Cost-effectiveness and Risk Assessment of Integrated Pest Management Strategies: Evidence from Spotting Wing Drosophila

Abstract

Invasive species present growing and significant threats to global agriculture and food production. Effectively managing these economically damaging species while mitigating the negative externalities of pesticide applications requires integrated pest management (IPM) approaches. However, over half a century since its conception, IPM adoption remains limited, especially in the fruit and vegetable industries, which have faced growing and persisting challenges from invasive species. The perceived high costs of IPM practices and the associated risks have been identified as key barriers to adoption. Yet, such economic evaluations of IPM strategies are sparse due to complex pest biology and data limitations, which might hinder the broader adoption of IPM strategies and sustainable agriculture. This research aims to evaluate the cost-effectiveness and risks associated with IPM strategies for controlling a devastating invasive species, spotted-wing drosophila (SWD), which poses a significant threat to the soft-skinned fruit industry worldwide. Building on over a decade of research on sustainable SWD management, we focus on a novel monitoring-based spraying strategy that shows the greatest potential for effectively managing SWD. We employ an advanced Bayesian bioeconomic framework that accounts for biological and economic uncertainties and apply it to conventional blueberry production in New York State. We find that the status quo strategy of calendar-based spraying throughout the production season, adopted by most growers, may not be the most profitable due to its high spraying costs. The fruit sampling-initiated spraying strategy yields the lowest expected total costs among all strategies. In most scenarios, it exhibits low variability in crop yield and total costs, even with additional monitoring costs. Compared to the status quo strategy, the sampling-initiated spraying strategy reduces expected total costs while remaining at a similar risk level. We also demonstrate that all SWD control strategies become more costly with reduced insecticide efficacy and increased labor costs. This research contributes to the growing research on bio-economic models for invasive species management, economic evaluations of integrated pest management (IPM), and informs food industries and policies that promote sustainable agricultural practices.

Key words: Bio-economics, Integrated Pest Management, Sustainability, Risk Management

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