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Influence of Weather Parameters on Emergence of Plant Diseases

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SUMMARY

Pathogens and plants do not interact in isolation. The famous "disease triangle" concept in plant pathology highlights the interaction of – host, pathogen and environment. For disease to occur, a susceptible plant host, a virulent pathogen, and the proper environmental conditions are required, if any of the 3 factors is altered, changes in the progression of a disease epidemic can occur. Thus, information about the weather elements becomes important for prediction of disease outbreaks and management of diseases.

INTRODUCTION

Globally, agricultural activities are highly sensitive to weather aberrations. Plant diseases and pests are one of the most significant factors that affect the global food production and their severity varies with crops and regions. The Great Bengal Famine in India during 1943 is a classic example which was triggered by a simple fungus and resulted in the deaths of about 3 million peoples. Hardwick (2002) has summarized that combined damage due to pests and diseases reduces about 30% global food production. The individual weather elements as well as their combination play an important role in disease–pest occurrence and their infestations. Therefore, agrometeorological information becomes pivotal for prediction of disease outbreaks for effective and judicious use of control measures, the prediction of crop yields and of the market potential for the crop. The major meteorological factors responsible for the plant disease outbreaks are temperature (both air and soil), precipitation (rainfall and dew), moisture (relative humidity, soil moisture), solar radiation (intensity and cloudiness), wind, etc. Apart from all these meteorological variables, climate change has emerged as another major threat in recent times which may bring new diseases and challenges ahead. Climate change causing global shifts in temperature, precipitation patterns, as well as an increase in unpredictable, extreme weather patterns. It is expected that climate change may affect plant–pathogen interactions as well as disease epidemiology.

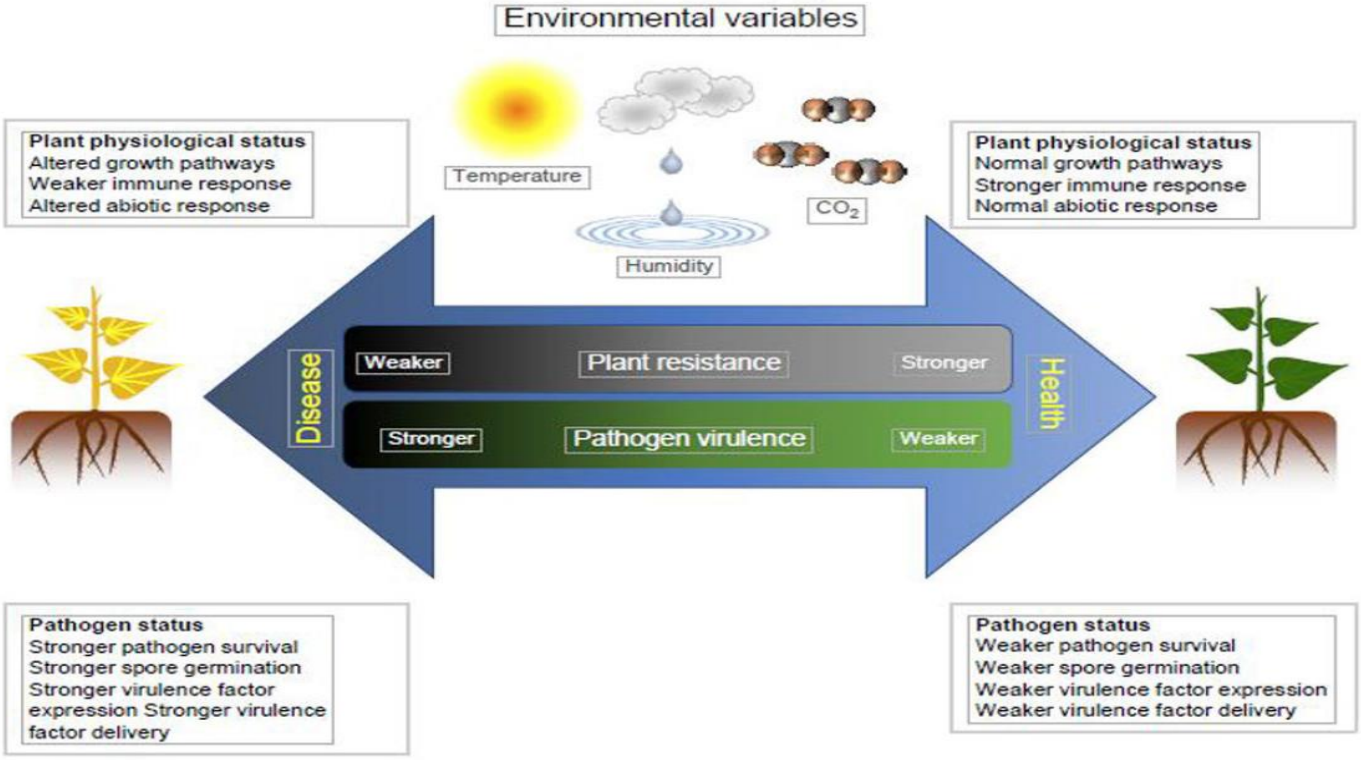

Figure 1. Impact of environmental conditions on plant pathogen interactions

Effect of Weather Elements on Plant Diseases

Many environmental conditions affect plant disease development, including temperature, light and water availability, soil fertility, wind speeds, and atmospheric ozone, methane and CO_2 concentration. Every plant disease requires specific temperature, humidity, wind, radiation, soil quality, and nutrition for their growth. Pathogens have their own environmental requirements for infection; therefore, agrometeorological information becomes crucial for protecting the crop through optimal use of available resources.

1. Temperature

Temperature is considered as one of the most significant weather factors that affect host, pathogen, and disease development together. Increase in temperature can increase the severity of diseases caused by pathogens of crops. For every plant-pathogen interaction, there is an optimal temperature range at which disease develops. For example, high humidity, rainfall, or dew with a combination of 10–15°C ambient air temperature has been found to be suitable for yellow rust disease of wheat in Punjab (Gill *et al*., 2012). Majority of rice varieties are vulnerable for rice blast disease if the night temperature is less than 26^0C. The development of powdery mildew disease in mustard was at peak when maximum temperature ranged between 27.2°C and 28.9°C and afternoon relative humidity ranged between 27 and 42% in the Saurashtra region of Gujarat, India (Kanzaria *et al*., 2013). Certain plant disease occurs during winter, others during summer and for many diseases rainy season is most favourable.

Temperature	Region	Diseases infestation
Low temperature	Temperate	Late blight of Potato, Powdery mildew of wheat, club rot of cabbage
High temperature	Tropical	Bacterial wilt of potato, Soft rot of vegetables
Medium range temperature	Sub-tropical	Loose smut of wheat, Powdery and downy mildews

2. Precipitation

There are various forms of precipitation but rain and dew are most significant in plant disease epidemics. Raindrops act as a transport medium for spores which carry away spores with them from one place to another, thus helping in the spread and transfer of disease to new places (Van der Wal, 1978). Among the several attributes of rain, the time, frequency, and duration are crucial factors that determine the plant wetness as well as pathogen's dispersal by trickling and splashing of rain water. The combined effect of these factors affects the plant disease epidemic outbreaks. Singh *et al*. (2010) reported that rainfall during the 3rd week of January was having favourable role in the formation and further multiplication of secondary spordia of Karnal bunt disease in wheat in Karnal region of Haryana, India. A recent study conducted by Pal *et al*. (2017) reported that heavy rainfall was found to be conducive for initiation of the sheath blight disease of rice, while low and intermittent rainfall of 13–38 mm was found to have a favourable effect for progression of the disease. Dew is another important form of precipitation and a vital source of moisture in certain arid regions. The dew is a major source of leaf wetness or free moisture which is a prime requirement for disease infection in several plants such as leaf blight on sweet corn (Levy and Pataky, 1992) or foliar infection of tomato (Byrne *et al*., 1998).

3. Moisture (Humidity)

Both air or soil moisture plays a pivotal role in the incidence of pest and diseases. All fungal pathogens affecting plants are strongly influenced by the moisture in different forms. In case, pathogen moisture requirements are fulfilled under favourable conditions, it replicates with the maximum possible rate which enhances the severity of disease incidence and intensity. Moisture activates the bacterial, fungal and nematode pathogens infecting the host plant. High relative humidity (80-90%) near the leaf and other plant surfaces is sufficient enough to bring infection with spores of several fungi. For example, the virulence of the fungus

Sclerotinia sclerotiorum increases as air humidity increases, with highest disease development in lettuce plants when the air relative humidity surpasses 80%. For fruit rot caused by *Phytophthora capsici*, pathogen growth and disease symptoms were highest at close to 100% relative humidity. For occurrence of all three types of rust diseases for wheat in India, higher than 70% relative humidity is a necessity (Mavi, 1994). For many fungal pathogens, the duration in which the leaf has water on its surface (i.e., leaf wetness) is critical for disease development, such as *Puccinia striformis* (stripe rust fungus) requiring a minimum of 5 hours of leaf wetness for disease to occur.

4. Wind

Wind influences the disease infection as transmission and spreading of pathogens, mechanical injuries by rubbing of plants through which penetration of pathogens will be started, Wind influences the vector activities, wind with rain will more severe for release of spores and their spread. Wind speed reduction also reduces dispersal of the pathogen, resulting in lesser disease spread and epidemic development. Hence, wind suppression techniques, for example, windbreaks help in minimizing the numbers of bacteria dispersed in the orchards.

5. Light

Light influences the host-pathogen relationship. Certain disease develops only when there is absence of solar exposure to the plants, for example, shade has been found to be beneficial for the coffee rust. Puccinia (Stem rust of Wheat) the susceptibility is decrease under low light condition but susceptibility of tomato infected by Fusarium is high in low light intensity. In case of some virus infection low light intensity before inoculation increases plant susceptibility but it will be decreased when the plant is exposed to low light intensity after inoculation.

Impact of Climate Change on Plant Disease- Pests

It is expected that climate change will directly influence the occurrence of various plant diseases and their severity. Since climate change may result in higher temperature and increased carbon dioxide concentrations, which may result in to the spreading of pathogen and vector distributions to new geographical locations. Susceptibility of cereal crops increases due to enhancement in temperature. Higher temperatures will lead to a poleward spread of many pests and diseases in both southern and northern hemispheres. This will lead to more attacks over longer periods in the temperate climatic zone. High night temperatures, especially during winter seasons help in the pathogen's survival. Carbon dioxide (CO_2) is the main greenhouse gas responsible for climate change. Manning and Tiedemann (1995) reported that increased CO_2 concentrations is helpful for several plant diseases, for example, leaf spots, rusts, powdery mildew, and blights as it increases the size and density of the plant canopy combined with a higher microclimate relative humidity. Lower plant decomposition rates observed in high CO_2 situations could increase the crop residue on which disease organisms can overwinter, resulting in higher inoculum levels at the beginning of the growing season, and earlier and faster disease epidemics. Elevated CO_2 can increase levels of simple sugars in leaves and lower their nitrogen content. These can increase the damage caused by many insects, who will consume more leaves to meet their metabolic requirements of nitrogen. Thus, any attack will be more severe. Another important greenhouse gas, namely, ozone (O_3) helps to enhance the senescence processes and necrosis and also promote attacks on plants by necrotrophic fungi.

CONCLUSION

Weather and its associated variables have a predominant role in pests and disease infestations. Understanding the potential effects of extreme weather factors on agriculture in terms of its impacts on severity and incidence of pests and diseases is an important issue. It is not precisely understood how these factors will affect crops, insects, diseases, and the relationships among them. Therefore, it is advisable to understand the combination of weather elements that may result in to disease outbreak so that risk of plant diseases can be minimized or avoided. Climate change has become another major threat in recent times which may bring new diseases and challenges ahead. And proper planning and execution is a necessity to overcome with the challenges ahead.

REFERENCES

Kocmánková, Eva, et al. (2009). Impact of climate change on the occurrence and activity of harmful organisms. *Plant Protection Science* 45.Special Issue.

Luck, J., et al. (2012). The effects of climate change on pests and diseases of major food crops in the Asia Pacific Region. *Final Report for APN (Asia-Pacific Network for Global Change Research) Project* 73.

Misra, A. K., Yadav, S. B., Mishra, S. K., & Tripathi, M. K. (2020). Impact of Meteorological Variables and Climate Change on Plant Diseases. *Plant Pathogens*, 313.

Velásquez, A. C., Castroverde, C. D. M., & He, S. Y. (2018). Plant–pathogen warfare under changing climate conditions. *Current Biology*, *28*(10), R619-R634.