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GENERAL ARTICLE

Pest Forecasting in Agriculture

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Abstract

Pest forecasting, which is based on data obtained through pest surveillance, involves predicting pest outbreaks that may require control measures or identifying the optimal timing for interventions to achieve maximum protection. Mathematical and computer-based models are used to anticipate the future activity of biotic agents that negatively impact crop production. The integration of insect body temperatures into these models stems from in-depth research on thermoregulation behaviour, habitat selection across developmental stages, and biophysical modelling using weather parameters.

Keywords: Forecasting, Prediction, Population dynamics, Modelling

Introduction

Pest forecasting is essential for timely pest management and includes several key types. Climatic forecasting uses weather data to predict pest outbreaks based on favourable conditions. Phenological forecasting links pest activity to specific crop growth stages. Population-based forecasting analyzes past and current pest densities to forecast future trends. Degree-day forecasting calculates heat accumulation to predict pest development stages. Remote sensing and GIS forecasting track pest-prone areas using satellite imagery and mapping. Model-based forecasting uses computer simulations and decision support tools to predict pest behavior accurately. The development of accurate pest forecasting models relies heavily on data related to weather conditions, pest populations, natural enemies, and crop phenology. Near real-time pest incidence data, when combined with remote sensing and GIS technologies, enables early warnings of potential pest outbreaks. Collection and analysis of weather data from affected regions also serve as crucial inputs for these forecasting models. Computer-based systems have enhanced the speed, accuracy, and cost-effectiveness of pest forecasting. This allows farmers to take timely action by applying bioagents and pesticides, making pest forecasting a vital tool for precision farming.

Forecasting in Lepidoptera

Jha et al. (2016) reported that during the 32nd Standard Meteorological Week (SMW), each degree rise in maximum temperature increased the odds of a high infestation of *Helicoverpa armigera* (pod borer) pest attack by a factor of 8.6. In comparison, a one percent increase in morning relative humidity raised the odds of a high or medium pest attack by 6.4 times. The maximum severity of *Spodoptera litura* moth catches (numbers per trap per week) was analyzed in relation to the mean weather variables across individual SMWs (26–44) during the Kharif seasons over a 25-year period. Vennila et al. (2011) conducted a study using a quantitative model to examine the factors influencing the population dynamics of *Pectinophora gossypiella* (commonly known as the pink bollworm). Their findings revealed that higher evening relative humidity levels during the two weeks prior had a negative impact on the pest's population. Additionally, the study identified several climatic thresholds associated with increased pest severity. Specifically, a maximum temperature exceeding 34 ºC during the 40th standard meteorological week, a minimum temperature dropping below 17 ºC during the 44th standard week, and both morning and evening relative humidity levels falling below 33% were found to be key indicators predicting the severity of *P. gossypiella* infestation. Furthermore, the aggregate model highlighted negative correlations between pest severity and minimum temperature, as well as both morning and evening relative humidity, with evening humidity being a particularly significant factor.

Forecasting in Diptera

Bactrocera dorsalis Hendel is a major fruit pest causing substantial global economic losses. Though mainly distributed in Asia, data on its density trends in Sri Lanka remain limited. A study conducted by W. M. C. D. Wijekoon et. al (2024) assessed its current (2020–2022) and projected (2023–2025) densities across Sri Lanka's bioclimatic zones using trap data from 40 random locations. The SARIMA model was used for forecasting, and QGIS was employed to map density trends. Findings revealed a year-round seasonal pattern and an increasing trend, with the arid zone showing the highest rise (37%) by 2025. This is the first SARIMA-based forecast and spatial mapping for B. dorsalis in Sri Lanka, aiding strategic pest management.

Forecasting in Hemiptera

According to the findings of Bana et al. (2021), mango hopper populations exhibited two major peaks during the crop cycle. The first surge occurred at the new flush stage, while the second and more intense peak was recorded during the flowering and fruit-setting stage of mango plants. Their study also explored the relationship between weather conditions and hopper activity, revealing that maximum temperature and relative humidity had a significant impact on hopper population trends. During the rainy season, the hopper population was at its lowest, likely due to unfavorable climatic conditions for their survival and reproduction. Conversely, the highest infestation levels were observed during the flowering stage, a critical period for mango development, followed by the vegetative stage. These insights highlight the role of climatic factors in pest population buildup and emphasize the need for stage-specific pest management strategies in mango cultivation.

Conclusion

Pest monitoring combined with weather data plays a crucial role in enhancing pest forecasting, leading to more efficient and sustainable agricultural practices. By tracking pest populations and integrating real-time weather parameters—especially temperature, humidity, and rainfall—forecasting models can accurately predict pest emergence, life cycles, and outbreak intensity. Tools like Degree-Day (DD) models quantify insect development based on accumulated heat units, while Decision Support Systems (DSS) and Expert Systems (ES) use this data to guide timely interventions. Software such as CIPRA leverages hourly weather data to simulate pest development and crop conditions, improving precision in management strategies. These advancements reduce pesticide overuse, cut production costs, protect crops from severe infestations, and ultimately safeguard environmental and public health. Thus, pest forecasting grounded in weather and monitoring data significantly boosts agricultural productivity and sustainability.

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