BioAssay

BioAssay, 21, 2026: ba21004
doi: 10.37486/1809-8460.ba21004
e-ISSN: 1809-8460
Open Access Full Text Article

Research Article

Artificial baits treated with imidacloprid or *Beauveria bassiana* (Bals.-Criv.) Vuill. reduce damage by *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae) in sugarcane

Alexandre de S. Pinto, Murilo M. da Silva, Matheus G. Berti, Matheus B. Oliva

Centro Universitário Moura Lacerda, Ribeirão Preto, SP, Brazil.
Corresponding author: alexandre@occasio.com.br

Edited by: Luis F. A. Alves

Received: January 25, 2026. Accepted: April 18, 2026. Published: May 06, 2026.

Abstract. The sugarcane weevil, *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae), causes severe damage to the basal portion of sugarcane stalks, and its management is limited by the low efficiency of conventional soil-directed control methods. This study evaluated the effectiveness of solid artificial attractive baits treated with imidacloprid or *Beauveria bassiana* (Bals.-Criv.) Vuill., applied at different densities, in reducing damage caused by *S. levis* in a commercial sugarcane field. The experiment was conducted in Mineiros do Tietê, São Paulo State, Brazil, using a randomized block design with six treatments and five replicates under commercial field conditions. Evaluations were performed at 0, 7, 15, 30, 45, and 60 days after the beginning of biweekly bait distribution, assessing the percentage of damaged stalk bases and the number of immature stages and adults per meter. From 30 days onward, baits treated with imidacloprid (50 and 200 baits ha^{-1}) and *B. bassiana* (100 and 200 baits ha^{-1}) promoted significant reductions in damage compared with the untreated control, with more consistent effects observed at 60 days. Counts of larvae, pupae, and adults were low throughout the experimental period, supporting damage assessment as a sensitive indicator of treatment effectiveness. The results demonstrate that solid artificial baits, particularly those treated with *B. bassiana*, represent a viable and operational alternative for integrated management of *S. levis* in sugarcane.

Keywords: Sugarcane weevil, Solid bait, Integrated pest management, Entomopathogenic fungus, Biological control.

The sugarcane weevil, *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae), is one of the most damaging pests of sugarcane in Brazil, particularly in the Center-South region. Larval feeding occurs at the basal portion of the stalks, where galleries compromise tillering, sprouting, and stool longevity, often resulting in significant yield losses and reduced crop longevity (Degaspari et al. 1987; Castelliani et al. 2020).

The management of *S. levis* remains challenging due to its cryptic behavior and the predominance of subterranean life stages, which limit the effectiveness of conventional soil-applied insecticides. Although chemical control is widely used, its efficiency is inconsistent and highly dependent on application technology, increasing production costs and environmental concerns (Evangelista et al. 2017; Xavier et al. 2024).

Biological control has become an important component of integrated pest management programs for *S. levis*. Entomopathogenic fungi, particularly *Beauveria bassiana* (Bals.-Criv.) Vuill., have shown promising results under laboratory and field conditions, contributing to the reduction of chemical insecticide use and enhancing sustainability in sugarcane production systems (Badilla & Alves 1991; Vega et al. 2009; Vinha et al. 2019).

In addition to microbial control, bait-based strategies targeting adult insects have gained attention. Adults of *S. levis* actively move on the soil surface and are attracted to volatile compounds released during the fermentation of sugarcane tissues. The use of attractive substrates associated with chemical or biological agents can increase adult exposure to control agents and reduce damage over time (Zarbin et al. 2003; Girón-Pérez et al. 2009; Pinto & Trujillo 2019).

This study evaluated the effectiveness of solid artificial attractive baits treated with imidacloprid or *B. bassiana*, applied at different densities, in reducing damage caused by *S. levis* in a commercial sugarcane field.

The experiment was conducted in a commercial sugarcane field located in Mineiros do Tietê, São Paulo State, Brazil. The area presented a history of infestation by *S. levis* and was managed according to standard agronomic practices for the crop.

The experimental design was a randomized complete block design with split plots, comprising six treatments and five replicates. Each experimental plot consisted of 10 sugarcane rows spaced 1.5 m apart and 250 m in length, corresponding to an area of approximately 3,750 m^2 under commercial field conditions.

The treatments consisted of solid artificial baits treated with imidacloprid at densities of 50, 100, and 200 baits ha^{-1}, and baits treated with the entomopathogenic fungus *B. bassiana* at densities of 100 and 200 baits ha^{-1}, in addition to an untreated control. Baits were manually distributed on the soil surface along the sugarcane rows according to the proposed densities for each treatment. Applications were performed biweekly throughout the experimental period.

Evaluations were carried out at 7, 15, 30, 45, and 60 days after the beginning of bait distribution. The percentage of damaged sugarcane stalk bases was assessed as the primary variable, based on visual inspection of plants along the rows. Additionally, the number of larvae + pupae and adults per linear meter was recorded at 60 days after the beginning of the experiment.

Data were subjected to analysis of variance (ANOVA), and treatment means were compared using Tukey's test at a 5% significance level. Statistical analyses were performed using Statistica for Windows software.

Data on the number of larvae + pupae and adults per linear meter were analyzed descriptively and interpreted as complementary variables due to the low population densities observed throughout the experiment.

At the beginning of the experiment, the sugarcane field exhibited a high level of damage caused by *S. levis*, with mean percentages of

damaged stalk bases exceeding 20% in all treatments, indicating a previously established infestation. In contrast, the number of larvae, pupae, and adults per linear meter was low at the initial evaluation, a condition commonly reported in fields with a long history of infestation, where damage persists even under low active population density (Degaspari et al. 1987; Castelliani et al. 2020).

The percentage of damaged stalk bases was the variable that best reflected treatment effects over time. Up to 15 days after the beginning of bait distribution, no consistent differences were observed between treated plots and the untreated control (Fig. 1). This response was expected considering the limited displacement rate of *S. levis* adults on the soil surface, which delays contact with treated baits during the initial period (Degaspari et al. 1987).

From 30 days onward, a progressive reduction in damage was observed in treatments receiving treated baits, particularly at higher bait densities. At 30 days after bait deployment, treatments with *B. bassiana* baits applied at 100 and 200 baits ha^{-1} and imidacloprid baits applied at 200 baits ha^{-1} showed lower mean percentages of damaged stalk bases compared with the untreated control (Fig. 1), indicating the onset of treatment effects.

At 60 days after the beginning of biweekly bait distribution, treatment differences became more pronounced (Fig. 2). Baits treated with imidacloprid at 50 and 200 baits ha^{-1} and those treated with *B. bassiana* at 100 and 200 baits ha^{-1} resulted in significantly lower percentages of damaged stalk bases compared with the untreated control. In contrast, the imidacloprid treatment at 100 baits ha^{-1} showed greater variability and did not consistently differ from the control.

The progressive reduction in damage observed from 30 days onward is consistent with strategies targeting adult populations of *S. levis*. The delayed response reflects the limited displacement rate of adults on the soil surface, which affects the time required for contact with treated baits (Degaspari et al. 1987).

The effectiveness of *B. bassiana*-treated baits observed in this study agrees with previous findings reporting significant reductions in damage when sugarcane-based baits associated with this entomopathogenic fungus were applied at densities between 100 and 200 baits ha^{-1} (Pinto & Trujillo 2019). These authors highlighted that the use of attractive substrates enhances adult exposure to the pathogen, resulting in lower infestation levels over time.

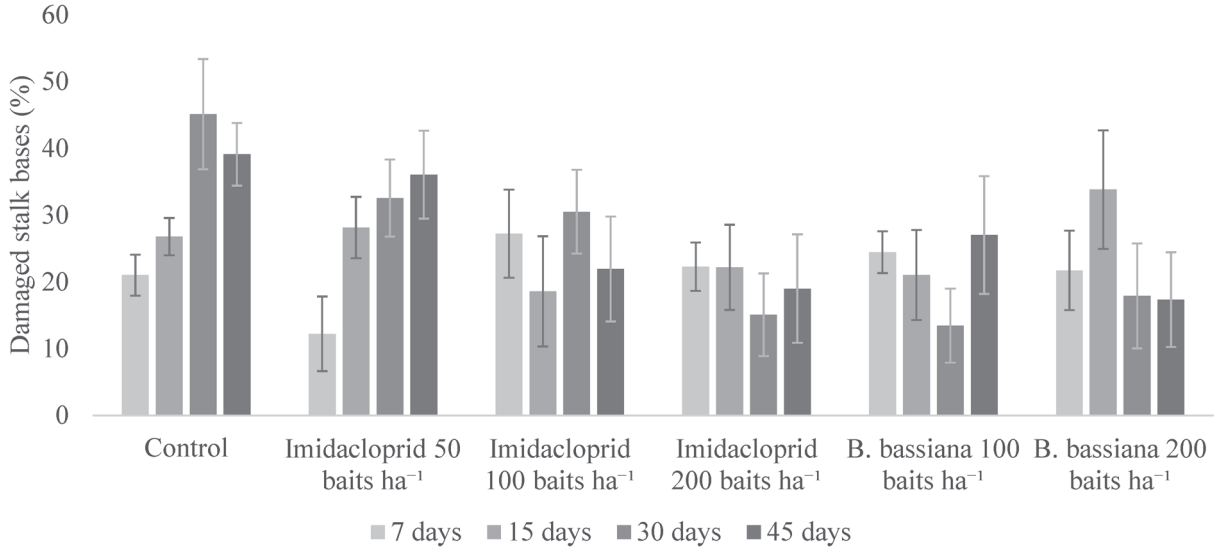

Figure 1. Percentage of damaged sugarcane stalk bases caused by *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae) from 7 to 45 days after the beginning of biweekly distribution of solid artificial baits treated with imidacloprid or *Beauveria bassiana* (Bals.-Criv.) Vuill. in a commercial sugarcane field. Bars represent means ± standard error of the mean (SEM). No significant differences among treatments were detected up to 45 days.

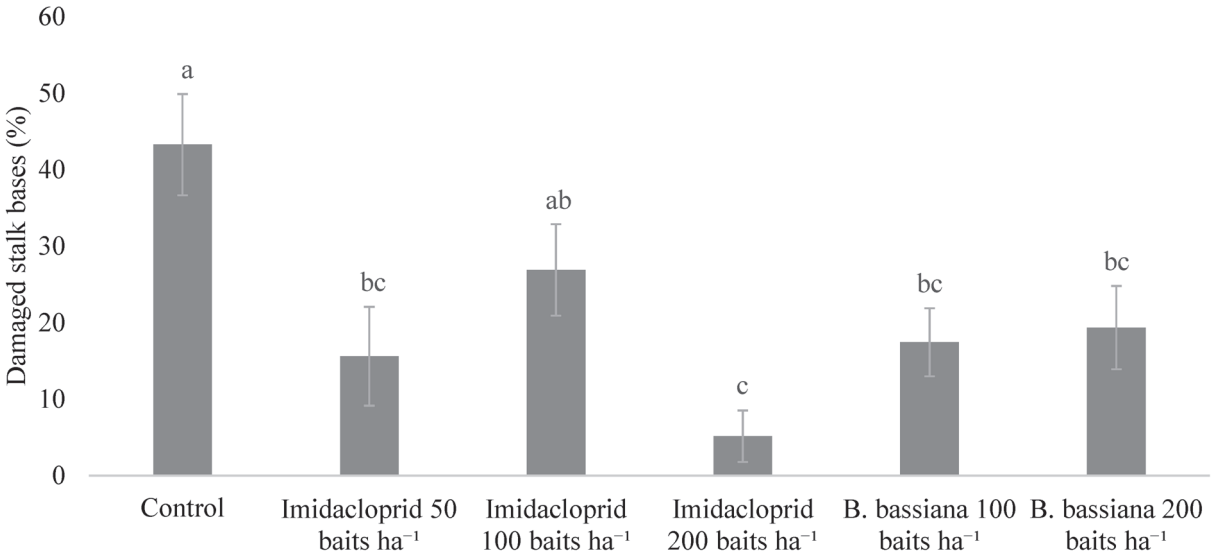

Figure 2. Percentage of damaged sugarcane stalk bases caused by *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae) at 60 days after the beginning of biweekly distribution of solid artificial baits treated with imidacloprid or *Beauveria bassiana* (Bals.-Criv.) Vuill. in a commercial sugarcane field. Bars represent means ± standard error of the mean (SEM). Means followed by the same letter do not differ by Tukey's test ($p \leq 0.05$).

Table 1. Mean number (± standard deviation) of larvae + pupae and adults of *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae) per linear meter at 60 days after the beginning of biweekly distribution of solid artificial baits treated with imidacloprid or *Beauveria bassiana* (Bals.-Criv.) Vuill. in a commercial sugarcane field. Mineiros do Tietê, São Paulo State, Brazil.

Treatment	Bait density (baits ha^{-1})	Larvae + pupae (no. m^{-1})	Adults (no. m^{-1})
Control	–	1.0 ± 0.71	0.2 ± 0.45
Imidacloprid	50	0.0 ± 0.00	0.0 ± 0.00
Imidacloprid	100	0.0 ± 0.00	0.0 ± 0.00
Imidacloprid	200	0.0 ± 0.00	0.0 ± 0.00
Beauveria bassiana	100	0.0 ± 0.00	0.0 ± 0.00
Beauveria bassiana	200	0.2 ± 0.45	0.0 ± 0.00

Similarly, applied studies conducted under commercial sugarcane conditions have indicated that bait-based strategies using *B. bassiana* contribute to damage reduction and represent a viable alternative to conventional control methods, particularly when integrated into broader pest management programs (Pinto 2019). The results of the present study reinforce these observations, demonstrating that solid artificial baits treated with *B. bassiana* provide consistent damage suppression when applied at adequate densities.

Counts of larvae + pupae and adults per linear meter were low throughout the experimental period (Tab. 1), limiting robust statistical analyses for these variables. Nevertheless, a numerical reduction in immature stages was observed in treated plots at 60 days after bait application compared with the untreated control, suggesting reduced pest recruitment over time. This response is biologically consistent with adult-targeted management strategies, as reduced adult activity on the soil surface leads to lower oviposition and, consequently, fewer larvae and pupae developing within stalk bases (Castelliani et al. 2020).

Although the evaluation period was limited to 60 days, the progressive reduction in damage observed in treated plots indicates a consistent treatment effect over time. Longer-term evaluations may provide additional insights into the persistence of bait effectiveness under commercial conditions.

Overall, the results demonstrate that solid artificial attractive baits, particularly those treated with *B. bassiana* and applied at higher densities, contribute to a progressive reduction in damage caused by *S. levis* in commercial sugarcane fields.

Solid artificial attractive baits treated with imidacloprid or *B. bassiana* promoted a progressive reduction in damage caused by *S. levis* in a commercial sugarcane field, with more consistent effects observed from 30 days after bait deployment.

Baits treated with imidacloprid at 50 and 200 baits ha^{-1} and those treated with *B. bassiana* at 100 and 200 baits ha^{-1} showed the best performance in reducing the percentage of damaged stalk bases.

The results indicate that bait-based strategies, particularly those associated with *B. bassiana*, represent a viable and operational alternative for integrated management of *S. levis* under commercial sugarcane field conditions.

Acknowledgments

The authors thank Centro Universitário Moura Lacerda for providing laboratory facilities used in the development and preparation of the baits. We also thank the sugarcane mill for granting access to the commercial field area where the experiment was conducted.

Funding Information

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' Contributions

ASP: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Supervision; MMS: Investigation, Data curation, Methodology, Writing – review & editing; MGB: Investigation, Data curation, Writing – review & editing; MBO: Investigation, Methodology, Writing – review & editing.

Conflict of Interest Statement

The authors declare no conflict of interest.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

Badilla, F.; Alves, S. B. (1991) Controle do gorgulho da cana-de-açúcar *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae) com *Beauveria* spp. em condições de laboratório e campo. *Anais da Sociedade Entomológica do Brasil*, 20(2): 251-263. doi: 10.37486/0301-8059.v20i2.710

Castelliani, A.; Martins, L. F.; Cardoso, J. F. M.; Silva, M. S. O.; Silva, R. S. A.; Chacon-Orozco, J. G.; Casteliani, A. G. B.; Puza, V.; Harakava, R.; Leite, L. G. (2020) Behavioral aspects of *Sphenophorus levis* (Coleoptera: Curculionidae), damage to sugarcane and its natural infection by *Steinernema carpocapsae* (Nematoda: Rhabditidae). *Crop Protection*, 137: 105262. doi: 10.1016/j.cropro.2020.105262

Degaspari, N.; Botelho, P. S. M.; Almeida, L. C.; Castilho, H. J. (1987) Biology of *Sphenophorus levis* Vaurie, 1978 (Col.: Curculionidae) on artificial diet and under field conditions. *Pesquisa Agropecuária Brasileira*, 22(6): 553-558.

Evangelista, E. F. D.; Serpa-dos-Santos, L.; Simone-Zera, F.; Cruz, B. R. G. (2017) Controle químico de *Sphenophorus levis* Vaurie (Coleoptera: Curculionidae) na cultura da cana-de-açúcar. *Entomología Mexicana*, 4: 347-352.

Girón-Pérez, K.; Nakano, O.; Silva, A. C.; Oda-Souza, M. (2009) Atração de adultos de *Sphenophorus levis* Vaurie (Coleoptera: Curculionidae) a fragmentos vegetais em diferentes estados de conservação. *Neotropical Entomology*, 38(6): 842-846. doi: 10.1590/s1519-566x2009000600019

Pinto, A. de S. (2019) Sucesso do controle biológico de pragas da cana-de-açúcar. *Informe Agropecuário*, 40(305): 57-65.

Pinto, A. de S.; Trujillo, S. E. L. (2019) Sugarcane. In: Souza, B.; Vazquez, L. L.; Marucci, R. C. (Eds.), *Natural enemies of insect pest in neotropical agroecosystems: biological control and functional biodiversity*, pp. 413-425. Switzerland: Springer.

Vega, F. E.; Goettel, M. S.; Blackwell, M.; Chandler, D.; Jackson, M. A.; Keller, S.; Koike, M.; Maniania, N. K.; Monzón, A.; Ownley, B. H., et al. (2009) Fungal entomopathogens: new insights on their ecology. *Fungal Ecology*, 2(4): 149-159. doi: 10.1016/j.funeco.2009.05.001

Vinha, F. B.; Rodrigues, L. R.; Pinto, A. de S. (2019) Controle do gorgulho-da-cana *Sphenophorus levis* com fungos entomopatogênicos em diferentes doses e formulações. *Nucleus*, 16(1): 329-335. doi: 10.3738/1982.2278.3541

Xavier, G. G.; de Sá Farias, E.; do Carmo, D. G.; Guedes, A. G.; Samuels, R. I.; Freitas, D. R.; Pereira, E. J. G.; Lima, E.; Picanço, M. C. (2024) Determining Factors and Economic Injury Levels for Sphenophorus levis for Chemical and Biological Control in Irrigated and Non-

irrigated Sugarcane Crops. *Neotropical Entomology*, 53(4): 955-963. doi: 10.1007/s13744-024-01175-0

Zarbin, P. H. G.; Arrigoni, E. de B.; Reckziegel, A.; Moreira, J. A.; Baraldi, P. T.; Vieira, P. C. (2003) Identification of a male-specific chiral compound from the sugarcane weevil *Sphenophorus levis*. *Journal of Chemical Ecology*, 29(2): 377-386. doi: 10.1023/a:1022634012212