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ORIGINAL PAPER

Toxicity of synthetic and biological insecticides against adults of the *Eucalyptus* snout-beetle *Gonipterus scutellatus* Gyllenhal (Coleoptera: Curculionidae)

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Abstract Toxicity by contact and by ingestion of lufenuron, flufenoxuron, lambda (λ)-cyhalothrin, cypermethrin, thiamethoxam and five entomopathogenic insecticides (three formulations of *Beauveria bassiana*, a compound containing spores of *Metarhizium anisopliae* var. *acridum*, and a mixture of *Brevibacillus laterosporus*, *Bacillus licheniformis* and *Bacillus chitinosporus*) were evaluated on adults of the *Eucalyptus* snout-beetle *Gonipterus scutellatus* Gyllenhal (Coleoptera: Curculionidae) under laboratory conditions. By contact, entomopathogenic fungus *B. bassiana* EC and the pyrethroid λ-cyhalothrin exhibited the highest efficiency, achieving 100 and 97.5% mortality, respectively. By ingestion, the highest mortality was obtained by *B. bassiana* EC (100%) and thiamethoxam (95%). Flufenoxuron and lufenuron, bacteria mixture and *M. anisopliae* showed a weak toxicity. Furthermore, we found a sex-biased mortality, being males more affected. Due to the good performance and low risk to humans and environment, *B. bassiana* EC (strain PPRI 5339) appears to be the most promising product to promote an IPM programme in South Africa.

Keywords *Beauveria bassiana* · *Gonipterus scutellatus* · IGRs · *Metarhizium anisopliae* · Neonicotinoid · Pyrethroid

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Introduction

The *Eucalyptus* snout-beetle *Gonipterus scutellatus* Gyllenhal (Coleoptera: Curculionidae), native to south-eastern Australia, is one of the most important defoliators of *Eucalyptus* plantations worldwide (Tooke 1955; Arzone 1976; Cordero-Rivera et al. 1999; Hanks et al. 2000; Lanfranco and Dungey 2001; Loch 2008). Currently, it is present in four continents and twenty-two countries, where eucalypts are cultivated for commercial and ornamental purposes (OEPP/EPPO 2005). Adults and larvae of *G. scutellatus* feed on leaves, buds and shoots, causing severe defoliation of susceptible trees, growth reduction, and contorting and eventually killing branches (Mally 1924; Tooke 1955; Lanfranco and Dungey 2001). Therefore, the snout-beetle is considered a quarantine pest by the European and Mediterranean Plant Protection Organization (OEPP/EPPO), Commonwealth Agriculture Bureaux International (CABI), Comité de Sanidad Vegetal del Cono Sur (COSAVE), Caribbean Plant Protection Commission (CPPC), Junta del Acuerdo de Cartagena (JUNAC) and Comunidad Andina de Naciones (CAN) (CABI/EPPO 1997; OEPP/EPPO 2005).

In 1916, *G. scutellatus* larvae were found for the first time in South Africa, feeding on *Eucalyptus lehmanni* (Schauer) Benth. at Cape Town (Mally 1924; Tooke 1955). During the years following its discovery, the snout-beetle spread rapidly throughout South Africa, becoming a threat to the forestry industry to the extent that highly susceptible eucalypts such as *E. globulus* Labill. and *E. viminalis* Labill. ceased to be planted (Tooke 1935, 1955; Richardson and Meakins 1986).

Chemical applications, pruning, burning heavily infested areas or ploughing up the ground to expose pupal cells, did not lead to satisfactory results of pest control (Tooke