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

ISSN (E): 2583 – 1933

Curr. Agri.Tren.:e- Newsletter, (2025) *4*(12), 16-19

Current Agriculture Trends: e-Newsletter

Article ID: 506

Insect-Born Threats: Understanding Emerging Crop Pests

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Article History
Received: 29. 11.2025
Revised: 4. 12.2025
Accepted: 9. 12.2025

INTRODUCTION

Crop production has always been vulnerable to insect pests. Insects feeding on roots, stems, leaves, flowers, fruits or stored produce significantly reduce both yield and harvest quality. In recent decades, a worrisome trend has emerged: insect species that were once minor pests or absent in certain agro-ecosystems are now becoming major threats. These emerging pests pose serious risks to global food security, farmer livelihoods and agricultural sustainability.

Several factors contribute to the rise of emerging insect pests. Climate change, changing land use, shifts in cropping patterns, global trade and increasing movement of plant material facilitate the spread of pests into new regions or allow previously minor pests to expand their populations. As a result, farmers and agricultural systems face a shifting pest landscape. Old management practices may no longer suffice.

Understanding these emerging threats is crucial. It requires identifying which pests are becoming serious, why they are increasing, how they damage crops, and what management strategies remain effective. This article reviews current evidence on emerging insect pests, examines underlying drivers, highlights implications for crop security, and discusses possible management responses. In this way, it aims to inform researchers, extension workers and growers about evolving insect-borne threats to agriculture.

What Defines an Emerging Insect Pest

An emerging insect pest is a species whose status has shifted within a cropping system: from minor to major, from secondary to primary, or from rare/absent to frequent and damaging. Emerging pests may be:

- formerly known species that are increasing in prevalence or intensity of attack,
- pests shifting to new crop hosts,
- invasive species newly introduced into a region, or
- native species whose behaviour or population dynamics have changed under altered environmental conditions.

The shift in pest behaviour or status is often driven by environmental, ecological and human-mediated changes. Therefore, pest emergence is not random but reflects broader transformations in agriculture and the environment.

Drivers of Pest Emergence

Climate Change and Environmental Shifts

Rising global temperatures, increased atmospheric CO_2 levels, altered rainfall patterns, and more frequent extreme weather events are reshaping the ecology of insect pests. These changes influence pest development, survival, reproduction and distribution. For example, warmer temperatures can accelerate insect development, increase overwintering survival and allow more generations per year. Such changes often result in expanded geographic range, more rapid population build-up and invasion into previously unsuitable zones.

Changes in precipitation and humidity may also affect pests differently than crops or natural enemies. In some cases, moderate drought increases pest feeding pressure because weakened plants become more susceptible and natural enemy populations decline.

Changes in Land Use, Agricultural Practices and Crop Systems

Conversion of natural ecosystems to croplands, intensification of agriculture, expanded monocultures, high fertilizer and irrigation use, uniform high-yielding crop varieties and increased cropping intensity alter the agro-ecosystem environment. These changes often reduce biodiversity, including populations of natural enemies of pests, and create favourable conditions for pest proliferation.

Additionally, shifting cropping patterns or the introduction of new crops may expose plants to pests that previously did not target them. In such cases, pests may shift hosts or expand their diet breadth, becoming newly significant problems.

Global Trade and Movement of Plant Material

Globalization of trade networks facilitates the unintentional introduction of non-native or invasive insect species into new regions. Once introduced, such species may establish if the environment and host plants are suitable, and local natural enemies are absent. These invasive pests often become serious threats because existing pest-management knowledge or traditional practices may not apply to them.

Examples of Emerging Crop Pests and Changing Pest Patterns

Recent studies and reviews document multiple cases in which insect pest status has changed, minor pests have become major, and new pests have invaded or expanded.

- A study on vegetable crops under climate change identified increasing incidence of insects such as mealybugs, certain fruit-flies, stem borers, moths and red spider mites. In particular, new invasions or outbreaks affecting tomato, chilli and other vegetables have caused serious harvest losses.
- For pulse crops, some pests that were previously secondary are now emerging as major threats, challenging production stability under climate variability.
- For staple cereals such as rice, wheat and maize, pest pressure is projected to increase under warming: yield losses due to insect pests are expected to increase by 10–25 per cent per degree of global surface warming.
- Invasive alien pests that adapt quickly pose special threats. For instance, a globally invasive pest on maize has become more difficult to control under changing climate and management scenarios.

These examples illustrate that pest status is not static. Under changing environmental and agronomic conditions, the pest spectrum and threat landscape evolve dynamically.

Risks and Impacts on Agriculture and Food Security

Emerging insect pests threaten agriculture and food security in multiple ways:

- Increased pest pressure can lead to yield reductions, partial or total crop losses, and reduced crop quality.
- Economic burden on farmers increases, especially for smallholders and resource-poor farmers who may lack access to advanced pest-management resources.

- Overreliance on chemical controls may increase, leading to environmental degradation, harm to beneficial organisms, soil and water contamination, and development of pesticide resistance.
- Traditional pest-management knowledge and locally adapted control systems may become inadequate or fail when pest species shift or new pests appear.
- Food security at regional or national levels may be compromised when staple crops (rice, wheat, maize, pulses, vegetables) face elevated pest-induced losses.
- Biosecurity risk grows due to invasive pests entering through trade or migration, threatening agro–ecosystems and requiring new surveillance and management systems.

Therefore, emerging insect pests represent more than a transient or local problem. They pose a systemic challenge to agriculture, livelihoods and sustainability.

Challenges in Managing Emerging Pest Threats

Several challenges complicate an effective response to emerging insect threats:

- Limited or no prior knowledge about the biology, life-cycle, host range and ecology of newly emerging pests.
- Delays in detection and response, as early infestations may go unnoticed until damage is significant.
- Existing pest-management strategies and integrated pest management (IPM) packages may not cover new pests or be effective under changed environmental conditions.
- Limited capacities for monitoring, surveillance, early warning and forecasting of pest outbreaks.
- Weak biosecurity, quarantine, and regulation of plant material movement in many regions.
- Increased dependence on chemical pesticides in the absence of effective biological, cultural or ecological alternatives.
- Socioeconomic constraints: smallholder farmers may lack access to information, resources, and support systems needed for adaptive pest management.

These challenges require urgent attention from agricultural researchers, extension services, policymakers and the farming community.

Management Strategies and Pathways Forward

Addressing emerging insect-borne threats requires a multi-pronged, adaptive and integrated approach. Some key strategies include:

Adaptive Integrated Pest Management

Update and expand existing IPM frameworks to account for new pests. This involves regular surveillance, pest identification, threshold-based interventions, biological control, cultural practices (crop rotation, intercropping), use of resistant or tolerant varieties, and judicious use of chemical control only when necessary. This approach must be flexible and revised as pest dynamics change.

Monitoring, Early Warning and Research

Establish robust monitoring systems for pest populations, distribution, and environmental parameters. Use long-term datasets, predictive modelling under climate change scenarios, and early-warning mechanisms. Invest in research on pest biology under changing climate and cropping systems, host-range expansion, pest-natural enemy interactions, and effective control methods.

Biosecurity, Quarantine and Trade Regulation

Strengthen phytosanitary measures at national and regional levels. Implement inspection, quarantine protocols and rapid response for invasive pest detection, especially in the trade of seeds, planting materials and produce. Improve cooperation among countries and regions to prevent the spread of pests across borders.

Agroecological Practices and Diversification

Promote crop diversification, mixed cropping, intercropping, agroforestry, habitat for natural enemies, and soil health. Increased agro-ecosystem biodiversity enhances resilience against pest outbreaks and reduces reliance on chemical pesticide use.

Capacity Building and Farmer Empowerment

Provide training and extension services to farmers for early identification of pests, use of

sustainable pest-management techniques, record-keeping, and understanding of pest-climate-crop interactions. Encourage farmer networks and community-based pest-monitoring, collective actions and knowledge sharing.

Innovative Technologies and Tools

Adopt technologies such as remote sensing, GIS, climate forecasting, modelling, and automated pest detection tools to enhance surveillance and early detection. For example, recent research on machine-learning-based insect identification systems shows promise to detect pests in real time.

CONCLUSION

Insect pests in agricultural systems are no longer a static or predictable threat. Environmental changes, climate shifts, land use transformations, global trade and evolving agricultural practices are reshaping the pest landscape. Emerging insect pests and shifting pest pressures present a severe challenge to crop productivity, food security and livelihoods worldwide. To meet this challenge, we must adopt integrated, adaptive, scientifically informed and ecologically sound pest-management strategies. Robust monitoring, early-warning systems, agroecological resilience, biosecurity, capacity building and farmer empowerment are essential components. The era of static pest management is over. Agriculture must evolve with changing pest dynamics. Only then can we safeguard crops, ensure sustainable food production and protect farming livelihoods in a rapidly changing world.

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