DOI: 10.54083/BRT/08.05.26/77-79

Bio. Res. Today 2026, 8(5):77-79

Biotica Research Today

e-ISSN: 2582-6654

May, 2026

Article ID: RT1886 **Popular Article**

El Niño and Insect Pest Dynamics: Implications for Crop Protection

Rittik Sarkar*, Ram Keval, Sova Yadav, Sneha Sharma and Rohit Raman

Dept. of Entomology and Agricultural Zoology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (221 005), India

Open Access

Corresponding Author

Rittik Sarkar

: rittikrnj197@gmail.com

Conflict of interests: The authors have declared that no conflict of interest exists.

How to cite this article?

Sarkar, R., Keval, R., Yadav, S., *et al*., 2026. El Niño and Insect Pest Dynamics: Implications for Crop Protection. *Biotica Research Today* 8(5), 77-79. DOI: 10.54083/BRT/08.05.26/77-79.

Abstract

The El Nino-Southern Oscillation (ENSO) is emerging from its cool phase and forecasts issued in March 2026 gave a 62% chance that El Niño would develop during June-August 2026 and persist through at least the end of the year. ENSO events have wider implications in addition to displacing weather patterns. Insects are ectotherms, which means that temperature and, by extension, humidity have a direct influence on their development, reproduction and dispersal. As a result of their sensitivity to temperature and aridity, ENSO exerts a discernible influence on crop pests. The nature and extent of this influence are determined by the thermal tolerances of the pests and the reactions of rainfall to ENSO in a given region. One of the most effective ways of improving predictive, climate-informed pest management is to build on ENSO seasonal forecasts by developing regional entomological alerts, such as those produced by the Desert Locust Watch (DLW) service at the Food and Agriculture Organization of the United Nations (Rome, Italy).

Keywords: Crop pests, Crop protection, El Niño-Southern Oscillation, Thermal thresholds

Introduction

On March 12, 2026, the U.S. National Oceanic and Atmospheric Administration (NOAA) Climate Prediction Center placed the tropical Pacific under a combined La Niña Advisory and El Niño Watch, reporting that a transition from La Niña to ENSO-neutral was expected within the following month. The outlook indicated a 55% probability that ENSO-neutral conditions would prevail through May-July 2026 and a 62% probability that El Niño would emerge during June-August 2026 and persist through at least the end of the year (NOAA Climate Prediction Center, 2026). The eventual strength of the event remained highly uncertain at that stage, with roughly a one in three chance that it would qualify as strong during October-December 2026. If that forecast holds, much of the tropics and subtropics will enter the coming cropping season under a developing warm phase. For agriculture, this is far more than a seasonal weather concern. El Niño can alter rainfall and temperature patterns across large parts of the tropics and subtropics, exposing major food-producing regions in the Americas, Africa, Asia and Australia to climate risks that may occur simultaneously or in close succession.

The agricultural impacts of El Niño are often discussed in terms of crop responses, particularly drought, heat and excess rainfall. Yet another part of the system can respond just as quickly: insect pests. As ectothermic organisms, insects depend heavily on their surrounding environment to regulate body temperature and consequently processes such as development, reproduction, survival and dispersal. Changes in temperature and moisture associated with ENSO can thus extend beyond the crop itself, influencing pest population growth and seasonal outbreaks (Skendžić *et al.*, 2021). This article reviews how El Niño reshapes insect pest biology, examines three well-documented case studies, considers what happens to the natural enemies that normally keep pests in check and outlines how forecasting

Article History

RECEIVED on 29th April 2026 RECEIVED in revised form 13th May 2026 ACCEPTED in final form 15th May 2026

tools and adaptive integrated pest management (IPM) can convert seasonal climate outlooks into practical crop protection decisions.

How a Warm Pacific Rewires Insect Biology

El Niño develops when sea surface temperatures in the central and eastern tropical Pacific become unusually warm, disrupting the atmospheric circulation that helps organize rainfall across the planet. This shift produces a broadly recognizable pattern of climate anomalies, although its expression varies from one region to another. Drier than normal conditions often develop across parts of Southeast Asia, southern Africa and northeastern South America, while wetter conditions may occur in parts of East Africa, the southern United States and western South America (NOAA Climate Prediction Center, 2026).

For insects, temperature is the single most direct influence on development. Within their physiological thermal limits, warmer conditions generally accelerate the progression from one life stage to the next, potentially allowing insects to complete more generations within a year. This response has been documented across many European butterfly and moth species, where warmer spring temperatures can increase the number of generations produced annually and allow some multivoltine species to add an extra generation. A similar temperature-dependent pattern occurs in the coffee berry borer. Degree-day models show that the number of generations it can complete increases as temperatures rise above its developmental threshold of about 14.9 °C, with development performing best between approximately 20 °C and 30 °C (Jaramillo *et al.*, 2009). Rainfall and humidity add a second layer of influence. Heavy rainfall and flooding can wash away eggs and larvae and dislodge small-bodied pests such as aphids, mites and whiteflies, and can disrupt the diapause of stages that overwinter in the soil, whereas drought-stressed plants become both more attractive and more vulnerable to attack because they produce fewer defensive secondary metabolites (Skendžić *et al.*, 2021). The biological response to El Niño is thus rarely uniform. Much depends on how the temperature anomaly compares with a species' thermal optimum and how changes in rainfall coincide with its reproductive cycle and host-plant availability. As a result, the same El Niño event may drive an increase in one pest population while reducing another, even within the same agricultural season.

Three Pests, Three Warnings

Fall Armyworm

Spodoptera frugiperda is native to the Americas but was first confirmed in West and Central Africa in early 2016. Since its arrival, outbreaks across the region have frequently been associated with the onset of the rainy season, particularly when rainfall follows a prolonged period of drought. Climate-suitability modelling using the CLIMEX platform shows the pest is now capable of establishing across much of eastern and central Africa as well as large parts of West Africa. Its further expansion into northern and southern Africa appears to be constrained mainly by extremes of temperature and moisture. Because a drought-then-rain sequence is a classic El Niño signature in parts of the continent, ENSO cycles help set the calendar for when fall armyworm populations rebound.

Desert Locust

Schistocerca gregaria, the desert locust, provides a striking example of how unusual rainfall can transform insect population dynamics. Normally, the species occurs at low densities in its arid habitats, where individuals remain in a solitary phase. When substantial and persistent rainfall creates favourable breeding conditions across normally dry areas of the Horn of Africa and the Arabian Peninsula, population densities can rise rapidly and trigger a shift to the gregarious phase. The resulting swarms can cause severe damage to crops and pasture over large areas. The 2019-2020 desert locust upsurge, the most severe in roughly 25 years, followed an exceptional sequence of Indian Ocean cyclones associated with a strongly positive Indian Ocean Dipole (IOD). The IOD is an ocean-atmosphere climate pattern that interacts with ENSO and often occurs alongside El Niño or La Niña events. These large-scale climate connections matter because they can influence where and when the rainfall needed for locust breeding occurs. This relationship remains relevant to seasonal forecasting. Desert Locust Watch (DLW) of the Food and Agriculture Organization continues to incorporate ENSO and IOD signals into its assessments. In its early 2026 outlooks, FAO highlighted the developing shift toward El Niño together with a positive IOD as a combination that could favour wetter than normal spring conditions in several locust affected regions (FAO, 2026).

Coffee Berry Borer

One of the clearest quantitative examples comes from Colombian coffee systems, where populations of the coffee berry borer, *Hypothenemus hampei*, have been monitored across multiple ENSO phases. A single coffee berry borer-infested berry left on the ground at 1,218 m elevation during an El Niño year produced an average of about 959 coffee berry borer-infested berries on coffee trees. The corresponding figure was only about 152 during La Niña and 590 during a neutral year. Thus, the same initial source of infestation was followed by more than a six-fold difference in infestation levels depending on the prevailing climate phase (Constantino *et al.*, 2021). A separate multi-year study in the same coffee-growing basin recorded average borer densities of 1,850 individuals per tree under El Niño conditions against 629 under La Niña conditions, alongside a measured 2.5 °C increase in temperature above the historical average during the warm phase.

When the Guardians Falter?

Pest outbreaks are mostly constrained by parasitoids, predators and pathogens, yet these natural enemies do not necessarily respond to climate variability in the same way as their hosts. Their abundance, activity and effectiveness can shift with temperature and moisture, sometimes changing the balance between different sources of pest mortality. In a Panamanian rainforest, for example, ENSO altered not only the intensity of natural-enemy activity but also which biological-control guild accounted for most mortality in herbivorous beetles. During the warmer and drier conditions of El Niño years, parasitism by wasps became more prominent. In the cooler and wetter conditions associated with La Niña, mortality was instead dominated by competition between flies and wasps attacking larval stages. The result suggests that climate phase can change the identity of the principal biological-control agent, rather than simply increasing or decreasing natural-enemy activity. Patterns observed at larger spatial scales reinforce the need for caution. Rangeland grasshopper populations across the western United States have been linked to both ENSO and the Pacific Decadal Oscillation, but their responses were strongly asynchronous among regions. The same climatic index could be associated with rising grasshopper densities in one area while coinciding with population declines elsewhere during the same season. Such spatial variability is important when converting ENSO forecasts into pest-risk assessments. A climate signal that indicates elevated pest risk at one location should not automatically be interpreted as evidence of similar risk across an entire continent.

From Reaction to Anticipation

The tools needed to move pest management from a reactive approach to a more anticipatory one are already largely available. Seasonal ENSO forecasts from agencies such as NOAA's Climate Prediction Center now offer several months of lead time on a developing event and FAO's Desert Locust Watch offers a practical example of how such forecasts can be operationally fused with rainfall monitoring and field surveillance to issue actionable warnings well ahead of a swarm (FAO, 2026). Degree-day and CLIMEX-type models, of the kind used for fall armyworm and coffee berry borer, can translate a seasonal temperature and rainfall outlook directly into an expected number of pest generations or a shift in suitable range. A climate-smart extension of conventional integrated pest management has also been proposed for climate-variable agroecosystems, combining climate and pest monitoring, pest risk forecasting, climate-resilient crop varieties, crop diversification and agroecosystem management, and coordinated action across production, extension, research and policy (Heeb *et al.*, 2019). The major gap is now less about whether the necessary tools exist and more about connecting them. Seasonal ENSO outlooks are generated by meteorological agencies, while pest surveillance and crop-protection recommendations are usually developed through separate agricultural advisory systems. What is still missing in many regions is a routine operational pathway that links these two streams, so that a seasonal climate signal can be translated into crop and pest specific advice several months before an outbreak is likely to occur. Building this connection at the regional and crop level represents one of the most practical frontiers for climate-informed crop protection.

Conclusion

The El Niño event now forecast to develop gives this question immediate relevance rather than purely academic interest. If the 2026-2027 event emerges as predicted, farmers, extension services and crop protection agencies across the tropics and subtropics can expect the kind of pest pressure shifts described here: faster development in some systems, altered range and outbreak timing in others and a natural-enemy community that will not necessarily respond in lockstep with its hosts. Because these effects vary by species, region and even by trophic level, blanket assumptions are of limited use. A more useful approach is to integrate ENSO-informed seasonal forecasts with pest surveillance, local weather information and region-specific IPM decision-making. The operational experience of the Desert Locust Watch of FAO provides a strong starting point. Similar anticipatory systems could be developed for fall armyworm, coffee berry borer and other pests known to respond to ENSO-related climate variability. The goal is straightforward: use the climate signal to identify emerging pest risks early enough to act, rather than waiting for an outbreak to make the forecast relevant.

References

Constantino, L.M., Gil, Z.N., Montoya, E.C., Benavides, P., 2021. Coffee berry borer (*Hypothenemus hampei*) emergence from ground fruits across varying altitudes and climate cycles and the effect on coffee tree infestation. *Neotropical Entomology* 50(3), 374-387. DOI: https://doi.org/10.1007/s13744-021-00863-5.

FAO, 2026. Desert Locust: Seasonal precipitation predictions, 20 March 2026. In: *FAO Locust Watch*. Food and Agriculture Organization of the United Nations, Rome, Italy. Available at: https://www.fao.org/locust-watch/information/news/brief-detail/20-march-2026--seasonal-precipitation-predictions/en.

Heeb, L., Jenner, E., Cock, M.J.W., 2019. Climate-smart pest management: Building resilience of farms and landscapes to changing pest threats. *Journal of Pest Science* 92(3), 951-969. DOI: https://doi.org/10.1007/s10340-019-01083-y.

Jaramillo, J., Chabi-Olaye, A., Kamonjo, C., Jaramillo, A., Vega, F.E., Poehling, H.M., Borgemeister, C., 2009. Thermal tolerance of the coffee berry borer *Hypothenemus hampei*: Predictions of climate change impact on a tropical insect pest. *PLoS ONE* 4(8), e6487. DOI: https://doi.org/10.1371/journal.pone.0006487.

NOAA Climate Prediction Center, 2026. El Niño/Southern Oscillation (ENSO) diagnostic discussion, 12 March 2026. National Oceanic and Atmospheric Administration, College Park, Maryland, USA. Available at: https://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_disc_mar2026/ensodisc.shtml.

Skendžić, S., Zovko, M., Pajač Živković, I., Lešić, V., Lemić, D., 2021. The impact of climate change on agricultural insect pests. *Insects* 12(5), 440. DOI: https://doi.org/10.3390/insects12050440.