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Climate Change: A modulator of Plant Diseases

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SUMMARY

Change in global climate is due to the increasing concentration of greenhouse gases in the atmosphere that is mostly caused by human activities. These activities are driven by, economic, demographic, social and technological changes that have a major impact on climate change. The important elements governing the spread of plant diseases are temperature, moisture, light, and CO2 concentration. Climate change causes a significant impact on germination, reproduction, sporulation and spore dispersal of pathogens. New races may evolve rapidly under elevated temperature and CO2, as evolutionary forces act on massive pathogen population. Various minor diseases appeared as major ones due to alteration in climatic parameters and thus posing a threat to food security.

INTRODUCTION

Climate change is a long-term shift in the statistics of the weather. Worldwide climate change is a major concern of discussion within both scientific and political forums. The last decade of the 20th century and the starting of 21st century years have been the hottest span as per available records. Greenhouse gases like methane (CH_4), carbon dioxide (CO_2), water vapour (H_2O), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) and ozone (O_3) present in the earth's atmosphere trap the reflected radiation; and in turn warm the earth surface (Mahato, 2014). Many environmental factors affect plant disease development *viz.*, temperature, light and water availability, soil fertility, wind speeds, and atmospheric ozone, methane and CO_2 concentrations. Among these, three factors *viz.*, CO_2 concentration, temperature, and water availability are mostly changed and affect the environment. Climate change affects crop pests and diseases susceptibility which affects crop health, and these changes result in a shift in farming practices to manage the effects of these changes and to prevent a reduction in productivity. The effect of environmental factor on plants and pathogens can have favourable, neutral or negative outcomes on plant disease development (Zayan, 2019). Both pathogens and plants need an optimal environmental condition for their growth and reproduction, which is best for disease outbreak. Severe plant disease epidemics can be induced by changing weather, which threatens food security if they affect staple crops. There is an exemplar shift in nature, time and type of occurrence of viral and other diseases of various horticultural crops due to climate change. Cereal, spices and vegetables are most affected by the disease due to changing climate parameters. The incidence of colocasia leaf blight and with a moderate incidence of blast and brown spot of paddy, bacterial blight and false smut of paddy, Stripe rust of wheat, Curvularia leaf spot of maize, leaf blotch and leaf spot of turmeric, tomato leaf curl, citrus canker, downy mildew and powdery mildew of cucurbits, fruit rot and anthracnose of king chilli, banana and Sigatoka diseases (Das *et. al.*, 2016).

Climate Change and Plant Pathosystems

Plant diseases play a key role in agriculture. Previously, many plant diseases considered minor emerged as a major one as a result of changing climatic scenario. Plant pathologists continuously study the environmental effect on plant diseases. The disease triangle focuses on the relationship between plant hosts, pathogens and the environment in causing disease. This global climate changes by various factors and changes or influence all the three major elements of the disease triangle, *viz*., host, pathogen and environment. Plant health is commonly suffered under climate change through various mechanisms like rapid pathogen evolution.

Environmental factors affecting Plant Diseases

Many environmental parameters affect plant disease development *viz.*, temperature, light, CO_2 concentrations, water availability, soil fertility, wind speeds etc. Among these, three factors are most likely to change and affect the climate – temperature, water availability and CO_2 concentrations which are discussed thoroughly in the next sections.

Effects of change in Temperature

For any plant-pathogen interaction, there is a range of optimal temperature which is needed for the development of diseases. An alteration in temperature may facilitate the evolution of many inactive plant pathogens, which can induce an epidemic. Temperature affects the chain of events in the disease cycle *viz.*, survival, dispersal, penetration, development and reproduction rate of many pathogens (Dabala and Tola, 2018). Due to continuously change in temperatures; climate change may affect the growth stage, development rate, physiology and resistance of the host plant. The effect of elevated temperature on pathogen aggressiveness is both high and low (Table 1). The rise in temperature with enough soil moisture may increase evapotranspiration which creates humid conditions in the crop which lead to elevated incidence of diseases.

Table 1: Influence of elevated temperature on few host-pathogen interactions

S. N	Host	Pathogen	Change in Severity
1.	Wheat	*Tilletia controversa*	Increase
2.	Wheat	*Puccinia striformis*	Increase
3.	Citrus	*Colletotrichum acutatum*	Increase
4.	Citrus	*Guignardia citricarpa*	Increase
5.	Potato	*Phytopthora infestans*	Increase
6.	Coffee	*Meloidogyne incognita*	Increase
7.	Chilli	*Ralstonia solanacearum* *Xanthomonas campestris* pv. *vesicatoria*	Increase
8.	Grapevine	*Plasmopara viticola*	Increase

Effect of Rising CO_2 Levels

Tropospheric CO_2 concentrations are estimated to raise from 355 ppm to 710 ppm, by the year 2050. There is an enormous literature on the beneficial effects of elevated CO_2 concentrations on biomass production, probably due to increased water use. Much less is known about CO_2, effects on the incidence and severity of biotic diseases of plants. An increase in CO_2 concentration has a direct effect on both the host plant and the pathogen. The well-known effects are an increase in leaf area, leaf thickness, tillering, branching, dry weight and stem and root length. An increase in CO_2 concentration leads to an increase in canopy size and density resulting in increased high nutritional quality biomass (Thompson *et. al.*, 2017). When this CO_2 concentration combined with increased canopy humidity, it promotes foliar diseases such as rust, powdery mildew, blight and leaf spot.

Table 2: Influence of elevated CO_2 concentration on few host-pathogen interactions

S. N	Crop/Host	Disease/Pathogen	Severity level
1.	Wheat	Leaf rust (*Puccinia triticina)*	Increase
2.	Aspen (Poplar)	Rust (*Melampsora medusae* f. sp *tremuloidae*)	Increases
3.	Rice	Sheath Blight (*Rhizoctonia solani*)	Increase
4.	Rice	Blast (*Pyricularia oryzae*)	Increase
5.	Chilli	Phytophthora blight (*Phytophthora capsici*), Bacterial wilt (*Ralstonia solanacearum*) and Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*)	Increase
6.	Soybean	Septoria brown spot (*Septoria glycine*)	Increase
7.	Grapevine	Downy Mildew (*Plasmopara viticola*)	Increase
8.	Rocket salad	Alternaria leaf spot (*Alternaria japonica*), Basil black spot (*Colletotrichum gloeosporiodes*)	Increase
9.	Wheat	Fusarium Head Blight (*Fusarium graminearum*), *Septoria tritici* Blotch	Increase
10.	Wild Rocket and Radish	Leaf spot (*Fusarium equiseti*)	Increase

Effect of moisture

Moisture is one of the main factors affecting the growth of pathogens. Irregular rainfall patterns for longer period aids in retaining moisture as leaf surface and RH in the atmosphere for a long time and thus provides a conducive condition for pathogens and diseases such as late blights and vegetable root diseases including powdery mildews. High moisture facilitates foliar diseases and some soil-borne pathogens such *Pythium*, *Phytophthora*, *R. solani* and *Sclerotium rolfsii*. Moreover, powdery mildew conidia hold their ability to germinate in low moisture. Some do so even at 0 % relative humidity. Spores of *Erysiphe necator* germinate at temperatures from 6 - 23°C with an RH from 33 - 90 % (Bendek *et. al.*, 2007). Low soil moisture affects the incidence and severity of viruses such as *Beet yellows virus* (BYV) and *Maize dwarf mosaic virus (*MDMV). Due to the large variation in the response of plant pathogens to climate change, the incidence of pathogens must be characterized as a function of temperature and humidity. The climate is becoming increasingly extreme and unpredictable, and climate change is affecting plants in natural and agricultural ecosystems (Stern, 2007).

CONCLUSION

Climate change can have a positive, negative and neutral impact on individual pathosystems because of the specific nature of the interactions of host and pathogen. Climate change is one the most serious issue in today's century as not in agriculture only; it is posing threat to all forms of earth life. Globally, plant pathogens destroy 10-16% of crop production even with improved pest and disease management measures. Since both CO_2 and temperature are important factors affecting plants and their pathogens, global food supply and disease risk are attracting great research interest in many countries. Researchers concluded that increased CO_2 generally produced larger plants with more and/or larger organs, while warmer temperatures stimulated the rate of organ development and expansion but decreased organ lifetime. Temperature is one of the main factors in conjunction with rain to determine the incidence and severity of disease, but the effect could be positive and negative. The current management strategies should be constantly evaluated and alternative suggestions to be kept to get prepared against the global threat.

REFERENCES

Bendek, C.E., Campbell, P.A.,Torres, R., Donoso, A., Latorre, B.A. (2007) The risk assessment index in grape powdery mildew control decisions and the effect of temperature and humidity on conidial germination of *Erysiphe necator*. *Spanish J Agri Res*: 5(4): 522-532.

Debela, C., Tola, M. (2018) Effect of elevated CO2 and temperature on crop-disease interactions under rapid climate change. *Int J Environmental Sci Nat Res*: *13*(1): 01-07.

Das, T., Hajong, M., Majumdar, D., Tombisana Devi, R.K. and Rajesh, T. (2016) Climate change impacts on plant diseases. *SAARC J Agri:* 14(2): 200-209.

Mahato, A. (2014) Climate Change and its Impact on Agriculture. *Int J Sci Res:* 4(4): 18-26.

Stern N. (2007) The economics of climate change: The Stern review. Cambridge, UK: Cambridge University Press. p. 712.

Thompson, M., Gamage, D., Hirotsu, N., Martin, A., Seneweera, S. (2017) Effects of elevated carbon dioxide on photosynthesis and carbon partitioning: a perspective on root sugar sensing and hormonal crosstalk. *Front Physiol*: 8: 578.

Zayan, S.A. (2019) Impact of climate change on plant diseases and IPM strategies. In *Plant Diseases-Current Threats and Management Trends*. Intech Open.