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Comprehensive Impact of Climate Change on Insects and Insect Plant Interaction

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G. K. Sujayanand, T. V. Prasad, Zakaullah Khan and S. Sheelamary

Climate change occurred from the beginning on its own pace, but due to some undesired anthropogenic activities, the momentum of change has increased in last 50 years. For example, in case of global average temperature, 0.8°C has been increased in the last two decades of 20th century (IPCC 2007). Insects are known to occupy this habitat 500 million years ago, i.e., during the Devonian period. Since then, they have been continuously evolving along with their environment. Insects constitute almost half of the biodiversity on the earth (Speight *et al.* 1999). Insects offer various ecosystem services such as predators, parasitoids, pollinators, beneficial insects, *viz*., silkworm, lac, honeybee, etc., apart from as insect pest. Insects are among the groups of organisms which are most likely to be affected by climate change because climate has a strong direct influence on their development, reproduction, and survival (Bale *et al.* 2002). Due to climate change, the insect's abundance, geographic distribution, population size, community structure, and diversity may also change; thereby, hampering the service they render to the ecosystem (Hillstrom and Lindroth 2008). As insects are ectotherms (cold-blooded organisms), i.e., the temperature of their bodies is approximately the same as that of the environment, the external environment influences the insect's key physiological processes very much.

The occurrence of climate changes is evident from increase in global average temperature, changes in the rainfall pattern, and extreme climatic events. These seasonal and long term changes would affect the fauna, flora, and population dynamics of insect pests. Climate change can have positive, negative, or neutral impact on individual pest systems because of the specific nature of interactions of host, the pest, and the environment. Global climate changes affect species distribution, life histories, community composition, and ecosystem function. In ecosystem, the tritrophic interaction between plants, herbivores insects, and its natural enemies (predators, parasitoids, and pathogens) result from a long co-evolution process; and effects are likely to be more pronounced at higher trophic levels.

Impact of Climate Change on Population Dynamics of Insect Pests

Changes in climate and weather could profoundly affect the population dynamics of insects and status of insect pests of crops which is explained below.

- Changes in population dynamics may arise as a result of direct effects on distribution and abundance of pest populations, but also indirect effects on the pests' host plants, competitors, and natural enemies.
- Warmer temperatures associated with climate changes will tend to influence and frequently amplify insect species' population dynamics directly through effects on survival, generation time, fecundity, and dispersal.
- Individual insect species' responses to climate change will depend on their geographic range, trophic level, and natural history.
- Insect populations in mid to high latitudes are expected to benefit most from climate change through more rapid development and increased survival. Much less is known about the effects of increased warming on tropical insect species.
- Insect species' mortality may decrease with warmer winter temperatures, thereby, leading to pole ward range expansions.
- The physiological effects of climatic warming on insect species can also act indirectly through trophic interactions, i.e., host plants and natural enemies.
- Because insect species, in general, have relatively short life cycles, high reproductive capacity, and high degree of mobility, the physiological responses to warming temperatures can produce large and rapid effects on species population dynamics. Thus, rise in temperature plays a pivotal role in insect population dynamics.
- Some pests which are already present but only occur in small areas or at low densities may be able to exploit the changing conditions by spreading more widely and reaching damaging population densities.
- The abiotic parameters such as temperature, rainfall, photoperiod, wind speed, etc., are known to have direct impact on insect population dynamics through modulation of developmental rates, survival, fecundity, voltinism, and dispersal.
- Among the climatic factors, temperature is an important factor. Increase in temperature might affect any stage of the life cycle, and therefore, limit distribution and abundance through its effect on survival, reproduction, diapauses, winter mortality, and flight and dispersal. In case of aphids, a 2°C temperature increase

Few Pages are not available

speed. If heavy precipitation is there, then pollinator's activity will be reduced. On the other side, if drought condition prevails due to water stress, the flowers will be reduced and there will be scarcity for food (Nectar or pollen). The bumble bees have been shown to respond more to snow cover than to temperature (Inouye 2008). Bumble bees are prone to overheating because of their large body, dark color, and hairiness in the body. Extreme events like long periods of rain, late frost also affect pollinator activity. The nectar and pollen quality changes with changes in temperature which in turn affects the pollinators indirectly.

Conclusion

The insects are very good indicator organism with regards to climate change because 54% of known species are insects (Schowalter 2000). Hence, the insects reflect a clear picture on the changes that occur in biological systems due to climate change. Trophic level interactions, such as plant-insect, insect-natural enemy, and plant pollinator will be affected to a larger extent due to climate change. Very few works have been done on this trophic level interactions especially tri-trophic interaction. The critical fact in climate change is the combined effect of drivers of climate change. For example, extensive studies were done in case of effect of elevated temperature or CO_2 as a single factor, but combined effect on insects was not studied extensively. Still this area remains unexplored. Better understanding of the effects of climate change on insect pests will enable us to take the necessary measures to counteract or mitigate the possible negative consequences on the agricultural ecosystems. Thus, predicting the impact of climate change on insects is a very complex exercise and involves a great deal of modelling. A deeper understanding of the complex relationships between a changing climate, agriculture, and agricultural pests are vital to enable those in crop health protection and management to expect; and prepare for changes in pest behaviors, outbreaks, and invasions. Pest management strategies in agriculture will require adjustments. Under the emerging scenario, modelling techniques, monitoring, mapping, and conservation of biodiversity are likely to become the important tools of Integrated Pest Management (IPM).

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