UDC: 634.5:632.937 DOI: https://doi.org/10.53040/ppap2026.51

ORGANIC CONTROL STRATEGIES USING MICROBIAL BIOPESTICIDES IN INTEGRATED PEST MANAGEMENT OF WALNUT ORCHARDS

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The decreasing number of approved synthetic plant protection products, together with the transition toward organic production, has substantially changed fruit-production practices in Europe. Crop protection in organic orchards is therefore increasingly challenging, especially because many modern cultivars have limited tolerance to pest pressure. These conditions highlight the need to integrate environmentally compatible biological tools into effective pest-management programmes.

Biopesticides based on the insecticidal proteins produced by *Bacillus thuringiensis* (Bt) are important components of integrated pest management (IPM). Among microbial bioinsecticides, *B. thuringiensis* var. *kurstaki* is particularly relevant because of its selective activity against lepidopteran larvae and its compatibility with sustainable crop-protection systems. Current research focuses on improving field performance, formulation stability, and practical adoption in commercial production.

The objective of this study was to assess the potential of *B. thuringiensis* var. *kurstaki* as a microbial bioinsecticide for sustainable walnut protection, with particular emphasis on its insecticidal activity, environmental compatibility, and practical role in IPM.

The study was conducted in a 12-year-old, 3-ha walnut orchard located in Malcoci, Republic of Moldova. The orchard was planted with the cultivars ”Franquette” and ”Fernor”, with ”Ronde de Montignac” used as a pollinizer. Treatments consist-

ing of a culture suspension of *B. thuringiensis* var. *kurstaki* were applied using a piloted drone. Pest populations were monitored with a digital trap equipped with a camera and optical sensors that automatically transmitted images of captured insects to an online analysis platform. This system enabled continuous monitoring, reduced the need for frequent field visits, and created a visual archive for subsequent species confirmation. Monitoring data showed three codling moth (*Cydia pomonella* L.) flight periods: the first during the first ten days of June, with an average of 10 males; the second during the second ten-day period of July, with an average of 16 males; and the third during the first ten days of september, with an average of 12 males. The wood leopard moth (*Zeuzera pyrina*) population was monitored using a species-specific pheromone lure, and two males were detected. Adults appeared from mid-June, did not feed, and had a short lifespan; oviposition continued until mid-August, with the greatest activity in the second half of July. The population was monitored using the *Zeuzera pyrina* pheromone lure; two males were detected. The pheromone-based system provided a cost-effective and environmentally compatible method for assessing pest risk and supporting decisions on the need for additional control measures. The results indicate that Bt-based treatments are most effective against the early larval instars of *C. pomonella* and *Z. pyrina*. Correctly timed applications at these stages can reduce pest population density before substantial damage develops in walnut orchards. The integration of *B. thuringiensis* var. *kurstaki*, drone-assisted application, and digital pheromone monitoring can support sustainable walnut protection within IPM systems.

Keywords: *Bacillus thuringiensis* var. *kurstaki*; *Cydia pomonella*; *Zeuzera pyrina*; walnut orchard; integrated pest management; digital monitoring; drone application.

Acknowledgments The research was carried out within the Subprogram 011103 “Development of ecologically harmless means of reducing the impact of harmful organisms of agricultural crops against the background of climate change”, funded by the Ministry of Education and Research of the Republic of Moldova.