Available online at
http://agrospheresmagazine.vitalbiotech.org/

ISSN (E): 2582 – 7022

Agrospheres:e- Newsletter, (2025) *6*(11), 50-53

Article ID: 829

Insect Pests in a Changing Climate: Impacts and Management Strategies

D. Prakash[*1], Vivek Kumar[2], Lavudya Kumar[3], Vireesha P[4] and Sagar Komalsing Thakare[5]

[1]Assistant Professor, Department of Entomology, School of Agricultural Sciences, Sri Manakula Vinayagar Engineering College, Madagadipet, Puducherry
[2]Ph.d. Scholar, Department of Entomology, Bihar Agricultural University, Bhagalpur, Bihar
[3]M.Sc. Scholar, Department of Entomology, Bidhan Chandra Krishi Viswavidyalaya, West Bengal
[4]PhD Scholar, Department of Entomology, Indian Agricultural Research Institute, Pusa, New Delhi
[5]Assistant Professor, Department of Agronomy, Dr. Ulhas Patil College of Agriculture, Jalgaon

*Corresponding Author
D. Prakash*

Article History
Received: 2. 11.2025
Revised: 6. 11.2025
Accepted: 11. 11.2025

INTRODUCTION

Climate change is reshaping ecosystems across the globe, and agricultural systems are among the most vulnerable to its impacts. Rising temperatures, altered precipitation patterns, shifting seasons and an increase in extreme weather events are collectively transforming the environmental conditions under which crops and their associated organisms—both beneficial and harmful—interact. Among these, insect pests pose one of the most significant threats to agricultural productivity and food security. As climate variables change, pest populations are responding rapidly, often in ways that intensify their destructive potential.

Insects are ectothermic (cold-blooded) organisms, meaning their metabolism, development, survival and reproduction are directly influenced by external environmental conditions. Even small changes in temperature or humidity can have profound effects on their life cycles. Warmer temperatures can accelerate insect development, reduce generation time and increase the number of generations per year, leading to larger and more frequent pest outbreaks. Extended warm seasons may also allow pests to survive winters that once limited their distribution, enabling them to expand into new geographic regions. Similarly, changes in rainfall and relative humidity influence pest feeding behavior, dispersal ability, survival rates and population density. Drought conditions may weaken crop plants, making them more susceptible to pest attack, while excessive rainfall can create favorable breeding conditions for certain pests.

These climatic shifts not only affect pests directly but also influence their interactions with natural enemies, host plants and pathogens. For example, beneficial insects such as parasitoids and predators may not adapt as quickly as pests, potentially disrupting natural biological control. Climate change can also alter plant physiology, nutrient composition and defensive mechanisms, further influencing pest performance. Such complex ecological interactions make pest management increasingly challenging.

Traditional pest management strategies—including chemical control, cultural practices and biological control—may become less effective under changing climate scenarios. Pesticide efficacy can be reduced by temperature-driven shifts in pest metabolism, while altered cropping patterns or phenological changes may disrupt the timing of control measures. As pests migrate to previously unaffected zones, new pest complexes emerge, requiring farmers and researchers to adopt innovative and adaptive approaches.

Addressing these multifaceted challenges demands a deep understanding of how climate change influences pest biology, ecology and population dynamics. It requires interdisciplinary research that integrates climatology, entomology, agronomy and environmental science. Moreover, sustainable and resilient pest management strategies—such as integrated pest management (IPM), climate-smart agriculture, habitat management and predictive modeling—must be developed and implemented to safeguard crop production.

1. Effects of Climate Change on Insect Pests

1.1 Temperature Changes

Temperature is a critical factor in insect physiology. Rising temperatures generally accelerate metabolism, shorten developmental cycles and increase the number of generations per year. For example, the diamondback moth (*Plutella xylostella*), a major pest of cruciferous vegetables, now completes more generations annually in tropical and subtropical regions. Warmer winters also reduce insect mortality, allowing pests to survive in regions that were previously too cold.

1.2 Rainfall and Humidity

Changes in precipitation can favor some pests while limiting others. Increased rainfall may encourage pests that thrive in wet conditions but suppress drought-tolerant pests. Conversely, drought-stressed crops are often more susceptible to pest attacks, particularly by sucking insects like aphids and whiteflies.

1.3 Range Expansion

Climate change is driving pests into previously unsuitable areas. The fall armyworm (*Spodoptera frugiperda*), native to the Americas, has now spread to Africa and Asia, threatening maize and other cereal crops. Similarly, warmer temperatures allow pests to invade higher altitudes and latitudes, expanding their ecological footprint.

1.4 Phenological Shifts

Climate changes can shift the timing of insect life cycles relative to crop development. Earlier springs may cause misalignment between pest emergence and crop vulnerability. In some cases, this reduces damage; in others, it intensifies outbreaks if pests adapt faster than crops.

2. Major Insect Pests and Their Impacts

Insect Pest	Crops Affected	Impact of Climate Change	Management Strategies
Diamondback Moth	Cabbage, Cauliflower	Increased generations per year; warmer winters increase survival	Resistant cultivars, biological control (parasitoids), IPM
Fall Armyworm	Maize, Sorghum	Rapid spread to new regions; drought favors outbreaks	Bt maize, crop rotation, pheromone traps, targeted pesticide use
Aphids	Wheat, Barley, Vegetables	Thrive under mild winters; reproduce rapidly	Ladybird beetles, intercropping, neem-based sprays
Locusts	Cereals, Pasture	Swarming events increase due to wetter conditions	Early warning systems, biological pesticides, habitat management
Whiteflies	Tomato, Cotton, Cucurbits	Outbreaks linked to high temperatures and drought stress	Natural enemies, reflective mulches, selective insecticides

3. Impacts on Agriculture and Ecosystems

3.1 Crop Losses and Food Security

Increased pest pressure leads to reduced crop yields and quality, threatening food security, particularly in developing regions. Some studies suggest climate-induced pest outbreaks could cause 10–25% additional losses for staple crops.

3.2 Increased Pesticide Use

Frequent pest outbreaks may drive higher pesticide use, increasing costs and environmental pollution. Excessive chemical application can also disrupt beneficial insect populations, exacerbating the problem over time.

3.3 Disruption of Natural Pest Control

Climate change can affect predators, parasitoids, and pollinators differently than pests. For instance, ladybird beetles may decline in extreme heat, reducing their control of aphid populations. This imbalance can worsen pest outbreaks if natural checks are weakened.

4. Management Strategies in a Changing Climate

4.1 Monitoring and Early Warning Systems

Weather-based pest prediction models, pheromone traps and remote sensing tools allow early detection of potential outbreaks. Timely intervention minimizes crop damage and reduces chemical use.

4.2 Integrated Pest Management (IPM)

IPM combines cultural, biological, mechanical, and chemical control methods. Crop rotation, intercropping, and mulching disrupt pest lifecycles, while natural predators reduce pest populations sustainably.

4.3 Biological Control

Promoting populations of predators, parasitoids, and entomopathogenic fungi helps control pests naturally. For example, Trichogramma wasps parasitize lepidopteran eggs, reducing the need for chemical pesticides.

4.4 Resistant Crop Varieties

Using pest-resistant varieties, such as Bt maize for fall armyworm, reduces reliance on chemicals and provides sustainable protection under changing climatic conditions.

4.5 Climate-Smart Agronomic Practices

Adjusting planting dates, irrigation, and fertilization based on climate predictions reduces crop vulnerability. Practices like intercropping, mulching and proper spacing also help limit pest proliferation.

4.6 Judicious Pesticide Use

Pesticides should be applied only when necessary and in targeted zones. Rotating chemical modes of action prevents resistance development and minimizes environmental contamination.

5. Research, Technology and Policy Support

Effective pest management under climate change requires:

- **Research:** Studying pest-climate interactions and natural enemies to develop adaptive strategies.
- **Technology:** Remote sensing, AI-based prediction models and mobile applications for real-time pest monitoring.
- **Policy Support:** Providing farmers access to climate-resilient seeds, IPM training and subsidized tools to promote sustainable pest management.

6. Climate-Induced Pest Outbreaks: Case Studies

Real-world examples illustrate how climate change has already altered pest dynamics:

6.1 Fall Armyworm in Africa and Asia

- Originally from the Americas, fall armyworm has spread rapidly due to warmer climates and changing rainfall patterns.
- Outbreaks in maize-growing regions of Africa have caused up to 50% yield losses, demonstrating the need for early detection and resistant varieties.

6.2 Locust Swarms in East Africa

- Unusually heavy rainfall in 2019–2020 fueled massive locust swarms, threatening food security across multiple countries.
- Climate-linked factors such as warmer temperatures and cyclonic rains created ideal breeding conditions for locusts.

6.3 Aphid Infestation in Temperate Crops

- Warmer winters in Europe have increased aphid survival rates, leading to early spring infestations in cereals and vegetables.
- This case highlights the need for integrated pest management and biological control measures in temperate zones.

7. Interaction with Other Climate Stressors

Pests do not act in isolation; they interact with other environmental stressors:

7.1 Drought and Water Stress

- Drought-stressed plants are often more vulnerable to sucking insects like aphids and whiteflies.
- Water stress can also reduce the effectiveness of natural enemies, worsening pest outbreaks.

7.2 Heatwaves and Extreme Events

- Extreme heat can sometimes reduce pest survival, but it can also accelerate reproduction in heat-tolerant species.
- Floods and storms can disperse pests over large areas, creating sudden infestations.

7.3 CO2 Concentration and Plant-Pest Interactions

- Elevated CO2 affects plant physiology, altering nutrient content and leaf structure.
- These changes can increase feeding by some pests while decreasing susceptibility to others, creating complex interactions.

8. Role of Technology in Pest Monitoring and Management

Technology is critical for climate-adaptive pest management:

8.1 Remote Sensing and Drones

- Monitor large fields quickly for pest hotspots and crop stress.
- Provide early warning and enable targeted interventions.

8.2 Artificial Intelligence and Predictive Modeling

- AI models can predict pest outbreaks based on temperature, rainfall and crop stage.

- Farmers can make proactive decisions, such as adjusting planting dates or applying targeted pest control.

8.3 Mobile Apps and Farmer Networks

- Apps provide real-time pest alerts and weather-based advice.
- Farmer networks facilitate knowledge sharing and coordinated action, essential in managing mobile pests like locusts.

CONCLUSION

Climate change is reshaping the dynamics of insect pests, leading to more frequent, severe and geographically widespread outbreaks. Rising temperatures, altered rainfall patterns and extreme weather events affect pest survival, reproduction and distribution, posing significant threats to crop productivity and food security. Addressing these challenges requires an integrated approach that combines monitoring and early warning systems, climate-smart agronomic practices, biological control, resistant crop varieties and judicious pesticide use. Advances in technology, including remote sensing, AI-based predictive models and farmer networks, offer promising tools for proactive pest management. Coupled with research and policy support, these strategies can help farmers adapt to a changing climate while promoting sustainable and resilient agricultural systems.

REFERENCES

Chen, Y., Liu, Y. & Zhang, S. (2020). Impact of climate change on insect pests: Implications for crop production and pest management. Agricultural Systems, 181, 102835. https://doi.org/10.1016/j.agsy.2020.102835

FAO. (2021). Climate change and pests: Impacts and management strategies. Food and Agriculture Organization of the United Nations. https://www.fao.org/climate-change/en/

Gutierrez, A. P., Ponti, L. & Herren, H. R. (2019). The effects of climate change on insect pest populations and crop yield. Current Opinion in Insect Science, 35, 9–15. https://doi.org/10.1016/j.cois.2019.05.003

IPCC. (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/wg2/

Parsa, S., Morse, S., Bonifacio, A., Chancellor, T. C. B., Condori, B., Crespo-Pérez, V. & Babin, R. (2014). Limits of biological control of pests under climate change. Biological Control, 75, 50–59. https://doi.org/10.1016/j.biocontrol.2013.11.012