Impact of abiotic factors on insect pests and management strategies in a changing climate

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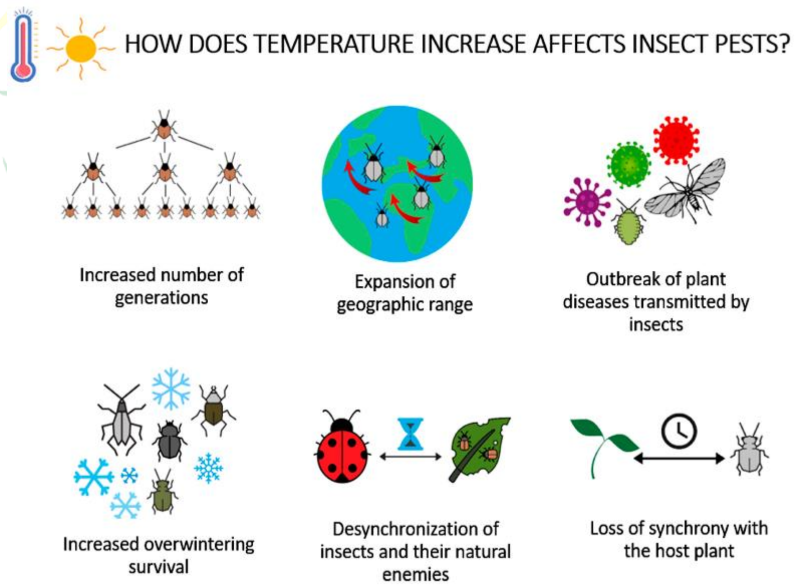
Introduction

The reactions of insect pests to continuing climate change are not easily generalizable, and species must be evaluated individually in order to forecast their reaction more precisely. Insect pests are major constraints on agricultural and forestry production and their impacts are likely to increase in importance as the global human demand for food fibre, bioenergy feedstocks, and other renewable products continues to grow. Ongoing and anticipated challenges posed by phytophagous insect pests are likely to be exacerbated by projected global warming which may promote pest population growth, increase outbreak frequencies, and facilitate the geographic spread of numerous pest species, resulting in increased economic losses and decreased food security However, given the restricted environmental niche requirements, physiological tolerances of insects, and the varying impacts of temperature on their phenology and life cycle, warmer temperatures may not enhance insect pest severity equally. Because of these sensitivity, regional climate change may result in population decreases or extinctions. In order to establish successful pest control measures, this ambiguity concerning pest reactions to rising temperatures must be addressed.

Temperature-Responsive Behaviour of Insect Pests



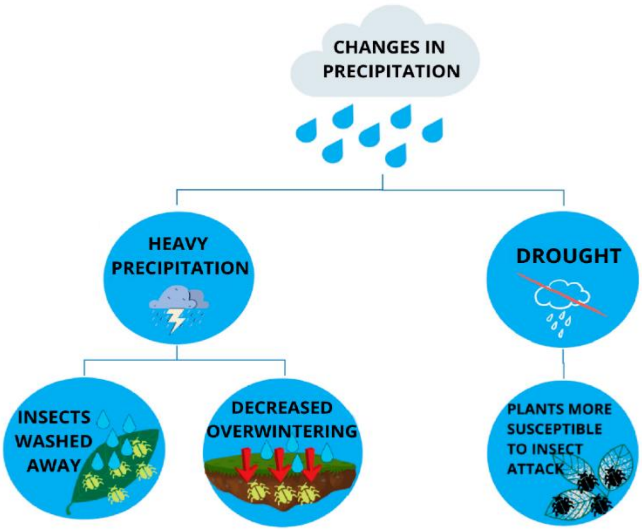
Temperature influences metabolism, metamorphosis, movement, and host availability, all of which influence the probability of changes in pest population and dynamics. Insect physiology is extremely sensitive to temperature fluctuations, and their metabolic rate nearly doubles with a 10°C increase. Many studies have demonstrated that increasing temperature hastens insect eating, development, and migration, which can have an impact on population dynamics by altering fecundity survival, generation time, population size, and geographic range. Species that are unable to adapt and develop in response to rising temperatures have a tough time sustaining their numbers, whereas other species flourish and reproduce fast.

Insect Pest Reaction to Increased CO2 Concentration

Elevated CO2 levels in the atmosphere can have an impact on the range, quantity, and performance of herbivorous insects. Such increases can have an impact on insect pest intake rates, growth rates, fecundity, and population densities. Data now available indicate that the effect of increased atmospheric CO2 on herbivory is not only highly unique to individual insect species, but also to specific insect pest–host plant systems. The impact of rising CO2 levels on insect pests are greatly reliant on the plants that they feed on. CO2 increases would have a bigger influence on C3 crops (wheat, rice, cotton, and so on) than on C4 crops (corn, sorghum, etc.).

Insect Pest Reactions to Variable Precipitation Patterns

Changes in precipitation volume, intensity, and frequency are major markers of climate change. The frequency of precipitation has reduced but the severity of precipitation has increased, as has been observed in most occasions. Droughts and floods have been exacerbated by this sort of rainfall pattern. Overlapping rainfall has a direct impact on insect species that overwinter in the soil. In brief, significant rainfall can cause floods and protracted water stagnation. This occurrence jeopardises insect survival and, at the very least, interferes with diapause. Insect eggs and larvae can also be carried away by strong rains and flooding. Pests with small bodies, such as aphids, mites, jassid, and whiteflies, might be washed away after heavy rain. Variable rainfall patterns can have a significant influence on insect populations.



Pest Management Adaptation and Mitigation Strategies in a Changing Climate

Climate change adaptation may be seen of as an ongoing process of integrating current risk management methods and mitigating the possible risk from climate change consequences. Pest infestations are commonly projected to become more unpredictable as a result of climate change, as well as to expand geographically. In addition to the uncertainties around how climate change may affect agricultural production, the interactions between insects and plants in ecosystems remain unknown. Several biological, economic, and sociocultural elements will influence agricultural production systems' adaptation potential. Potential adaptation measures have been discovered in order to limit the risks of new pests and illnesses spreading, as well as to lessen the detrimental effects of current pests. Modified

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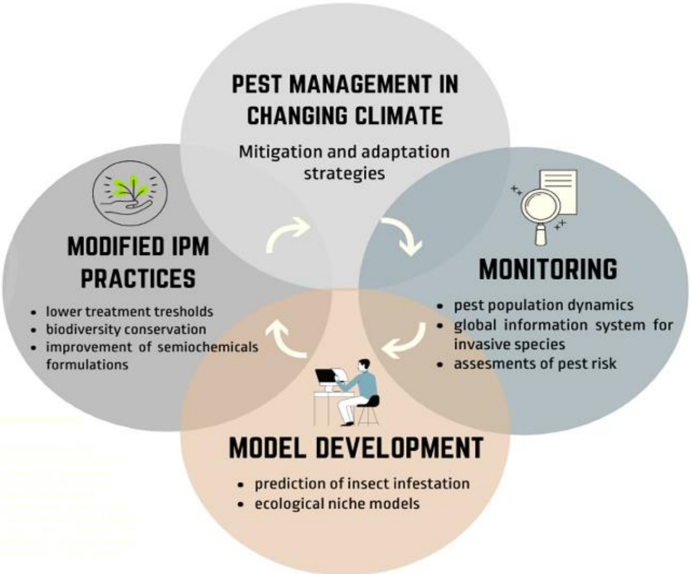
integrated pest management (IPM) approaches, monitoring climate and insect pest populations, and the use of modelling prediction tools are the most often recommended strategies.

Modelling predictions tools

Model Development and Climate Forecasting Because of the variability of changes in average temperature and other climatic parameters throughout the world, it is hard to construct a priori climate change adaptation methods for specific national or global climate change scenarios. Regional climate change and associated uncertainties must be accommodated in pest management methods. Sensitivity assessments and combined findings derived by combining predicted climate change scenarios with sensitivity analyses for a specific location over a wide range of variable values are among the alternatives available. This technique might be effective in informing pest management professionals when creating pest control adaption strategies under new environmental circumstances. Climate models paired with the environmental needs of a specific pest species (envelope) can be an excellent tool for estimating the potential range of global changes. Modelling pest risk in conjunction with plant host reactions to climate change might therefore improve the capacity to forecast the outcome of an insect infestation. Ecological niche models are generally used to evaluate the probable range of insect pest species (ENMs).



They can be divided into two groups:

Correlative modelling:

It is a commonly used method for forecasting future changes in the geographic distribution of species, estimating extinction rates, and establishing conservation priorities.

These models discover statistical correlations between a specific species' existing geographic distribution and climate characteristics, which are then used to climate change forecasts to recommend climatically acceptable habitats for the that species in the future. Correlative model output is frequently displayed in the form of maps depicting future climatically sufficient regions for a certain species, the total area of which may then be compared to existing geographic ranges to evaluate the future risk of their arrival and establishment.

Mechanistic models:

Mechanistic models are forecasting tools that employ the values of environmental variables in a specific region in conjunction with knowledge about a given species' ecological tolerances.