increased CO2 and ozone levels, drought, and so on.

Up to the end of the last Century, few data report the impact of climate change on plant diseases and in most cases refer only to the increase of some pollutants (mainly ozone, SO_2, CO_2) in the atmosphere and their direct effects on plants.

Climate changes and pathogens

Aside from crop yield losses and reduced growth and productivity of tree species caused by high levels of O3, pollutants can influence plant pathogens, and foliar pathogens can influence leaf responses to O3. Generally, ozone exposure tends to decrease the incidence of disease caused by obligate parasites, increasing the disease incidence caused by facultative parasites (Table 1)

Table-1 Effect of ozone (O_3) on some fungal plant diseases

Fungi	Host plant	Effect on disease
Obligate biotrophs		
Puccinia graminis f. sp. *tritici*	Wheat	Decreased hyphal growth and urediospore production on O_3- injured leaves
Erysiphe graminis f. sp. *hordei*	Barley	Reduce rate of infection if exposed to sufficient O_3 during incubation
Necrotrophs		
Botrytis cinerea	Potato	Infection only in O_3 injured leaves
Lophodermium sp.	Pine	Increased severity of needle blight

Commonly, necrotrophic and biotrophic pathogens show a different behaviour as regards their nutrition. The first obtain nutrients from dead tissues, while the second derives nutrients from living

cells and maintains a prolonged and deep interaction with their host. Therefore, all climatic factors that cause or accelerate tissue death (high temperatures or O3 levels) could favour necrotrophic pathogens. Some aspects associated with climate change, such as the increase in temperature and changes in precipitation and moisture, can directly affect pathogens, enhancing their fitness in terms of a number of generations and sexual reproduction (influencing the evolutionary potential of individual populations), extending the amount of time available for reproduction and dissemination. This is the case with Phytophthora species which increased the incidence of root rot in central Europe Forest trees as a result of the rise in mean winter temperatures, the shift in precipitation from summer to winter and the tendency toward heavier rains (Elad and Pertot, 2014). In the last decades, a northward shift was observed in Cercospora beticola causing leaf spots in sugar beet in southern Germany, probably due to an annual mean temperature increase of approximately 0.8°C-1°C in the last century (Richerzhagen et al., 2011).

Climate changes and disease management

Plant disease management still relies on the use of chemicals although alternative methods have been under investigation for a long time. The persistence of a chemical on the plant surface depends on weather conditions, in particular precipitation and temperature. Changes in duration, frequency and intensity of rain events alter the efficacy of fungicides since they can quickly wash away. The temperature influences the degradation of pesticides and alters the morphology and physiology of plants affecting their penetration, translocation and mode of action (Elad and Pertot, 2014).

The living style of Pathogens and the activity of biological control agents can be also influenced by environmental parameters, although there is very little information on the impact of climate change on plant disease biological control. These are living organisms, and diverse climate conditions regularly affect their efficacy. For example, *Trichoderma harzianum* T39 is more active against grey mould at higher temperatures and lower relative humidity levels.

Conclusion

The impact of climate change on plant diseases needs more research. Although this topic has developed hastily in the last few decades, there are still some gaps that need explaining. The prediction and the management of climate change effects on plant health are influenced by interactions with global change drivers. The models of plant disease development jerry can vary under different forms of

climate change, requiring different management approaches based on more participatory approaches and multidisciplinary science.

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