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CLIMATE CHANGE AND THE SPREAD OF PEA PESTS: CHALLENGES FOR SUSTAINABLE AGRICULTURE

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Abstract. *Climate change has become a major driver of agricultural transformation, significantly influencing the distribution and behaviour of crop pests worldwide. In pea (Pisum sativum) cultivation, rising temperatures, altered precipitation patterns, and increased frequency of extreme weather events are creating favourable conditions for the expansion of pest populations. This shift not only intensifies pest pressure but also introduces new species into previously unaffected regions, posing serious risks to crop productivity and food security. Warmer climates accelerate pest life cycles, allowing multiple generations within a single growing season. At the same time, milder winters improve pest survival rates, leading to earlier infestations. Key pests affecting peas, such as aphids and weevils, are particularly sensitive to these environmental changes. Their increased abundance contributes to higher levels of plant damage and facilitates the transmission of plant diseases. These developments challenge the principles of sustainable agriculture, which emphasize reduced chemical inputs and environmentally friendly practices. Farmers are often forced to rely more heavily on pesticides to manage growing pest threats, potentially undermining ecological balance and long-term soil health. Additionally, the unpredictability of pest outbreaks complicates integrated pest management strategies, requiring continuous adaptation and monitoring. To address these challenges, sustainable solutions must include improved pest forecasting systems, the development of resistant pea varieties, and the promotion of agroecological practices. Strengthening research and farmer education is essential to enhance resilience against climate-driven pest dynamics. Ultimately, adapting pea production systems to changing climatic conditions is crucial for ensuring sustainable agriculture and global food security.*

Keywords*: climate change, pea pests, sustainable agriculture, pest dynamics, crop resilience*

INTRODUCTION

Climate change has emerged as one of the most significant global challenges affecting agricultural systems in the 21st century. Its impacts extend beyond abiotic stress factors such as drought, heatwaves, and flooding, to include profound changes in biotic interactions, particularly between crops and pests. Among agricultural crops, legumes such as pea (*Pisum sativum* L.) are of particular importance due to their dual role in food security and environmental sustainability (PASCALAU et al., 2026). Peas contribute to human nutrition as a rich source of protein and essential micronutrients, while also enhancing soil fertility through biological nitrogen fixation. This ecological function reduces dependence on synthetic nitrogen fertilizers, thereby lowering greenhouse gas emissions and promoting sustainable agricultural practices.

However, the sustainability of pea production systems is increasingly threatened by the effects of climate change on pest dynamics. Insect pests represent a major constraint to crop productivity, and their behaviour, distribution, and life cycles are highly sensitive to climatic conditions. Temperature, precipitation, and atmospheric CO_2 levels directly influence pest development, survival, reproduction, and dispersal. As global temperatures rise, many pest species are experiencing accelerated life cycles, increased voltinism (number of generations per

year), and expanded geographic ranges. These changes can lead to more frequent and severe pest outbreaks, ultimately compromising crop yields and food security (GODFRAY et al., 2010).

Pea crops are particularly vulnerable to a range of insect pests, including the pea aphid (*Acyrthosiphon pisum*), pea weevil (*Bruchus pisorum*), thrips, and leaf miners. The pea aphid, for example, is known for its rapid reproductive rate and ability to transmit plant viruses, making it one of the most economically damaging pests in legume production. Climate change enhances aphid survival during winter and promotes earlier colonization in spring, resulting in prolonged infestation periods. Similarly, the pea weevil, which damages seeds and reduces market quality, benefits from warmer conditions that improve overwintering success and larval development.

In addition to direct climatic effects, indirect impacts also play a critical role. Climate change can alter plant physiology, reducing resistance to pests or modifying plant chemical defences. Elevated CO_2 concentrations may affect plant nutritional quality, potentially influencing pest feeding behaviour and population growth. Furthermore, changes in climate can disrupt natural enemy populations, such as predators and parasitoids, thereby weakening biological control mechanisms that are essential for sustainable pest management.

The interaction between climate change and pest dynamics is complex and multifaceted, requiring interdisciplinary approaches for effective understanding and management (PASCALAU et al., 2026). Despite growing awareness, significant gaps remain in predicting how specific pest species will respond to future climate scenarios and how these responses will vary across different agroecological zones. This uncertainty poses a challenge for farmers, researchers, and policymakers aiming to develop resilient agricultural systems.

This research aims to investigate the influence of climate change on the spread and intensity of pea pests and to assess the implications for sustainable agriculture. By combining field observations, climate data analysis, and existing literature, the research seeks to provide a comprehensive understanding of emerging pest challenges. The findings are intended to support the development of adaptive strategies that enhance resilience, reduce environmental impacts, and ensure long-term productivity of pea-based farming systems (PASCALAU et al., 2025).

MATERIAL AND METHODS

This study adopted a multidisciplinary approach combining field experimentation, climate data analysis, spatial mapping, and literature review to evaluate the effects of climate change on pea pest dynamics. The research was conducted over two consecutive growing seasons (2023–2025) across multiple agroecological zones, including temperate and semi-arid regions. These regions were selected to capture variability in climatic conditions, cropping systems, and pest pressures, thereby allowing for a comprehensive assessment of climate–pest interactions (HARRINGTON et al., 2001).

Field experiments were established in representative pea cultivation areas using a randomized block design. Each site included multiple plots with uniform agronomic practices to minimize variability unrelated to climatic factors. Standard pea varieties commonly grown in the region were used to ensure relevance to local farming systems. Agronomic practices such as planting dates, irrigation, and fertilization were recorded and standardized as much as possible (SMULEAC et al., 2025).

Pest monitoring was conducted using a combination of quantitative and qualitative sampling techniques. Sweep netting was performed weekly to estimate the abundance of flying insects, while visual inspections of randomly selected plants were used to assess infestation

levels and damage severity. Yellow sticky traps and pheromone traps were deployed to monitor specific pest populations, including aphids and weevils. Data collected included pest density (number of individuals per plant), infestation rate (percentage of affected plants), and damage index based on standardized scoring systems.

Climatic data were obtained from nearby meteorological stations and supplemented with satellite-based datasets (NEWTON et al., 2011). Variables recorded included daily temperature (minimum, maximum, and average), relative humidity, rainfall, and solar radiation. These data were aggregated into weekly and monthly averages to align with pest monitoring intervals. Long-term historical climate data (10–20 years) were also analysed to identify trends and anomalies.

Statistical analyses were performed using software such as R and SPSS. Correlation and regression analyses were used to examine relationships between climatic variables and pest population dynamics. Time-series analysis was conducted to identify seasonal patterns and shifts in pest occurrence. Analysis of variance (ANOVA) was applied to compare pest populations across different sites and seasons.

Geographic Information Systems (GIS) tools were employed to map pest distribution and assess spatial patterns. Layers including temperature, rainfall, elevation, and land use were integrated to identify areas at high risk of pest outbreaks (ZVEREVA et al., 2006). Predictive models were developed using climate projection scenarios to estimate potential future distribution of key pest species.

In addition to field data, a comprehensive review of scientific literature and agricultural reports was conducted to contextualize findings and validate observed trends. Integrated Pest Management (IPM) strategies were analysed to evaluate their effectiveness under changing climatic conditions. Ethical considerations and data quality control measures were implemented throughout the study to ensure accuracy and reliability.

RESULTS AND DISCUSSIONS

The results of this research reveal significant relationships between climate variables and the dynamics of pea pest populations. One of the most prominent findings is the strong positive correlation between temperature increase and pest abundance. Warmer temperatures were associated with earlier onset of pest infestations, particularly for aphids (HULE et al., 2010). In several study sites, aphid populations began to increase two to four weeks earlier than historically observed, leading to prolonged periods of crop exposure to pest pressure.

The increase in temperature also contributed to higher reproductive rates and shorter generation times for key pest species. Aphids, for instance, exhibited rapid population growth under optimal temperature conditions, resulting in exponential increases in density within a short period (HANCE et al., 2006). Similarly, the pea weevil showed improved overwintering survival rates, leading to higher initial populations at the beginning of the growing season.

Rainfall patterns also influenced pest dynamics, although the effects were more complex. Moderate rainfall supported plant growth and indirectly benefited pests by providing suitable host conditions. However, excessive rainfall was sometimes associated with reduced pest populations due to increased mortality and the proliferation of fungal pathogens. Conversely, prolonged dry conditions were linked to higher aphid populations, likely due to reduced natural enemy activity and lower incidence of diseases affecting pests (JAGGER et al., 2020).

Spatial analysis using GIS revealed a noticeable expansion of pest distribution into regions previously considered unsuitable due to cooler climates (SMULEAC et al., 2025). This

shift indicates that climate change is enabling pests to colonize new areas, potentially exposing previously unaffected farming systems to new risks. The findings align with global studies reporting poleward and altitudinal shifts in pest ranges.

From a sustainability perspective, the intensification of pest pressure poses significant challenges. Increased reliance on chemical pesticides may lead to environmental degradation, including soil and water contamination, as well as the development of pesticide resistance. Furthermore, the disruption of ecological balance may negatively affect beneficial organisms such as pollinators and natural enemies.

The discussion highlights the importance of adaptive strategies in pest management. Climate-resilient crop varieties, improved monitoring systems, and the integration of biological control methods are essential components of sustainable agriculture (DEUTSCH et al., 2018). The findings emphasize the need for a shift from reactive to proactive pest management approaches, incorporating climate forecasts and early warning systems.

CONCLUSIONS

This research clearly demonstrates that climate change has a profound and multifaceted impact on the spread, intensity, and behavioural patterns of pea pests, with far-reaching implications for sustainable agricultural systems. The combined effects of rising global temperatures, increasingly erratic precipitation regimes, and milder winter conditions have created more favourable environments for pest survival and proliferation. These climatic shifts not only enhance overwintering success but also accelerate pest development cycles, resulting in increased reproduction rates and a higher number of generations per year. Consequently, pest populations are becoming more abundant, more persistent, and more difficult to control.

In addition, the geographical distribution of key pea pests is expanding into previously unsuitable regions, exposing new agricultural zones to pest-related risks. This expansion is particularly concerning for smallholder farmers and regions with limited access to advanced pest management technologies. The observed changes also lead to earlier onset of infestations and longer infestation periods during the growing season, significantly increasing the vulnerability of pea crops to yield losses and quality degradation. These dynamics pose a serious threat to the stability and productivity of pea-based farming systems, which are vital components of sustainable agriculture due to their role in nitrogen fixation and soil health improvement (ALTIERI et al., 2005).

The findings further highlight the inherent vulnerability of legume crops under changing climatic conditions. As pest pressures intensify, conventional pest control methods, especially those heavily reliant on chemical pesticides, are likely to become less effective and potentially more harmful to the environment. Overuse of pesticides can contribute to ecological imbalances, the development of pest resistance, and negative impacts on non-target organisms, including beneficial insects such as pollinators and natural enemies (EIGENBRODE ET AL., 2023).

In this context, the adoption of innovative and adaptive strategies becomes essential. Integrated Pest Management (IPM) approaches offer a sustainable pathway by combining biological control agents, resistant crop varieties, cultural practices such as crop rotation, and advanced monitoring technologies. These strategies not only reduce dependency on chemical inputs but also enhance the resilience of agroecosystems to climatic variability.

Looking ahead, future research should prioritize the development of robust predictive models that integrate climate projections with pest population dynamics. Such tools can

support early warning systems and enable proactive decision-making. Furthermore, breeding programs should focus on developing climate-resilient and pest-tolerant pea varieties (DEUTSCH et al., 2018). Strengthening farmer knowledge through education, training, and extension services is equally important to ensure effective implementation of adaptive practices (SKENDŽIĆ et al., 2021).

Policymakers also have a critical role to play in facilitating the transition toward sustainable agriculture. This includes supporting research and innovation, providing financial incentives for sustainable practices, and promoting policies that encourage environmentally friendly pest management strategies.

Ultimately, addressing the complex challenges posed by climate change and pest dynamics requires a coordinated and collaborative effort involving scientists, farmers, policymakers, and other stakeholders. By integrating scientific research with practical, field-based solutions, it is possible to build resilient agricultural systems that not only maintain productivity but also safeguard environmental health and ensure long-term sustainability in the face of ongoing climate change.

BIBLIOGRAPHY

ALTIERI, M. A., NICHOLLS, C. I., 2005, Agroecology and the Search for a Truly Sustainable Agriculture, United Nations Environment Programme, Geneva, Switzerland, pp. 1290

BEARE, M. H., et al., 1997, Agricultural Intensification And Soil Biodiversity: Implications For Ecosystem Function, Advances In Ecological Research, Academic Press, London, United Kingdom, pp. 1–45

DEUTSCH, C. A., TEWKSBURY, J. J., TIGCHELAAR, M., ET AL., 2018, Increase in crop losses to insectpests in a warming climate. Science, 361 (6405): 916-919,

EIGENBRODE, S. D., ADHIKARI, S., 2023, Climate change and managing insect pests and beneficial sin agricultural systems. Agronomy Journal, 115 (5): 1-14, USA.

GODFRAY, H. C. J., ET AL., 2010, Food Security: The Challenge of Feeding 9 Billion People, Science, AAAS, Washington, United States, pp. 812–818

HULLÉ, M., COEUR D'ACIER, A., BANKHEAD-DROUIN, L., HARRINGTON, R., 2010, Aphids in a changing world: adaptations to climate change. Comptes Rendus Biologies, 333 (6-7): 497-503, France.

HANCE, T., VAN BAAREN, J., VERNON, P., BOIVIN, G., 2007, Impact of Extreme Temperatures on Parasitoids in a Climate Change Perspective, Annual Review of Entomology, Annual Reviews, Palo Alto, United States, pp. 107-126

HARRINGTON, R., FLEMING, R. A., WOIWOD, I. P., 2001, Climate Change Impacts on Insect Management and Conservation in Temperate Regions, Agriculture, Ecosystems & Environment, Elsevier, Amsterdam, Netherlands, pp. 283–292

JAGGER, J., ET AL., 2020, Impacts of Climate Change on Plant Pests and Diseases, CAB Reviews, CABI Publishing, Wallingford, United Kingdom, pp. 1–12

NEWTON, A. C., et al., 2011, Impacts of Climate Change on Diseases of Plants, Food Security, Springer, Dordrecht, Netherlands, pp. 453–483

PAȘCALAU, R, POPESCU A.C., SMULEAC, L., HORABLAGA ,A., IMBREA, F., 2025, Teaching for tomorrow: the importance of Earth and environmental sciences in 21st century education in Higher Education Institutions, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEMConference Paper2025, DOI: 10.5593/sgem2025/5.1/s21.111

PAȘCALAU, R, POPESCU A.C., IMBREA, F., HORABLAGA, A., SMULEAC, L., 2026, Building multilingual environmental education platforms: integrating translation technologies with curriculum design, SWS 2026 Conference Preprints,

PAȘCALAU, R, STANCIU S.M., SMULEAC, L., DUMITRESCU, C.S., SMULEAC,A., 2026 Bridging languages, bridging nations: translation as a tool for international climate change mitigation, SWS 2026 Conference Preprints,

PIMENTEL, D., et al., 2005, Update on the Environmental and Economic Costs Associated with Alien-Invasive Species, Ecological Economics, Elsevier, Amsterdam, Netherlands, pp. 273–288

PORTER, J. R., et al., 1991, The Potential Effects of Climatic Change on Agricultural Insect Pests, Agricultural and Forest Meteorology, Elsevier, Amsterdam, Netherlands, pp. 221–240

ROSENZWEIG, C., et al., 2001, Climate Change and Extreme Weather Events: Implications for Food Production, Plant Diseases, and Pests, Global Change & Human Health, Springer, New York, United States, pp. 90–104

SAVARY, S., et al., 2012, Crop Health and Its Global Impacts on the Components of Food Security, Food Security, Springer, Dordrecht, Netherlands, pp. 519–537

SAVARY, S., FICETOLA, G. F., KIM, S. H., et al., 2019 – The global burden of pathogens and pests On major food crops. Nature Ecology & Evolution, 3: 430–439, United Kingdom.

SKENDŽIĆ, S., ZOVKO, M., ŽIVKOVIĆ, I. P., et al., 2021 – The impact of climate change on agricultural insect pests. Insects, 12 (5): 440, Switzerland.

ȘMULEAC, L., IMBREA, F., SMULEAC, A., PASCALAU, R., BACHNER-GUI R., 2025, The utilization of groundwater as an irrigation source in Western Romania for a better climate changes' mitigation, International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEMConference Paper2025, DOI: 10.5593/sgem2025v/3.2/s11.22

ȘMULEAC, A., ȘMULEAC, L., PAȘCALĂU,R., DRAGOMIR, L., POPESCU,G., 2025, , Research Journal of Agricultural Science, Volume 57, no.2, Timisoara.

TRIPATHI, H. G., et al., 2022, Climate-Smart Agriculture and Trade-Offs with Biodiversity and Crop Yield, Frontiers in Sustainable Food Systems, Frontiers Media, Lausanne, Switzerland, pp. 1–14

VAN EMMERIK, T., et al., 2013, Pea Aphid (Acyrthosiphon pisum): A Model Organism in Ecological Research, Journal of Insect Science, Oxford University Press, Oxford, United Kingdom, pp. 1–10

ZAYED, A., ET AL., 2021, Climate Change and Insect Pest Distribution, Current Opinion in Insect Science, Elsevier, Amsterdam, Netherlands, pp. 1–7

ZVEREVA, E. L., KOZLOV, M. V., 2006, Consequences of Simultaneous Elevation of Carbon Dioxide and Temperature for Plant–Herbivore Interactions: A Meta-Analysis, Global Change Biology, Wiley-Blackwell, Oxford, United Kingdom, pp. 27–4

*** Food And Agriculture Organization Of The United Nations (FAO), 2019, Climate Change and Plant Pests, FAO Publishing, Rome, Italy, pp. 1-40

*** Intergovernmental Panel On Climate Change (Ipcc), 2021, Climate Change 2021: The Physical Science Basis, Cambridge University Press, Cambridge, United Kingdom, pp. 1–2391