UNIVERSIDADE ESTADUAL PAULISTA "JÚLIO DE MESQUITA FILHO"
FACULDADE DE CIÊNCIAS AGRÁRIAS E VETERINÁRIAS
CAMPUS DE JABOTICABAL

EFEITO DE *Beauveria bassiana* (BALS.) VUILL (HYPOCREALES: CORDYCIPITACEAE) NO COMPORTAMENTO ALIMENTAR E SOBREVIVÊNCIA DE *Chrysoperla externa* (HAGEN, 1861) (NEUROPTERA: CHRYSOPIDAE)

Felipe Scarelli Tavares
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JABOTICABAL – SP
2º SEMESTRE/2025

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Trabalho de Conclusão de Curso apresentado à Faculdade de Ciências Agrárias e Veterinárias – UNESP, Câmpus de Jaboticabal, para graduação em ENGENHARIA AGRONÔMICA.

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Orientador: Prof. Dr. SERGIO ANTONIO DE BORTOLI
Coorientadora (se houver): MSc. ISABELA CRISTINA DE OLIVEIRA PIMENTA

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Via de Acesso Prof. Paulo Donato Castellane, s/n CEP 14884-900 Jaboticabal/SP - Brasil
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“A única maneira de fazer um excelente trabalho é amar o que você faz.”

Steve Jobs

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SUMÁRIO

RESUMO

A cana-de-açúcar é uma das culturas agrícolas de maior relevância econômica para o Brasil, ocupando extensas áreas em diversos estados e constituindo a principal matéria-prima para a produção de açúcar, etanol e bioenergia. Entretanto, sua produtividade é frequentemente comprometida pela ocorrência de artrópodes-praga e, dentre os principais que comprometem o rendimento da cultura, destaca-se a broca-da-cana *Diatraea saccharalis* (Lepidoptera: Crambidae), considerada uma das pragas mais prejudiciais. Dentre as estratégias de manejo adotadas para essa praga, pode-se citar o uso de controle microbiológico com o fungo entomopatogênico *Beauveria bassiana* (Hypocreales: Cordycipitaceae) e o controle macrobiológico por crisopídeos predadores. Este estudo avaliou, em condições laboratoriais, o comportamento alimentar de *Chrysoperla externa* (Neuroptera: Chrysopidae) com lagartas de segundo ínstar de *D. saccharalis* contaminadas ou não por *B. bassiana*. Foram conduzidos testes com e sem chance de escolha, utilizando larvas de terceiro ínstar de *C. externa*. No teste com chance de escolha, os predadores demonstraram preferência significativa por presas contaminadas (63,78%), enquanto no sem chance de escolha não houve diferença significativa no consumo entre os tratamentos. Os resultados indicam que *C. externa* é capaz de reconhecer e preferir presas debilitadas pela infecção fúngica, mas mantém sua taxa de consumo mesmo na ausência de alternativa. Esses resultados reforçam o potencial de compatibilidade entre o uso de predadores e fungos entomopatogênicos em programas de Manejo Integrado de Pragas (MIP), contribuindo para estratégias de controle biológico mais eficazes e sustentáveis da broca-da-cana.

Palavras-chave: controle biológico; crisopídeo; fungos entomopatogênicos; interação trófica; seletividade; cana-de-açúcar.

ABSTRACT

Sugarcane is one of the most economically important agricultural crops in Brazil, occupying vast areas across several states and serving as the main raw material to produce sugar, ethanol, and bioenergy. However, crop productivity is often affected by the occurrence of pest arthropods. Among the main insect pests that reduce crop yield, the sugarcane borer *Diatraea saccharalis* (Lepidoptera: Crambidae) stands out as one of the most damaging. Among the management strategies adopted for this pest are the use of microbiological control with entomopathogenic fungi such as *Beauveria bassiana* (Hypocreales: Cordycipitaceae) and macrobiological control using the predators' green lacewings. This study evaluated, under laboratory conditions, the feeding behavior of *Chrysoperla externa* (Neuroptera: Chrysopidae) toward larvae of *D. saccharalis* infected or not by *B. bassiana*. Choice and no-choice tests were conducted using third-instar larvae of *C. externa*. In the choice test, predators showed a significant preference for infected prey (63.78%), whereas in the no-choice test, no significant difference in prey consumption was observed between treatments. The results indicate that *C. externa* can recognize and prefer fungus-weakened prey, while maintaining its predation rate in the absence of alternatives. These results support the compatibility between predatory insects and microbial agents in Integrated Pest Management (IPM) programs, contributing to more effective and sustainable strategies for the biological control of the sugarcane borer.

Keywords: biological control; Chrysopidae; entomopathogenic fungi; trophic interaction; selectivity; sugarcane.

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EFEITO DE *Beauveria bassiana* (BALS.) VUILL (HYPOCREALES: CORDYCIPITACEAE) NO COMPORTAMENTO ALIMENTAR E SOBREVIVÊNCIA DE *Chrysoperla externa* (HAGEN, 1861) (NEUROPTERA: CHRYSOPIDAE)

Felipe Scarelli Tavares, Isabela Cristina de Oliveira Pimenta (Orcid: 0000-0003-3839-4490), Sergio Antonio De Bortoli (Orcid: 0000-0003-0957-6164)

[1] Universidade Estadual Paulista (Unesp) - Faculdade de Ciências Agrárias e Veterinárias (FCAV), Departamento de Fitossanidade, Jaboticabal, SP, Brazil.

Autor correspondente: felipe.scarelli@unesp.br

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RESUMO: A cana-de-açúcar é uma das culturas agrícolas de maior relevância econômica para o Brasil, ocupando extensas áreas em diversos estados e constituindo a principal matéria-prima para a produção de açúcar, etanol e bioenergia. Entretanto, a produtividade da cultura é frequentemente comprometida pela ocorrência de artrópodes-praga, dentre os principais que comprometem significativamente o rendimento da cultura, destaca-se a broca-da-cana, *Diatraea saccharalis* (Lepidoptera: Crambidae), considerada uma das pragas mais prejudiciais. Dentre as estratégias de manejo adotadas para essa praga, pode-se citar o uso de controle microbiológico com fungos entomopatogênicos, como *Beauveria bassiana* (Hypocreales: Cordycipitaceae), e o macrobiológico utilizando crisopídeos predadores. Este estudo avaliou, em condições laboratoriais, o comportamento alimentar de *Chrysoperla externa* (*Ch.*) (Neuroptera: Chrysopidae) predando lagartas de *D. saccharalis* contaminadas ou não por *B. bassiana*. Foram conduzidos testes com e sem chance de escolha, utilizando larvas de terceiro ínstar de *Ch. externa*, tendo o teste com chance de escolha demonstrado que os predadores têm preferência significativa por presas contaminadas (63,78%), enquanto no teste sem chance de escolha não houve diferença significativa no consumo entre os tratamentos. Os resultados indicam que *Ch. externa* é capaz de reconhecer e preferir presas contaminadas, mantendo, porém, sua taxa de consumo mesmo na ausência de alternativa. Esses resultados reforçam o potencial de compatibilidade entre o uso do predador e *B. bassiana* em programas de Manejo Integrado de Pragas (MIP), contribuindo para estratégias de controle biológico mais eficazes e sustentáveis da broca-da-cana.

Palavras-chave: controle biológico; crisopídeo; fungos entomopatogênicos; interação trófica; seletividade; cana-de-açúcar.

INTRODUÇÃO

A cana-de-açúcar, *Saccharum* spp. (Poales: Poaceae), representa uma das culturas agrícolas de maior relevância econômica para o Brasil, ocupando extensas áreas em diversos estados e constituindo a principal matéria-prima para a produção de açúcar, etanol e bioenergia (Bodornal et al. 2018; Ogura et al. 2022; Vandenberghe et al. 2022). Na safra 2024/2025, a produção nacional atingiu 676,96 milhões de toneladas, com produtividade média de 75,45 ton/ha, representando uma redução de 2,3% em relação à safra anterior (CONAB 2025). A produtividade da cultura é frequentemente comprometida pela ocorrência

de artrópodes-praga, cuja incidência é favorecida pelas condições climáticas, pela colheita de cana-de-açúcar verde, e pelo monocultivo extensivo e contínuo, que contribui para o desequilíbrio ecológico dos agroecossistemas (Dinardo-Miranda e Fracasso 2013; Carbonari et al. 2020).

Dentre os principais insetos-praga que comprometem o rendimento da cultura, destacam-se as cigarrinhas *Mahanarva* spp. (Hemiptera: Cercopidae), o bicudo-da-cana *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae) e, sobretudo, a broca-da-cana *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae), considerada uma das pragas mais prejudiciais (Moraes e Ávila 2014; Francischini et al. 2017). A fase larval é a responsável pelos danos, uma vez que, após a eclosão, as larvas neonatas alimentam-se do parênquima foliar, permanecendo na parte externa da planta até o segundo ínstar (Matioli et al. 2019). Em seguida, penetram no colmo da cana-de-açúcar, abrindo galerias, normalmente no sentido ascendente, que comprometem a integridade estrutural da planta (Geetha et al. 2018; Li et al. 2024a). Os danos diretos incluem a morte das gemas, secamento dos ponteiros (conhecido como "coração morto"), enraizamento aéreo, brotações laterais e o tombamento das plantas devido à fragilidade causada pelas galerias (Macedo et al. 2015; Pérez et al. 2023). Além disso, os orifícios criados pelas larvas favorecem a entrada de microrganismos oportunistas, como os fungos *Colletotrichum falcatum* Went (Glomerellales: Glomerellaceae) e *Fusarium moniliforme* Sheld (Hypocreales:Nectriaceae), que causam a podridão vermelha do colmo, resultando na inversão da sacarose e redução da pureza do caldo, o que compromete o rendimento industrial na produção de açúcar e etanol (Macedo et al. 2015; Gallan et al. 2022; Viswanathan 2025).

Diante da relevância econômica dessa praga, diversas estratégias de controle têm sido adotadas por produtores e usinas sucroalcooleiras com base nos princípios do Manejo Integrado de Pragas (MIP) (Sampaio et al. 2022; Li et al. 2024a). Esse conceito preconiza o uso racional e integrado de diferentes táticas de controle, priorizando métodos sustentáveis e relegando o controle químico a uma última alternativa, a ser empregada somente quando os níveis de dano econômico forem atingidos (Falkenberg et al. 2022). Entre as principais estratégias utilizadas para a broca-da-cana, destacam-se o controle biológico aplicado, com o uso de parasitoides, como *Cotesia flavipes* Cameron, 1891 (Hymenoptera: Braconidae) (Parra et al. 2010; Matioli et al. 2019; Rosa et al. 2024), e o controle microbiológico, por meio da aplicação de fungos entomopatogênicos como *Beauveria bassiana* (Bals.) Vuill (Hypocreales: Cordycipitaceae) e

Metarhizium anisopliae (Metschn.) Sorokin (Hypocreales: Clavicipitaceae), que têm demonstrado eficácia no manejo de pragas em cana (Li et al. 2024a). Também se valoriza o controle biológico natural, o que é promovido por práticas agrícolas que conservam inimigos naturais presentes no agroecossistema, destacando-se dentre eles predadores de ovos e lagartas da broca-da-cana, como tesourinhas (Dermaptera), formigas (Hymenoptera: Formicidae) e crisopídeos (Neuroptera: Chrysopidae) (Souza et al. 2022; Arroyo et al. 2023; Braghini et al. 2024), normalmente presentes em canaviais brasileiros (Oliveira et al. 2025).

Os predadores da família Chrysopidae são amplamente utilizados em programas de MIP em diversas culturas agrícolas, tanto no controle aplicado, quanto no conservativo (Figueira et al. 2003; Cruz et al. 2019; Abdou et al. 2024; Borges et al. 2024). Como exemplo, em cultivos de tomate, *Solanum lycopersicum* L. (Solanales: Solanaceae), em condições de estufa, *Chrysoperla* (*Ch.*) *externa* (Hagen, 1861) (Neuroptera: Chrysopidae) mostrou-se eficaz no controle de *Frankliniella occidentalis* (Pergande, 1895) (Thysanoptera: Thripidae), reduzindo significativamente os danos aos frutos (Luna-Espino et al. 2020). Em cultivos de rosas, *Rosa* spp. (Rosales: Rosaceae), *Ch. externa* também demonstrou eficiência no controle da cochonilha *Planococcus citri* (Risso, 1813) (Hemiptera: Pseudococcidae), especialmente quando utilizada em conjunto com o predador *Cryptolaemus montrouzieri* Mulsant, 1853 (Coleoptera: Coccinellidae) (Paula et al. 2022). Já em cultivos de sorgo, *Sorghum bicolor* (L.) Moench (Poales: Poaceae), pesquisadores mostraram que a combinação de genótipos resistentes com a presença do predador *Ch. externa* reduziu significativamente os danos causados pelo pulgão *Schizaphis graminum* (Rondani, 1852) (Hemiptera: Aphididae).

No Brasil, algumas empresas já comercializam crisopídeos para uso no controle biológico aplicado, sendo *Ch. externa* disponibilizada pela Vittia® com o nome comercial Criso-Vit® (Vittia, 2025), cuja técnica de criação já está bem desenvolvida, o que possibilita sua produção em larga escala (Haramboure et al. 2016; Bezerra et al. 2017)

Além do controle biológico aplicado, estratégias de controle conservativo também têm sido empregadas, como o uso de produtos seletivos que preservem populações naturais de crisopídeos no campo. Salienta-se ainda que *Ch. externa* está amplamente distribuída em áreas de cultivo de cana-de-açúcar no Brasil, onde ocorre naturalmente (Degaspari et al. 2010; Resende et al. 2014; Santos et al. 2017; Pinto e Trujillo 2019), muito embora o seu uso comercial ainda não seja amplamente adotado nesse cultivo,

existindo, porém, estudos que têm evidenciado seu potencial como agente de controle biológico, particularmente devido à voracidade de suas larvas, e a capacidade de predar ovos e lagartas neonatas de *D. saccharalis*, além de seu elevado potencial reprodutivo (De Bortoli et al. 2006; Dias et al. 2018; Braghini et al. 2024). Nesse contexto, torna-se relevante considerar as interações entre predadores de ocorrência natural e métodos de controle utilizados em campo, visando avaliar compatibilidade e seletividade dos produtos a esses inimigos naturais (Dias et al. 2019; Dias et al. 2020)

Agentes microbiológicos, como *B. bassiana*, podem interferir no desempenho de inimigos naturais como *Ch. externa.* Pessoa et al. (2005) observaram que concentrações usuais do fungo não afetaram significativamente ovos nem larvas jovens de *Ch. externa*, embora larvas de terceiro ínstar tenham apresentado alterações quando expostas a concentrações mais elevadas ($1{,}0 \times 10^7$ e $1{,}0 \times 10^8$ conídios/mL). De forma semelhante, Dias et al. (2020) relataram que, apesar de baixas taxas de mortalidade nas primeiras 96 horas, *B. bassiana* causou efeitos letais em até 26% das larvas de primeiro ínstar após 120 horas, exposta à concentrações mais elevadas. Por outro lado, Dias et al. (2019) mostraram que o consumo de presas infectadas por *B. bassiana* não interferiu no desenvolvimento de *Ch. externa*, cuja viabilidade permaneceu em 100%, sugerindo compatibilidade entre o fungo e o predador. Esses resultados reforçam a importância de se considerar a seletividade e a dose do agente microbiológico nas estratégias de MIP, especialmente em programas que visam a integração entre controle biológico aplicado e conservativo. Dessa forma, este trabalho teve como objetivo investigar, em condições de laboratório, as interações entre o fungo entomopatogênico *B. bassiana* e o predador *Ch. externa*, a partir de testes de preferência com a presa *D. saccharalis*.

MATERIAL E MÉTODOS

Os experimentos foram conduzidos no Laboratório de Biologia e Criação de Insetos (LBCI), pertencente ao Departamento de Fitossanidade da Faculdade de Ciências Agrárias e Veterinárias (FCAV) da Universidade Estadual Paulista (UNESP), Campus de Jaboticabal, São Paulo, Brasil. O estudo foi conduzido em condições controladas de temperatura (25 °C ± 1 °C), umidade relativa (70% ± 10%) e fotoperíodo de 12:12 horas (luz:escuro).

Obtenção de *Diatraea saccharalis*

Ovos de *D. saccharalis* foram fornecidos pela biofábrica de *C. flavipes* da Usina São Martinho (USM), localizada em Pradópolis, SP, Brasil. Na biofábrica os insetos são criados conforme o protocolo descrito por Vacari et al. (2012), onde as posturas são realizadas em gaiolas cobertas internamente com folhas de papel sulfite branco (A4). Duas folhas de postura de dois dias foram encaminhadas ao LBCI, e foram acondicionadas em câmara climatizada tipo BOD, com temperatura de 25 ± 1 °C, até a eclosão das lagartas. Após a eclosão, os insetos neonatos foram transferidos para recipientes de vidro temperado (26,0 cm × 6,0 cm) contendo dieta artificial, formulada, com adaptação, com base na proposta por Hensley e Hammond Jr. (1968). As lagartas permaneceram nesses recipientes até atingirem o segundo ínstar, quando foram utilizadas nos bioensaios.

Criação de *Chrysoperla externa*

Os indivíduos de *Ch. externa* utilizados nos bioensaios foram obtidos na criação estoque do LBCI, Unesp, Jaboticabal, SP (De Bortoli et al. 2014). No laboratório a criação desses predadores é mantida em condições ambientais controladas (T = 25 ± 1 °C; fotoperíodo = 12L:12E horas; e umidade relativa = 70 ± 10%, sendo conduzida segundo os procedimentos descritos por Pinto (2019) para *Ceraeochrysa* (*Ce.*) *cincta* (Schneider, 1851) (Neuroptera: Chrysopidae), adaptados de Finney (1948) e Freitas (2001). Para a coleta dos ovos, adultos previamente mantidos em gaiolas de acasalamento e postura (tubos de PVC com 30,0 cm de altura × 20,0 cm de diâmetro, revestidos internamente com papel sulfite branco) são transferidos para tubos de ensaio de fundo chato (8,0 cm × 2,0 cm). A remoção dos ovos é realizada utilizando uma lâmina de estilete acoplada a um suporte adaptado, sendo estes posteriormente acondicionados em placas de Petri (14,0 cm × 3,0 cm), contendo aproximadamente 30 ovos por unidade. Tiras de papel toalha dobradas em formato sanfonado são inseridas para fornecer refúgio às larvas e minimizar o canibalismo. As placas são vedadas com filme de PVC e mantidas até a pupação. A alimentação larval consiste de ovos de *Corcyra cephalonica* (Stainton, 1865) (Lepidoptera: Pyralidae), oferecidos “ad libitum” três vezes por semana. Após a formação dos casulos, eles são individualizados em tubos de ensaio de fundo chato (8,0 cm × 2,0 cm), onde permanecem até a emergência dos adultos, que são transferidos para as gaiolas de reprodução/postura.

Insumos

O fungo *B. bassiana* (cepa IBCB 66) foi obtido a partir do inseticida microbiológico Bouveriz WP®, fornecido pela Nitro Química Brasileira, cuja concentração nominal é de $5x10^9$ UFC/g e a formulação Pó Molhável (WP). No laboratório, o inseticida foi mantido em freezer à temperatura de -1˚C ± 2˚C até o momento de uso. O adjuvante (óleo mineral) utilizado na diluição do inseticida biológico foi o Agris®, fornecido pela Sumitomo Chemical.

Teste de preferência com e sem chance de escolha

Para avaliar o comportamento predatório de *Ch. externa* com lagartas de segundo ínstar de *D. saccharalis* contaminadas com *B. bassiana*, foram aplicados 2,0 µL da suspensão fúngica sobre o dorso da região protorácica de cada lagarta. A suspensão foi preparada com 200,0 mL de água deionizada, 0,01% de Agris® (adjuvante) e 0,228 g do produto comercial Bouveriz®. Lagartas do grupo controle não receberam qualquer tipo de aplicação. Nos testes de preferência foram utilizadas larvas de terceiro ínstar de *Ch. externa*, mantidas sem alimentação por 24 horas. Os bioensaios foram realizados em arenas circulares (placas de Petri) de 16,0 cm de diâmetro × 2,0 de altura, sendo alocado um predador por arena. Na condição com chance de escolha, foram disponibilizadas 150 presas por arena, sendo 75 lagartas tratadas com *B. bassiana* (com 24 horas de exposição) e 75 lagartas não tratadas. Na condição sem chance de escolha, as arenas continham apenas presas tratadas ou não tratadas, em experimentos conduzidos separadamente. Após 24 horas do início do bioensaio, foi contabilizado o número de presas consumidas, sendo que cada condição experimental foi repetida por 15 vezes.

Sobrevivência de *Chrysoperla externa* após exposição ao fungo *Beauveria bassiana* (Boveriz®)

Após a realização dos testes de preferência com e sem chance de escolha, as larvas de *Ch. externa* foram transferidas para tubos de ensaio de fundo chato (2,5 cm de diâmetro × 8,5 cm de altura), com o objetivo de avaliar a sobrevivência após a exposição ao fungo entomopatogênico. As observações foram realizadas diariamente até a emergência dos adultos.

Análise estatística

A análise estatística foi realizada utilizando o software SAS (SAS Institute 2015). Os dados de análise de frequência foram trabalhados utilizando o Proc FREQ e interpretados pelo teste do qui-quadrado ($\chi 2$), no qual a razão de 1:1 foi assumida se *Ch. externa* não apresentasse diferença de alimentação. Os dados de sobrevivência obtidos foram submetidos à análise de variância (ANOVA) e ao teste de Tukey, com nível de significância de 5%. A normalidade e a homocedasticidade dos dados foram verificadas por meio dos testes de Kolmogorov-Smirnov e Bartlett, respectivamente.

RESULTADOS

No teste de preferência com chance de escolha, *Ch. externa* apresentou predação significativamente maior com lagartas de segundo ínstar de *D. saccharalis* contaminadas com *B. bassiana* (63,78 ± 3,63), em comparação às não contaminadas (36,22 ± 1,47) ($\chi^2 = 86,51$; $P < 0,0001$), indicando preferência por presas infectadas (Figura 1 e Tabela 1).

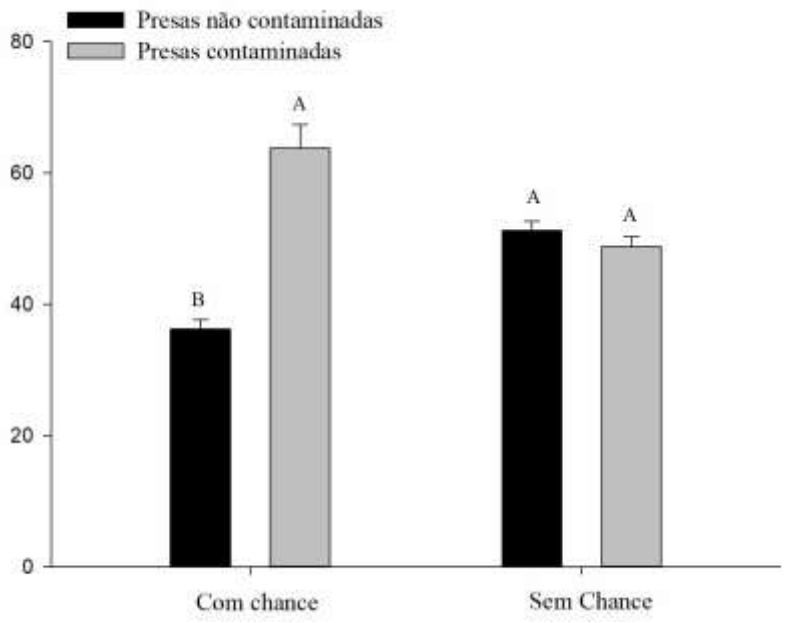

Figura 1. Porcentagem de presas consumidas por *Chrysoperla externa* após aplicação de *Beauveria bassiana*. Letras diferentes indicam diferença significativa pelo teste χ^2.

No entanto, na condição sem chance de escolha, não foram observadas diferenças significativas no número de presas consumidas entre os dois tratamentos (48,77 ± 1,58 para lagartas contaminadas e 51,23

± 1,43 para não contaminadas; $\chi^2 = 48,77$; P = 0,4622), sugerindo que a presença da infecção por *B. bassiana* não interfere no consumo das presas quando não há possibilidade de escolha.

Tabela 1. Porcentagem do consumo de presas contaminadas e não contaminadas por *Chrysoperla externa* com e sem chance de escolha.

	Com chance de escolha	**Sem chance de escolha**
Presas contaminadas	63,78 ± 3,63 a	48,77 ± 1,58 a
Presas não contaminadas	36,22 ± 1,47 b	51,23 ± 1,43 a
χ^2	86,51	48,77
P	< 0,0001	0,4622

Letras diferentes indicam diferença significativa pelo teste χ^2.

A sobrevivência de *Ch. externa* não foi significativamente afetada pela aplicação do produto a base de *B. bassiana* (Boveriz®), conforme indicado pelo teste estatístico (Z = 1,0209; GL = 1; P = 0,3157). Esses resultados sugerem que o fungo não causa mortalidade direta relevante ao predador.

DISCUSSÃO

O controle biológico, embora seja um dos pilares do MIP, ainda enfrenta desafios relacionados à previsibilidade de seus resultados e à integração eficaz entre diferentes agentes de controle (Ong e Vandermeer 2015; Wu et al. 2018). Esses obstáculos reforçam a necessidade de considerar interações multitróficas na formulação de estratégias de MIP mais sustentáveis (Quesada-Moraga et al. 2022), incluindo a avaliação da seletividade de agentes microbiológicos sobre inimigos naturais. Estudos anteriores já demonstraram que os efeitos de *B. bassiana* sobre predadores generalistas podem variar conforme a cepa utilizada, a dose aplicada e o tempo de exposição (Wu et al. 2014; González-Mas et al. 2019; Li et al. 2024b). Esses dados destacam a importância de investigações como a presente, que buscam fundamentar a compatibilidade entre diferentes táticas de controle.

Observou-se neste estudo que a aplicação de *B. bassiana* alterou significativamente o comportamento alimentar de *Ch. externa* em situações de possibilidade de escolha, nas quais os crisopídeos demonstraram preferência por lagartas de *D. saccharalis* contaminadas (63,78%). Essa preferência pode ser explicada pelo fato de lagartas infectadas estarem mais debilitadas o que facilitaria a predação, uma vez que *B. bassiana* atua aderindo seus conídios à cutícula do inseto, germinando e penetrando no hospedeiro

por meio da produção de enzimas como quitinases e proteases (Bhadani et al. 2022; Figueroa et al. 2024; Zhang et al. 2024a). No interior do corpo da lagarta, o fungo se prolifera, causando destruição tecidual e liberando toxinas que comprometem a fisiologia e biologia do inseto, levando à morte (Oliveira et al. 2008; Wang et al. 2021). Antes da morte, as lagartas infectadas apresentam redução na mobilidade e na capacidade de defesa (Mejía et al. 2020), tornando-se presas mais vulneráveis aos predadores, como *Ch. externa*. Esse tipo de preferência por presas contaminadas também foi observado em outros estudos, como o de Souza et al. (2024) onde relatam que o predador *Euborellia annulipes* (Lucas, 1847) (Dermaptera: Anisolabididae) apresentou preferência por ovos de *D. saccharalis* contaminados por *B. bassiana*, bem como o de Arroyo et al. (2023) que mostra oreferência por ovos contaminados com *M. anisopliae*.

No teste sem chance de escolha foi constatado que *Ch. externa* consumiu lagartas de *D. saccharalis* infectadas e não infectadas por *B. bassiana* em proporções semelhantes. Esse padrão comportamental é corroborado por estudos anteriores, como por exemplo, na pesquisa de Dias et al. (2019) onde *Ch. externa* manteve sua taxa de consumo ao se alimentar de ovos e larvas de primeiro ínstar de *Helicoverpa armigera* (Hübner, 1808) (Lepidoptera: Noctuidae) tratados com diferentes concentrações de *B. bassiana*, indicando que a contaminação não interferiu na capacidade de predação do crisopídeo. De maneira semelhante, Avery et al. (2022) observaram que o percevejo predador *Podisus maculiventris* (Say, 1832) (Heteroptera: Pentatomidae) não apresentou preferência significativa entre larvas de lepidópteros infectadas e não infectadas por fungos entomopatogênicos, sugerindo que a infecção não afeta a atratividade das presas para esse predador. Nunes et al. (2019) também observaram padrão semelhante para o predador *E. annulipes,* que não apresentou preferência alimentar entre lagartas de *Plutella xylostella* (Linnaeus, 1775) (Lepidoptera: Plutellidae) tratadas ou não tratadas com *B. bassaiana*.

Esse comportamento sugere que, na ausência de alternativa, a necessidade alimentar do predador leva à aceitação das presas disponíveis, independentemente da contaminação pelo fungo, priorizando a satisfação de suas necessidades nutricionais. O que pode ser particularmente vantajoso em programas de MIP, nos quais a combinação de predadores e fungos entomopatogênicos é frequentemente adotada para aumentar a eficácia no controle de populações de pragas (Abbas, 2020). Estudos indicam que a aplicação conjunta desses inimigos naturais pode gerar efeitos sinérgicos, promovendo uma supressão mais eficiente

das pragas do que quando utilizados isoladamente (Wu et al., 2018; Rizwan et al., 2021; Zhang et al., 2024b).

Quanto a exposição de larvas de *Ch. externa* ao produto *B. bassiana*, não foi constatada influência significativa na sobrevivência do crisopídeo. Essa constatação está alinhada com pesquisas anteriores que demonstraram a seletividade de *B. bassiana* em relação a predadores naturais. Nesse sentido, Dias et al. (2020) observaram que, mesmo após 120 horas de exposição, a mortalidade de larvas de *Ch. externa* não ultrapassou 26,0%, dependendo do ínstar larval e da concentração do fungo. Além disso, estudos com espécies relacionadas, como *Ch. lucasina* (Lacroix, 1912), mostraram taxas de sobrevivência superiores a 90,0% após sete dias de exposição a diferentes concentrações de *B. bassiana*, sem diferenças significativas em comparação ao grupo controle (Morda et al. 2024). Esses dados reforçam a compatibilidade entre o uso de *B. bassiana* e de *Ch. externa* em programas de manejo integrado de pragas, permitindo a combinação eficaz desses agentes de controle biológico sem comprometer a sobrevivência dos predadores naturais. No entanto, para validar e ampliar os resultados observados neste estudo, são necessárias investigações adicionais em condições de campo ou ambientes semi-controlados, bem como experimentos que explorem a interação de *Ch. externa* com outros entomopatógenos e a influência de diferentes estágios de desenvolvimento das presas e do predador, o que poderá oferecer novas perspectivas para estratégias integradas de controle biológico da broca-da-cana.

CONCLUSÃO

A aplicação de *B. bassiana* influencia o comportamento alimentar de *Ch. externa* em situações de escolha, com preferência por presas contaminadas. Contudo, na ausência de alternativas, o predador tem mantida sua taxa de consumo, independentemente da contaminação das presas, o que indica que *Ch. externa* possui potencial para integração com o controle microbiológico em programas de MIP, sem comprometer sua eficácia como agente de controle biológico. A compatibilidade observada sugere que a combinação entre predadores generalistas e fungos entomopatogênicos pode ser uma estratégia promissora para o manejo sustentável da broca-da-cana, com estudos adicionais em condições de campo recomendados para validar esses resultados e expandir seu uso em programas de controle biológico aplicado e conservativo.

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