AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
ISSN: 2582-7049
Volume: 07 Issue:08 August 2026 Article No: 07

The Impact of High Temperature on Crops and Insect Pest Dynamics

Ritu Mishra[1]*, Deeksha Dhyani[2], Sapna[1], Himani Pundir[1]

[1]PhD scholar, Department of Entomology, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand-263145, India

[2]PhD scholar, Department of Plant Physiology, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand-263145, India

SUMMARY

High temperature is becoming one of the most significant environmental challenges affecting agricultural production worldwide. Rising temperatures influence crop growth, development, and productivity by disrupting physiological processes, reducing photosynthetic efficiency, increasing water demand, and affecting reproductive stages, ultimately leading to yield losses. Insect pests are equally sensitive to temperature because their growth, survival, reproduction, and distribution are closely linked to environmental conditions. Warmer climates often accelerate insect development, increase the number of generations per season, extend their geographical range, and alter their interactions with host plants and natural enemies. These changes can increase the frequency and severity of pest outbreaks, placing additional pressure on agricultural systems. However, the response of insect species to elevated temperatures is not uniform, as prolonged or extreme heat may reduce the survival and fitness of certain pests. Understanding the combined effects of high temperature on crops and insect pest dynamics is essential for developing effective adaptation and management strategies. Climate-resilient crop varieties, sustainable pest management practices, and modern monitoring technologies will play a crucial role in maintaining agricultural productivity and food security under future warming conditions.

INTRODUCTION

Agriculture has evolved alongside human civilization, supporting continuous advances in technology, science, and economic development. From the earliest farming practices to modern precision agriculture, each agricultural revolution has helped increase food production and improve human well-being. However, the unprecedented growth of the global population over the past century has placed immense pressure on agricultural systems. Coupled with changing environmental conditions, this rapid population increase has intensified concerns about global food security. It is projected that agricultural production will need to nearly double by 2050 to meet the food demands of an expanding population (Tilman *et al.*, 2011). Achieving this goal is increasingly challenging because crops face substantial losses from insect pests and diseases. Together, these biotic stresses are responsible for approximately 40% of annual global crop losses, posing a serious threat to food availability, farmer livelihoods, and economic stability. Insect pests damage crops by feeding on leaves, stems, roots, flowers, and fruits, transmitting plant pathogens, and disrupting normal plant growth and development. Beyond reducing crop yields, the financial burden of pest management further increases production costs, affecting both farmers and the agricultural economy (Ma *et al.*, 2021). At the same time, global climate change is altering the behavior, abundance, and geographical distribution of many insect pests. Although human activities have contributed to declines in overall insect biodiversity, many economically important crop pests are expected to become more prevalent and destructive under changing climatic conditions. Rising temperatures, shifting rainfall patterns, and the increasing frequency of extreme weather events are creating favorable conditions for the survival, reproduction, and spread of numerous pest species. These changes have the potential to increase pest outbreaks, expand their distribution into previously unaffected regions, and complicate existing pest management strategies. Given these emerging challenges, understanding how environmental changes influence insect pest populations has become a priority for ensuring sustainable agricultural production. A deeper knowledge of the interactions between climate, crop pests, and agroecosystems will be essential for developing resilient pest management strategies, safeguarding crop productivity, and strengthening global food security in the decades ahead.

Impact of High Temperature on Crop Production

Agriculture is highly dependent on climatic conditions, making it one of the sectors most vulnerable to climate change. Variations in temperature, precipitation, and atmospheric carbon dioxide (CO_2) directly influence crop growth, productivity, and food security. Although climate change may provide some regional benefits, particularly in cooler areas, its overall impact on global agriculture is expected to be negative, with adverse effects outweighing potential gains (Deshar & Koirala, 2019). Since insect pests rely on host plants for survival and reproduction, understanding how climate change affects crop production is essential for predicting future pest dynamics.

Impact of Rising Temperature

Temperature is a key environmental factor regulating crop distribution, growth, development, and yield. Every crop requires an optimum temperature range to complete its life cycle, while exposure to extremely high or low temperatures, especially during sensitive growth stages such as flowering, can significantly reduce productivity. In some high-latitude regions, warmer temperatures may extend the growing season and improve crop production. However, rising temperatures also increase evapotranspiration and atmospheric water demand, leading to soil moisture depletion and greater water stress, which ultimately reduces crop yields. Furthermore, higher temperatures increase the frequency of heat waves and indirectly intensify pest infestations, weed growth, and plant diseases, creating additional challenges for agricultural production.

Impact of Climate Change on Insect Pests

Climate change is reshaping the biology, ecology, and distribution of insect pests, with important consequences for agriculture and global food security. Changes in temperature, atmospheric CO_2, and precipitation directly influence insect growth, survival, reproduction, dispersal, and population dynamics, while indirectly altering interactions with host plants, natural enemies, competitors, and pollinators (Prakash *et al.*, 2014). Because insects are poikilothermic, their body temperature and physiological processes are closely regulated by environmental temperature, making them highly sensitive to climatic changes. Consequently, climate change is expected to increase pest outbreaks, expand their geographical ranges, and create new ecological niches for invasive species, ultimately increasing crop losses.

Response of Insect Pests to Rising Temperature

Temperature is the primary environmental factor governing insect metabolism, development, reproduction, and distribution (Dukes *et al.*, 2009). A rise of approximately 10 °C can nearly double insect metabolic activity, accelerating feeding, development, movement, and reproduction. As a result, warming generally shortens generation time, increases population growth, and enhances herbivory. However, responses vary among regions and species. In temperate areas, warming is expected to increase pest populations, particularly in crops such as wheat, whereas tropical pests may experience reduced growth because many already live near their thermal optimum. Soil-dwelling insects are generally less affected because soil buffers temperature fluctuations. Climate projections suggest a global temperature increase of 1.8–4 °C by the end of the century, which is likely to intensify pest infestations, although some species may experience reduced performance or restricted distribution due to physiological limitations. Overall, warming is expected to promote overwintering survival, facilitate the spread of invasive pests and insect-vectored diseases, and reduce the effectiveness of natural biological control.

Increased Risk of Invasive Alien Insect Species under Rising Temperature

Rising temperatures associated with climate change increase the risk of invasion by alien insect species by making previously unsuitable regions more favourable for their establishment, survival, and reproduction. Warmer conditions can expand the geographic range of invasive pests, increase their population growth, and enable additional generations each year (voltinism), thereby intensifying their impact on agriculture and natural ecosystems.Temperature also influences the establishment and dispersal of invasive insects by reducing thermal barriers and allowing them to colonize regions that were previously too cold for survival (Masters & Norgrove, 2010). Climate change and invasive alien species. Many invasive species possess broad thermal tolerance and high physiological plasticity, enabling them to adjust their development, behaviour, and host utilization under changing climatic conditions. These temperature-driven adaptations enhance their ability to establish, spread, and persist in new environments, increasing the threat posed by invasive insect pests.

Reduced Effectiveness of Biological Control by Natural Enemies under Rising Temperature

Increasing temperatures disrupt the synchrony between insect pests and their natural enemies, reducing the effectiveness of biological control (Thomson *et al.*, 2010). Because predators and parasitoids often respond differently to warming than their prey, changes in temperature can alter their development, emergence, and seasonal activity, leading to phenological mismatches that weaken natural pest suppression. Warmer conditions also promote shifts in the geographic distribution of pests, allowing them to expand into new areas where their natural enemies may be absent or slower to establish. This spatial mismatch enables pest populations to escape natural regulation and increase rapidly. Specialist natural enemies are particularly vulnerable to these changes because they have a limited ability to adapt to shifting host distributions, whereas generalist predators tend to be more resilient.

Mitigation Strategies for Rising Temperature in Pest Management

Rising temperatures increase the uncertainty of pest outbreaks, accelerate pest development, and expand their distribution, making pest management more challenging (Gregory *et al.*, 2009). To reduce these impacts, climate-resilient Integrated Pest Management (IPM**)** strategies should be strengthened by combining regular pest surveillance, temperature-based forecasting systems, and predictive models to enable timely interventions. Enhancing the adaptive capacity of farming systems through improved monitoring, rapid response measures, and locally tailored pest management practices can further reduce temperature-driven pest risks and improve agricultural resilience under a changing climate.

CONCLUSION

High temperature is increasingly reshaping agricultural ecosystems by influencing both crop performance and insect pest populations. Heat stress adversely affects plant growth, development, and reproductive success, resulting in reduced productivity and increased vulnerability to environmental stresses. Simultaneously, warmer conditions favour the rapid development, reproduction, survival, and geographical expansion of many insect pests, increasing the likelihood of severe pest outbreaks and greater economic losses. The interaction between heat-stressed crops and changing pest populations further complicates agricultural production and poses a growing threat to food security. Nevertheless, the impact of high temperature varies among crop species, insect pests, and local environmental conditions, highlighting the need for region-specific management approaches. Strengthening agricultural resilience will require the development of heat-tolerant crop cultivars, improved water management, continuous pest surveillance, and environmentally sustainable integrated pest management strategies. Combining these approaches with emerging technologies such as precision agriculture, remote sensing, and predictive pest forecasting will help minimize the adverse effects of rising temperatures and support sustainable crop production in the face of ongoing climate change.

REFERENCES

Deshar, R., & Koirala, M. (2019). Climate change and gender policy. In *Global Climate Change and Environmental Policy: Agriculture Perspectives* (pp. 411-422). Singapore: Springer Singapore.

Dukes, J. S., Pontius, J., Orwig, D., Garnas, J. R., Rodgers, V. L., Brazee, N., ... & Ayres, M. (2009). Responses of insect pests, pathogens, and invasive plant species to climate change in the forests of northeastern North America: what can we predict?. *Canadian journal of forest research*, *39*(2), 231-248.42).

Gregory, P. J., Johnson, S. N., Newton, A. C., & Ingram, J. S. (2009). Integrating pests and pathogens into the climate change/food security debate. *Journal of experimental botany*, *60*(10), 2827-2838.

Ma, C. S., Ma, G., & Pincebourde, S. (2021). Survive a warming climate: insect responses to extreme high temperatures. *Annual Review of Entomology*, *66*(1), 163-184.

Masters, G., & Norgrove, L. (2010). Climate change and invasive alien species.

Prakash, A., Rao, J., Mukherjee, A. K., Berliner, J., Pokhare, S. S., Adak, T., ... & Shashank, P. R. (2014). *Climate change: impact on crop pests* (pp. 2-19). Odisha: Applied Zoologists Research Association (AZRA), Central Rice Research Institute.

Thomson, L. J., Macfadyen, S., & Hoffmann, A. A. (2010). Predicting the effects of climate change on natural enemies of agricultural pests. *Biological control*, *52*(3), 296-306.

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proceedings of the national academy of sciences*, *108*(50), 20260-20264.