A STUDY OF *BACILLUS THURINGIENSIS* VAR. *KURSTAKI* IN SUSTAINABLE BIOTECHNOLOGIES FOR APPLE AND WALNUT CROP PROTECTION

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Background: Apple and walnut orchards are often affected by lepidopteran pests that reduce yield, impair fruit and nut quality, and decrease economic efficiency. Intensive use of synthetic insecticides has raised concerns regarding environmental contamination, pesticide residues, effects on non-target organisms, and resistant pest populations. These issues highlight the need for sustainable and biologically based alternatives. This study evaluated the relevance of *Bacillus thuringiensis* var. *kurstaki* as a microbial bioinsecticide for apple and walnut protection, focusing on insecticidal potential, environmental compatibility, and its role in integrated pest management.
Materials and methods: The study was based on a review and comparative analysis of recent literature regarding the biological properties, insecticidal activity, ecological safety, and practical application of *Bacillus thuringiensis* var. *kurstaki* in orchards. Particular attention was given to its use against lepidopteran pests in apple and walnut crops and its compatibility with sustainable protection strategies. Field observations on treatments against *Cydia pomonella* L. in apple were also included.
Results: The analysis showed that *Bacillus thuringiensis* var. *kurstaki* is an effective and selective agent against lepidopteran larvae. Its activity is due to Cry proteins which, after ingestion, damage the larval midgut and cause mortality. In apple orchards, treatments against codling moth reduced fruit damage from 21.3% in the untreated control to 4.3% at 10.0 L/ha, corresponding to 79.8% efficacy. In walnut orchards, application against *Cydia pomonella* L. achieved 82.8% biological efficiency. These findings highlight the potential of *Bacillus thuringiensis* var. *kurstaki* as an important component of environmentally friendly protection programs for both apple and walnut crops. Compared with conventional insecticides, Bt-based products have a lower ecological impact, pose a reduced risk to non-target organisms, and show greater compatibility with integrated pest management strategies. Their field effectiveness depends on application timing, pest developmental stage, and environmental conditions.
Conclusions: *Bacillus thuringiensis* var. *kurstaki* is a valuable component of sustainable apple and walnut protection strategies. Its use reduces dependence on synthetic insecticides, improves ecological safety, and supports long-term orchard sustainability. Bt-based bioinsecticides should be considered important tools in modern environmentally responsible biotechnologies for perennial fruit crop protection.

Keywords: *Bacillus thuringiensis* var. *kurstaki*, apple crop protection, walnut crop protection, bioinsecticide, sustainable biotechnology, integrated pest management.

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