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Dynamics of Crop Protection and Climate Change

Climate Change: Pest Incidence in Agricultural Crops 9

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Climate change on insect-pests and diseases of agricultural crops is multidimensional. The magnitude of this impact varied with the type of crop species and growth patterns. It may be assumed that the crop tolerating high salinity, temperature, and high carbondioxide use efficiency could be better than other species. Intergovernmental Panel on Climate Change (IPCC) in its report of 1995 predicted that doubling the level of carbon dioxide could possibly increase yield in several crops by 30%. Observations of changing crop pests (including pathogens) distributions over the twentieth century suggest that growing agricultural production and trade have been most important in disseminating them, but there is some evidence for a latitudinal bias in range shifts that indicates a global warming signal (Bebber 2015). The increased production may be offset partly or entirely by the insect-pests, pathogens, or weeds.

Development of pests is strongly dependent upon the temperature and humidity. Any change in temperature and humidity can significantly alter the scenario, which ultimately may result in yield loss. It can also result in altered virulence as well as the appearance of new pests in a region. Similarly, competition between crop and weed may be altered, depending upon their growth behaviour. The scenarios can be visualized regarding impact of climate change on pest dynamics in agriculture (Khan *et al*. 2009). With an increased level of carbon dioxide, there may be a change in nutritional status of the crop, and the overall effect on agricultural production may depend upon the interaction between pests and crops. The gradual warming of climate may lead to changes in the pest dynamics. High population growth rate of many species may ensure changes in pest distribution. If the rise in temperature during shorter days takes place, the duration of hibernation of pests may decrease, thus, increasing their activity. Uncongenial areas for pests due to the low temperature at present may become suitable due to rise in temperature. However, we should not forget that insects and microorganisms could adapt to gradual changes in the environment, and their favourable range of temperature may shift with increased temperature.

Swaminathan (1986) observed that the number of diseases on the same crops were much higher in tropics as compared to temperate conditions, which is an indication of how increasing temperatures affect the occurrence of plant diseases on agricultural crops. Much attention has given to the work related to climate change vis-à-vis plant diseases in rice (blast, bacterial leaf blight), horticultural (*Meloidogyne*) and wheat (*Puccinia, Septoria*) crops. The plant diseases likely to occur under the situation of elevated CO_2 and temperature is listed in Table 9.1. The trend indicates that severity of most of the diseases is recorded to be higher with increased levels of CO_2 (Chakraborty 2008), an offshoot of climate change. It is also in the opinion that climate change can lead to a changed profile (variants) of the pathogen (Bergot *et al*. 2004). The pathogens with wide host range may survive better. There is also a possibility of broadening of host ranges of the pathogens. The need for further work in this area has been highlighted in adaptation experiments using twice-ambient CO_2, which increased the aggressiveness (Chakraborty and Datta 2003) and fecundity (Chakraborty *et al*. 2000) of *Colletotrichum gloeosporioides*, anthracnose of tropical legumes. Elevated CO_2 may modify aggressivity of pathogen and/or susceptibility of host and leading to the initial establishment of the pathogen, especially fungi, on the host plant (Coakley *et al*. 1999; Plessl *et al*. 2005; Matros *et al*. 2006). The host resistance has increased, possibly due to changes in morphological structures, physiology, and composition of the host. The rapid growth of some fungal pathogens under increased level of CO_2 has also been reported (Kumar *et al*. 2013, 2014). Higher infections by *Fusarium, Sclerotinia* and Pochonia (*Verticillium)* (Nagarajan and Muralidharan 1995) was observed with low solar radiation and short-day period. Root rot has emerged as a serious threat to the rapeseed-mustard production system (Meena *et al*. 2010), which was initially identified as bacterial or fungal incidence or in combinations. In view of the fact that some isolates of *Alternaria brassicae* sporulated profusely at 35°C and several isolates had increased multiplication rate under higher RH. Wide variation recorded among the thirteen isolates of *A. brassicae* also indicates their ability to adapt to varied climatic conditions (Goyal *et al*. 2011). The pathogens such as *A. brassicae, Sclerotinia sclerotiorum*, etc., are predicted to be favoured by average warmer temperatures (Siebold and von Tiedemann 2012) in Germany.

Table 9.1 List of Plant Diseases Likely to Occur in Climate Changed Scenario

Pathogen/Disease	Impact
Elevated CO_2 level (550 ppm CO_2)	
Biotrophic fungi such as rust	Promotes the growth and development due to enhanced carbohydrate

Few Pages are not available

climate change on plant diseases/insect-pests has been done under real field conditions. Most of the recent plant protection technologies have been developed either in the laboratory or artificial condition (which are likely to occur in the changed climate scenario). However, some assessments are now being done in few countries, regions, crops and particular pathogens/insect-pests under field condition to counter the current as well as upcoming problems of crop insect-pests/diseases. Since, uncertainty analyses regarding objectives, available resources and model parameters will allow further assessments of the robustness of impacts and adaptation (Holzkämper *et al.* 2015), integrated assessment and farming systems analysis are needed to place the impacts of climate change into context, to enhance insight in adaptation measures and strategies, and to better inform farmers, policy makers and other actors (Reidsma *et al.* 2015). Now, emphasis must shift from impact assessment to developing adaptation and mitigation strategies as also options thereof. We have to systematically evaluate the efficacy of current physical, chemical and biological control tactics, including pest-resistant cultivars under climate change, and to include future climate scenarios in all research aimed at developing new tools and tactics. Pest risk analyses is based on host–pathogen/pests interactions should be done, and research on host response and adaptation should be conducted to understand how an imminent change in the climate could affect crop pests. India is fortunate enough to have such a diverse climate suitable to grow various types of crop plants with diverse pest population, which can help to counter the pest problems in the changing climate scenario.

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