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Integrated Lethal and Sub-Lethal Effects of Chlorfluazuron and Triflumuron on *Pieris Brassicae*

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ABSTRACT

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The biological effects of insect growth regulators may include direct mortality as well as disruption of development and larval growth. This study integrated mortality, concentration-response, developmental duration, head capsule width and body length data from a laboratory investigation of chlorfluazuron and triflumuron against *Pieris brassicae* (Linnaeus, 1758). Both compounds produced high mortality of second-instar larvae, with mortality increasing with concentration and exposure duration. At 120 h, chlorfluazuron mortality was 73–100% across 1–7%, while triflumuron mortality was 63–100%. Probit analysis showed 120-h LC₅₀ values of 0.542 ppm for chlorfluazuron and 0.758 ppm for triflumuron. Sublethal exposure was associated with altered developmental duration and reduced head capsule width and body length. The integrated pattern indicates that IGR activity against *P. brassicae* cannot be characterized adequately by mortality alone. The results provide a laboratory basis for future field studies of IGR-based management of this crucifer pest.

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Introduction

Integrated pest management increasingly emphasizes selective tools whose effects extend beyond immediate knockdown. IGRs are particularly relevant because they interfere with processes required for normal growth and development. Their biological impact can therefore include mortality, developmental disruption and impaired growth (Tunaz and Uygün 2004).

For *P. brassicae*, such endpoints are relevant because larvae undergo multiple molts before pupation. A compound that reduces survival and simultaneously affects the size and development of survivors could influence population performance more strongly than mortality alone would suggest.

The present study integrates the mortality, probit, developmental and morphological results obtained from a laboratory investigation of chlorfluazuron and triflumuron against second-instar *P. brassicae*.

Materials and Methods

The experiment was conducted in the Entomology Laboratory of the University of Poonch, Rawalakot, during 2012–2013. Second-instar larvae were exposed through a cabbage-leaf-dip method to 1, 3, 5 and 7% concentrations. Forty larvae were exposed to each concentration, with four replicate groups of ten larvae. Mortality was recorded at 24–120 h.

LC₂₅, LC₅₀ and LC₇₅ values were obtained by probit analysis as reported in the original thesis. Separate groups exposed to LC₂₅, LC₅₀ and LC₇₅ were followed for developmental and morphological observations. Developmental duration, head capsule width and body length were recorded.

Results

Mortality and LC₅₀

Compound	120-h mortality at 1%	3%	5%	7%	120-h LC ₅₀
Chlorfluazuron	73%	95%	98%	100%	0.542 ppm
Triflumuron	63%	93%	98%	100%	0.758 ppm

At 120 h, chlorfluazuron had the lower LC₅₀ estimate. However, triflumuron produced higher mortality than chlorfluazuron at every concentration during the 24-h observation.

Development

The developmental data showed changes across larval, prepupal and pupal stages. Chlorfluazuron-treated larvae had pupal durations of 7.86, 4.05 and 4.62 d at LC₂₅, LC₅₀ and LC₇₅, compared with 8.70 d in the control. Triflumuron-treated larvae had pupal durations of 4.47, 4.17 and 4.02 d at LC₂₅, LC₅₀ and LC₇₅.

Morphological growth

At LC₇₅, fifth-instar body length was 15.50 mm under chlorfluazuron and 15.53 mm under triflumuron, compared with 29.80 mm in the control. Fifth-instar head capsule width was 1.30 mm under chlorfluazuron and 1.15 mm under triflumuron, compared with 2.03 mm in the control.

Discussion

The integrated results show that the two IGRs affected *P. brassicae* at several biological levels. Mortality was high after prolonged exposure, and the concentration–response analysis demonstrated declining LC₅₀ values over time. This is consistent with the developmental mode of action expected for chitin-synthesis inhibitors (Cohen 2001).

The sub-lethal data add an important dimension to the toxicity assessment. Surviving larvae were smaller than control larvae and showed altered developmental duration. These responses could reduce the biological performance of survivors even when they are not immediately killed. Such effects are relevant to IPM because suppression of larval growth can reduce foliage consumption and may alter the timing and success of later life stages.

The two compounds did not show identical response profiles at every endpoint. Triflumuron produced greater early mortality, whereas the 120-h LC₅₀ estimate was lower for chlorfluazuron. The developmental and morphological data likewise showed stage-specific variation. These differences indicate that compound evaluation should use multiple endpoints and defined exposure times rather than a single measure of efficacy.

The principal limitation is that the study was laboratory based and the developmental/morphological data available for this retrospective manuscript are means $\pm$ SE without the original replicate-level observations. Consequently, the present analysis is descriptive for those endpoints. Field validation, residue studies, non-target assessments, and demographic endpoints are needed before practical recommendations can be made.

Conclusion

Chlorfluazuron and triflumuron produced both lethal and sub-lethal effects on *P. brassicae*. Mortality increased with concentration and exposure time, while surviving larvae showed altered development and reduced body size. These combined effects support further evaluation of IGRs as components of integrated management of *P. brassicae*, with particular emphasis on field efficacy and selectivity.

Transparency statement

This manuscript is derived from the author's master's thesis research conducted during 2012–2013. The same underlying experiment is analyzed in complementary manuscripts addressing mortality, concentration–response toxicity, developmental duration, and morphology. Any journal submission should disclose this relationship and should be made only after confirming that the target journal permits thesis-derived and related manuscripts.

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