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Study of Plant-Pathogen Interaction under Changing Climatic Conditions

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SUMMARY

Plant diseases have devastating effects on economy, society and environment globally. Some of the most documented plant diseases known to effect humans have resulted in massive death, immigration and changes to the landscape (Anagnostakis, 1987). Apart from the existing plant diseases there is emergence of newer diseases. By the next century, it is predicted that biotic stress alone will cause an estimated loss of 41% direct production losses for the major agricultural crops (Savary et al., 2012). For the scientific community this has posed as a great challenge, wherein one has to understand the molecular, epidemiological and ecological basis of plant diseases and find way to prevent the disease, reduce the effect or manage the disease in ever changing environmental conditions.

INTRODUCTION

Climate change due to natural ecological process or human influences affects the living system with its multitropic interactions (Chakraborty et al., 2012). Agriculture today experiences large number of challenges due to changing environmental conditions like increase in temperature and decrease of water availability. One of the many reasons of global increase in temperature is the emission of green house gasses which has led to an increase in the CO_2 concentration. Savary et al. (2012) have reported how the temperature and CO_2 concentration may increase by 3.4°C and 1250 ppm by 2095, which will further lead to variation in the climatic conditions worldwide. These changes will however directly or indirectly affect flora and fauna and its multitropic interactions. Plant diseases play a huge role in the productivity of agricultural products and the ever changing climatic conditions magnifies the problems faced by the plants. While not every disease is equal, some plant pathogens have more devastating effects than others. In the past few decades it has been observed how previously mild diseases have grown on to acquire a serious status due to fluctuating environmental conditions. Pathogenic organisms that commonly infect plants range from viruses, bacteria, fungi, oomycete and nematodes. These organisms are classified as either biotrophs or necrotrophs depending on their nutrition acquiring nature. While, biotrophs can obtain nutrients from the living host cells, necrotrophs usually kill the host cells.

Interaction of the plants with other living organisms may either result in damage, benefits, or indifferences. Plants and pathogen interaction is described by the famous "disease triangle" concept which highlights the interplay between the plant, pathogen and environment. For example, in order for a disease to occur, the presence of susceptible host combined with a virulent pathogen and a favourable environmental condition is a pre-requisite. Fluctuating environmental conditions have however lately been observed as a critical parameter for emergence of newer plant disease. Although a huge number of plant crops are cultivated and consumed worldwide, humans however are roughly dependent on just around four or five crops for its nutritional uptake. Therefore, it is important to identify and highlight factors that affect plant diseases. There are several factors that affect plant diseases like environmental and molecular mechanism.

Environmental Factors Affecting Plant Disease

There are many environmental conditions affecting disease in plants like temperature, light and water availability, soil fertility, wind speeds, and atmospheric CO_2 concentration. Of

these factors CO_2 concentration, temperature and water availability are amongst the most likely to cause major changes. With the increase in the CO_2 concentration, it is projected there will be an increase in global temperature by 1.5 - 4°C by the end of the century (Velásquez et al., 2018). Higher CO_2 concentration are expected to increase the photosynthetic rate of the C_3 plants and also lead to an increase in crop yield, but they will also increase the disease severity in crops like rice and wheat (Velásquez et al., 2018).

An increase in global temperature will also see an unprecedented growth of opportunistic microorganism which however was not able to earlier. For example, *Puccinia striiformis* that causes rust disease in wheat was unable to cause infections in wheat seedlings at temperatures over 21 °C, while in the field conditions due to fluctuations in temperature between 18 °C to 30 °C it causes the disease (Par , 1990). Most plant diseases are observed in conditions with rain, high air humidity and high soil moisture. But there is an increasing number of diseases in plants caused due to drought like conditions for example, aggressive infections by *Magnaporthe oryzae* in rice are observed under drought like conditions (Bidzinski et al., 2016). While some plants are affected by a certain factor, there are reports of combined effect of changing environmental conditions causing diseases like in *Arabidopsis* a combined effect of heat, drought and turnip mosaic virus (TuMV) infection causes severe reduction in plant growth.

Molecular Mechanism Affecting Plant Diseases

Plants over the millennia have developed sophisticated defense mechanism to counter pathogen attack. These mechanisms include innate immunity to effector- triggered immunity in plants apart from intricate defense hormonal regulation. It has been reported how changes in the environmental factors also contribute to change in the molecular mechanism in plants viz., factors like humidity and water availability are known to influence the effectiveness of PAMP-triggered immunity (PTI) (Schwartz *et al.,* 2017*)* Likewise, in Arabidopsis temperature changes have been associated with alteration in PTI. Stress hormones, particularly ABA, SA, jasmonic acid (JA), and ethylene (ET), are well known regulators of abiotic and/or biotic responses in plants. Huot *et al.* (2017) have reported on the effect of warm temperatures on SA-mediated defense in the Arabidopsis-*Pseudomonas syringae* interaction wherein, at 30°C, Arabidopsis was more susceptible to *P. syringae.*

CONCLUSION

The ongoing changes in climatic patters have however led to the current scenario wherein with the fluctuations in environmental conditions plants are becoming more vulnerable to new emerging threats, thereby posing greater risk to global food security. Understanding the factors responsible and studying the disease patterns will possibly be able to predict certain diseases known to be of major concern worldwide. Basic research undertaken to study the combined effects of both biotic as well as abiotic factors together will yield better understanding of the mechanism of disease progression in plants. Therefore, future breeding programs for development of new improved varieties should try to incorporate the abiotic tolerance, growth, and biotic resistance variability that favour plant immunity and disfavour pathogen virulence.

REFRENCES

Anagnostakis, S.L. (1987). Chestnut blight: The classical problem of an introduced pathogen. Mycologia.79:23–37.

Bidzinski, P., Ballini, E., Ducasse, A., Michel, C., Zuluaga, P., Genga, A., Chiozzotto R., Morel, J.B. (2016). Transcriptional basis of drought-induced susceptibility to the rice blast fungus *Magnaporthe oryzae*. Frontiers in Plant Sciences. 7:1558.

Huot B, Castroverde CDM, Velásquez AC, Hubbard E, Pulman JA, Yoshida Y, Yao J, Howe GA, Childs KL, Tsuda K, et al. Dual impact of elevated temperature on plant defence and bacterial virulence in Arabidopsis. Nat Commun. 2017; 8:1808.

Park, R.F. (1990). The role of temperature and rainfall in the epidemiology of *Puccinia striiformis f. sp tritici* in the summer rainfall area of eastern. Australia Plant Pathology. 39:416–423.

Prasch, C.M., Sonnewald, U.(2013) Simultaneous application of heat, drought, and virus to Arabidopsis plants reveals significant shifts in signalling networks. Plant Physiology.162:1849–1866.

Savary, S., Ficke, A., Aubertot, J.N., Hollier, C. (2012). Crop losses due to diseases and their implications for global food production losses and food security. Food Security. 4:519–537.

Schwartz AR, Morbitzer R, Lahaye T, Staskawicz BJ. TALE-induced bHLH transcription factors that activate a pectate lyase contribute to water soaking in bacterial spot of tomato. Proc Natl Acad Sci USA. 2017; 114:E897– E903.

Velásquez, A.C., Castroverde, C. D. M., He, S.Y. (2018). Plant and pathogen warfare under changing climate conditions. Current Biology. 28: 619-634.