

TOPICS IN

AGRICULTURAL ENTOMOLOGY

XIII

JOACIR DO NASCIMENTO | CLAUDIANE MARTINS DA ROCHA
DANIEL DALVAN DO NASCIMENTO | EDIMAR PETERLINI
ÉRICA AYUMI TAGUTI | JOAO RAFAEL SILVA SOARES
MATHEUS CARDOSO DE CASTRO | SANDY SOUSA FONSÊCA
VINICIUS FERRAZ NASCIMENTO | RICARDO ANTONIO POLANCZYK
(ORGANIZADORES)



TOPICS IN

AGRICULTURAL ENTOMOLOGY XIII

JOACIR DO NASCIMENTO | CLAUDIANE MARTINS DA ROCHA
DANIEL DALVAN DO NASCIMENTO | EDIMAR PETERLINI
ÉRICA AYUMI TAGUTI | JOAO RAFAEL SILVA SOARES
MATHEUS CARDOSO DE CASTRO | SANDY SOUSA FONSÊCA
VINICIUS FERRAZ NASCIMENTO | RICARDO ANTONIO POLANCZYK
(ORGANIZADORES)



Editora chefe

Profª Drª Antonella Carvalho de Oliveira

Editora executiva

Natalia Oliveira

Assistente editorial

Flávia Roberta Barão

Bibliotecária

Janaina Ramos

Projeto gráfico

Bruno Oliveira

Camila Alves de Cremo

Daphynny Pamplona

Luiza Alves Batista

Natália Sandrini de Azevedo

Imagens da capa

iStock

Edição de arte

Luiza Alves Batista

2022 by Atena Editora

Copyright © Atena Editora

Copyright do texto © 2022 Os autores

Copyright da edição © 2022 Atena Editora

Direitos para esta edição cedidos à Atena Editora pelos autores.

Open access publication by Atena Editora



Todo o conteúdo deste livro está licenciado sob uma Licença de Atribuição *Creative Commons*. Atribuição-Não-Comercial-NãoDerivativos 4.0 Internacional (CC BY-NC-ND 4.0).

O conteúdo dos artigos e seus dados em sua forma, correção e confiabilidade são de responsabilidade exclusiva dos autores, inclusive não representam necessariamente a posição oficial da Atena Editora. Permitido o *download* da obra e o compartilhamento desde que sejam atribuídos créditos aos autores, mas sem a possibilidade de alterá-la de nenhuma forma ou utilizá-la para fins comerciais.

Todos os manuscritos foram previamente submetidos à avaliação cega pelos pares, membros do Conselho Editorial desta Editora, tendo sido aprovados para a publicação com base em critérios de neutralidade e imparcialidade acadêmica.

A Atena Editora é comprometida em garantir a integridade editorial em todas as etapas do processo de publicação, evitando plágio, dados ou resultados fraudulentos e impedindo que interesses financeiros comprometam os padrões éticos da publicação. Situações suspeitas de má conduta científica serão investigadas sob o mais alto padrão de rigor acadêmico e ético.

Conselho Editorial**Ciências Agrárias e Multidisciplinar**

Prof. Dr. Alexandre Igor Azevedo Pereira – Instituto Federal Goiano

Profª Drª Amanda Vasconcelos Guimarães – Universidade Federal de Lavras

Profª Drª Andrezza Miguel da Silva – Universidade do Estado de Mato Grosso

Prof. Dr. Arinaldo Pereira da Silva – Universidade Federal do Sul e Sudeste do Pará

Prof. Dr. Antonio Pasqualetto – Pontifícia Universidade Católica de Goiás

Profª Drª Carla Cristina Bauermann Brasil – Universidade Federal de Santa Maria



Prof. Dr. Cleberton Correia Santos – Universidade Federal da Grande Dourados
Prof^o Dr^a Diocléa Almeida Seabra Silva – Universidade Federal Rural da Amazônia
Prof. Dr. Écio Souza Diniz – Universidade Federal de Viçosa
Prof. Dr. Edevaldo de Castro Monteiro – Universidade Federal Rural do Rio de Janeiro
Prof. Dr. Fábio Steiner – Universidade Estadual de Mato Grosso do Sul
Prof. Dr. Fágner Cavalcante Patrocínio dos Santos – Universidade Federal do Ceará
Prof^o Dr^a Girlene Santos de Souza – Universidade Federal do Recôncavo da Bahia
Prof. Dr. Guilherme Renato Gomes – Universidade Norte do Paraná
Prof. Dr. Jael Soares Batista – Universidade Federal Rural do Semi-Árido
Prof. Dr. Jayme Augusto Peres – Universidade Estadual do Centro-Oeste
Prof. Dr. Júlio César Ribeiro – Universidade Federal Rural do Rio de Janeiro
Prof^o Dr^a Lina Raquel Santos Araújo – Universidade Estadual do Ceará
Prof. Dr. Pedro Manuel Villa – Universidade Federal de Viçosa
Prof^o Dr^a Raissa Rachel Salustriano da Silva Matos – Universidade Federal do Maranhão
Prof. Dr. Renato Jaqueto Goes – Universidade Federal de Goiás
Prof. Dr. Ronilson Freitas de Souza – Universidade do Estado do Pará
Prof^o Dr^a Talita de Santos Matos – Universidade Federal Rural do Rio de Janeiro
Prof. Dr. Tiago da Silva Teófilo – Universidade Federal Rural do Semi-Árido
Prof. Dr. Valdemar Antonio Paffaro Junior – Universidade Federal de Alfenas



Topics in agricultural entomology - XIII

Diagramação: Natália Sandrini de Azevedo
Correção: Yaidy Paola Martinez
Indexação: Amanda Kelly da Costa Veiga
Revisão: Os autores

Dados Internacionais de Catalogação na Publicação (CIP)

T674 Topics in agricultural entomology - XIII / Joacir do Nascimento, Claudiane Martins da Rocha, Daniel Dalvan do Nascimento, et al. – Ponta Grossa - PR: Atena, 2022.

Outros organizadores
Edimar Peterlini
Érica Ayumi Taguti
João Rafael Silva Soares
Matheus Cardoso de Castro
Sandy Sousa Fonsêca
Vinicius Ferraz Nascimento
Ricardo Antonio Polanczyk

Formato: PDF
Requisitos de sistema: Adobe Acrobat Reader
Modo de acesso: World Wide Web
Inclui bibliografia
ISBN 978-65-258-0544-3
DOI: <https://doi.org/10.22533/at.ed.443220109>

1. Agricultura. I. Nascimento, Joacir do (Organizador). II. Rocha, Claudiane Martins da (Organizadora). III. Nascimento, Daniel Dalvan do (Organizador). IV. Título.

CDD 338.1

Elaborado por Bibliotecária Janaina Ramos – CRB-8/9166

Atena Editora
Ponta Grossa – Paraná – Brasil
Telefone: +55 (42) 3323-5493
www.atenaeditora.com.br
contato@atenaeditora.com.br



Atena
Editora
Ano 2022

DECLARAÇÃO DOS AUTORES

Os autores desta obra: 1. Atestam não possuir qualquer interesse comercial que constitua um conflito de interesses em relação ao artigo científico publicado; 2. Declaram que participaram ativamente da construção dos respectivos manuscritos, preferencialmente na: a) Concepção do estudo, e/ou aquisição de dados, e/ou análise e interpretação de dados; b) Elaboração do artigo ou revisão com vistas a tornar o material intelectualmente relevante; c) Aprovação final do manuscrito para submissão; 3. Certificam que os artigos científicos publicados estão completamente isentos de dados e/ou resultados fraudulentos; 4. Confirmam a citação e a referência correta de todos os dados e de interpretações de dados de outras pesquisas; 5. Reconhecem terem informado todas as fontes de financiamento recebidas para a consecução da pesquisa; 6. Autorizam a edição da obra, que incluem os registros de ficha catalográfica, ISBN, DOI e demais indexadores, projeto visual e criação de capa, diagramação de miolo, assim como lançamento e divulgação da mesma conforme critérios da Atena Editora.



DECLARAÇÃO DA EDITORA

A Atena Editora declara, para os devidos fins de direito, que: 1. A presente publicação constitui apenas transferência temporária dos direitos autorais, direito sobre a publicação, inclusive não constitui responsabilidade solidária na criação dos manuscritos publicados, nos termos previstos na Lei sobre direitos autorais (Lei 9610/98), no art. 184 do Código Penal e no art. 927 do Código Civil; 2. Autoriza e incentiva os autores a assinarem contratos com repositórios institucionais, com fins exclusivos de divulgação da obra, desde que com o devido reconhecimento de autoria e edição e sem qualquer finalidade comercial; 3. Todos os e-book são *open access*, desta forma não os comercializa em seu site, sites parceiros, plataformas de *e-commerce*, ou qualquer outro meio virtual ou físico, portanto, está isenta de repasses de direitos autorais aos autores; 4. Todos os membros do conselho editorial são doutores e vinculados a instituições de ensino superior públicas, conforme recomendação da CAPES para obtenção do Qualis livro; 5. Não cede, comercializa ou autoriza a utilização dos nomes e e-mails dos autores, bem como nenhum outro dado dos mesmos, para qualquer finalidade que não o escopo da divulgação desta obra.



The authors are grateful to the São Paulo Research Foundation (FAPESP) for the grant 2022/04343-9

PREFACE

The Graduate Program in Agronomy (Agricultural Entomology) at the UNESP Faculty of Agricultural and Veterinary Sciences in Jaboticabal has always been characterized by its focus on Integrated Pest Management (IPM). Since its foundation, the program has graduated 287 students with a master's degree and 148 Ph.D. students. They are now active in various areas of the public or private sector and contribute to agriculture's economic and environmental sustainability.

This e-book entitled "Topics in Agricultural Entomology - XIII" was made possible through the immense effort of the Organizing Committee, formed by MSc and Ph.D. students from all research areas of our Graduate Program. In its 14 chapters, readers will find information on the most diverse areas of IPM, with a richness of information on both the fundamental and applied aspects of IPM.

As coordinator of the 2022 edition of the Winter Workshop on Agricultural Entomology, it is my pleasure to provide event attendees with an e-book of excellent content, demonstrating the importance of our research to society.

Prof. Ricardo Antônio Polanczyk

FCAV/UNESP


PPG Entomologia Agrícola Coordinator

SUMÁRIO

CAPÍTULO 1..... 1

QUALITY CONTROL IN MASS REARING OF INSECTS


Matheus Moreira Dantas Pinto
Dagmara Gomes Ramalho
Brenda Karina Rodrigues da Silva
Joice Mendonça de Souza
Marcelle Bezerra Silva
Thiago Nascimento de Barros
Sergio Antonio de Bortoli

 <https://doi.org/10.22533/at.ed.4432201091>

CAPÍTULO 2..... 18

CONSERVATION PRACTICES FOR MAINTENANCE OF NATURAL ENEMIES IN AGROECOSYSTEMS


Iwlianny Luiza Pereira dos Santos
Vinicius Ferraz Nascimento
Dagmara Gomes Ramalho
Letícia Barbosa de Lacerda
Márcio Aparecido de Melo
Pedro Gomes Peixoto
Sergio Antonio de Bortoli

 <https://doi.org/10.22533/at.ed.4432201092>

CAPÍTULO 3..... 36

IMPLEMENTATION CHALLENGES OF INTEGRATED PEST MANAGEMENT PROGRAMS IN AGRICULTURAL SYSTEMS

Marcelo Coutinho Picanço
Mayara Moledo Picanço
Ricardo Siqueira da Silva

 <https://doi.org/10.22533/at.ed.4432201093>

CAPÍTULO 4..... 43

LANDSCAPE STRUCTURE AND INSECT PEST MANAGEMENT


João Rafael Silva Soares
Sabrina Juvenal de Oliveira
Thaynara Arantes Soares Junqueira
Marina Guimarães Brum de Castro
Yasmin Esteves Izidro
Odair Aparecido Fernandes

 <https://doi.org/10.22533/at.ed.4432201094>

CAPÍTULO 5..... 59

TECHNOLOGICAL INNOVATIONS APPLIED TO INSECT PEST MANAGEMENT


Sandy Sousa Fonsêca
Ciro Pedro Guidotti Pinto
Ana Letícia Zéro dos Santos
Amanda Cristina Guimarães Sousa
Nicole de Paula Souza
Guilherme Duarte Rossi

 <https://doi.org/10.22533/at.ed.4432201095>

CAPÍTULO 6..... 71

GOOD PRACTICES IN AGRICULTURAL SPRAYING FOR PEST MANAGEMENT


Edimar Peterlini
Ana Beatriz Dilena Spadoni
Gabriela Pelegrini
Maria Thalia Lacerda Siqueira
Pedro Henrique Urach Ferreira
Marcelo da Costa Ferreira

 <https://doi.org/10.22533/at.ed.4432201096>

CAPÍTULO 7..... 83

RESISTANCE OF CITRUS PEST MITES TO ACARICIDES

Claudiane Martins da Rocha
Matheus Cardoso de Castro
Daniel Júnior de Andrade

 <https://doi.org/10.22533/at.ed.4432201097>

CAPÍTULO 8..... 90

CHALLENGES IN INSECT PEST MANAGEMENT IN SUGARCANE CROP


Aimée Regali Selegim
Sergio Antônio de Bortoli
Dagmara Gomes Ramalho






 <https://doi.org/10.22533/at.ed.4432201098>

CAPÍTULO 9..... 97

SELECTIVITY OF INSECTICIDES AND BIOINSECTICIDES TO COMMERCIALY USED PARASITOIDS OF *DIATRAEA SACCHARALIS* ON SUGARCANE

Érica Ayumi Taguti
Gabriel Gonçalves Monteiro
Ivana Lemos Souza
Nilza Maria Martinelli

 <https://doi.org/10.22533/at.ed.4432201099>

CAPÍTULO 10.....	109
INTEGRATED MANAGEMENT STRATEGIES FOR KEY PESTS OF COFFEE CROP	
Bruno Henrique Sardinha de Souza	
 https://doi.org/10.22533/at.ed.44322010910	
CAPÍTULO 11.....	123
CHALLENGES OF DIGITAL AGRICULTURE IN PEST MANAGEMENT	
David Luciano Rosalen	
 https://doi.org/10.22533/at.ed.44322010911	
CAPÍTULO 12.....	134
USE OF REMOTE SENSING TO IDENTIFY AND MANAGE NEMATODES IN SOYBEAN CROPS	
Gabriela Lara Leite Alcalde	
Edicleide Macedo da Silva	
Morgana Baptista Gimenes	
Lorena Tozi Bombonato	
Pedro Henrique Vasques Bocalini	
Pedro Luiz Martins Soares	
 https://doi.org/10.22533/at.ed.44322010912	
CAPÍTULO 13.....	147
ENDOPHYTIC ENTOMOPATHOGENIC MICROORGANISMS IN PEST MANAGEMENT	
Lana Leticia Barbosa de Carvalho	
Fabiana Santana Machado	
Ricardo Antônio Polanczyk	
 https://doi.org/10.22533/at.ed.44322010913	
CAPÍTULO 14.....	156
<i>BACILLUS THURINGIENSIS</i> CRY PESTICIDAL PROTEINS SUBLETHAL EFFECTS ON TARGET LEPIDOPTERA AND THEIR IMPACT ON THE AGROECOSYSTEM	
Amanda Cristiane Queiroz Motta	
Nayma Pinto Dias	
Ricardo Antonio Polanczyk	
 https://doi.org/10.22533/at.ed.44322010914	
SOBRE OS AUTORES	167

CHALLENGES IN INSECT PEST MANAGEMENT IN SUGARCANE CROP

Aimée Regali Seleglim

Sergio Antônio de Bortoli

Dagmara Gomes Ramalho

1 | INTRODUCTION

The sugar and ethanol world market moved US\$3.61 millions in 2019, with an estimated increase of 85% (US\$6.70 millions) by 2027, being in this market Brazil stands out for being the world's largest producer of sugarcane (*Saccharum* spp.) (Poaceae). According to the monitoring of the Brazilian sugarcane harvest by CONAB (2022), sugarcane production in the 2021/22 season totaled 585.2 millions tons, representing a volume of raw material 10.6% lower than the 2020/21 season. This reduction is due to a 3.5% decrease in cultivated area and, above all, adverse weather effects of drought during crop production cycle and low temperatures recorded in June and July 2021.

For Brazil to remain the world's largest producer of sugarcane, permanent studies on solutions about factors that impact and reduce sugarcane yields are required, with one of the bottlenecks being ethanol production costs, of which 70% is from sugarcane production (Santos et al., 2018).

Agrochemical costs, machinery, fleet, maintenance, new technologies and innovation, labor, harvesting (straw), management and monitoring (precision agriculture), transport and logistics, water use, finance, storage, agricultural planning, safety, personal protective equipment (PPE), topography, residues (e.g., vinasse), technical expertise and outdated in rural extension, droughts, fires, and frosts are just some of the challenges faced by farmers, in addition to issues related to pest control.

The exposure of crops to insect pest attacks have promoted losses of around 60 million tons, which also have significantly reduced industrial production (Parra et al., 2010; Oliveira et al., 2014). Moreover, owing to different climatic conditions, changes in sugarcane management, among other challenges mentioned above, many crops have undergone even higher losses due to pest insect infestations.

2 | SUGAR CANE PESTS AND MANAGEMENT APPROACHES

About 85 insect species have been recognized as damage-causing factors to sugarcane crops in Brazil. Among them, some are considered important or primary pests and, in some cases, of regional or national scope. The importance of one or another insect pest

species depends on several factors, the most relevant being: growing area (edaphoclimatic conditions), agricultural year, and techniques adopted for crop practice and management. The main pests for sugarcane, also called key pests, are sugarcane borer (Lepidoptera: Crambidae), root spittlebug (*Mahanarva* spp.) (Hemiptera: Cercopidae), and weevil, *Sphenophorus levis* (Coleoptera: Curculionidae), with each of them posing different challenges to production. Besides them, other pests attack stalk base or ratoon, such as: sugarcane rhizome borer, *Migdolus fryanus* (Coleoptera: Vesperidae), sugarcane hairy borer, *Hyponeuma taltula* (Lepidoptera: Erebididae), lesser cornstalk borer, *Elasmopalpus lignosellus* (Lepidoptera: Pyralidae), subterranean termite, *Heterotermes tenuis* (Isoptera: Rhinotermitidae), mound building termite, *Cornitermes cumulans* (Isoptera: Termitidae), and the burrower bug, *Scaptocoris castanea* (Hemiptera: Cydnidae).

Plant shoot pests can also be related, namely: small sugarcane borer, *Diatraea flavipennella* (Lepidoptera: Crambidae), giant sugarcane borer, *Telchin licus* (Lepidoptera: Castniidae), leaf-cutter ants, *Atta* spp. (Hymenoptera: Formicidae), leaf spittlebug, *Mahanarva posticata* (Hemiptera: Cercopidae), and West Indian cane weevil, *Metamasius hemipterus* (Coleoptera: Curculionidae) (Leslie, 2007; CTC, 2013; Selegim, 2020).

Challenges in *D. saccharalis* control are related to increased use of delta and pheromone traps to monitor adult movement patterns. This modality poses an operational challenge (in adapting yield to pest timing) and, due to the lack of a synthetic option in the market for natural pheromones, as well as difficulty in expanding, modeling and/or automating pest monitoring. Infestation modeling studies have brought great advances to the use of such technologies; however, pest and varietal management programs should be rethought due to the “borer-rot” complex, including the use of pest resistant Bt cultivars (Allen & Singh, 2016; Carbognin, 2019; Franco et al., 2021). Finally, *D. saccharalis* control is still being done by the parasitoids *Cotesia flavipes* (Hymenoptera: Braconidae) and *Trichogramma galloi* (Hymenoptera: Trichogrammatidae), which are reared in biofactories and released in the field. In this case, a great challenge is automation of laboratory production, which aims at improving production efficiency and quality of produced individuals, as well as reducing production costs. Also, the release of these parasitoids has represented a significant challenge for the sector, particularly via drones.

Remarkably, a great challenge for researchers in the field remains to obtain artificial diets for insect production in the laboratory in quantity and quality. Such conditions are needed for insects to be able to efficiently perform what is expected from them. Among the actions, one must highlight the improvement of borer diet and a diet that can efficiently produce *S. levis* and *H. taltula* in biofactories.

For root spittlebug and sugarcane weevils, challenges are mainly related to their control, since these species develop in the soil (Dinardo-Miranda, 2008). Allied to this is the fact that these pests require highly difficult monitoring and sampling and their presence is only noticed after attack symptoms become visible. Moreover, soil insect pests have been practically controlled by agrochemicals and in a very intensive way. In this sense, Arrigoni (2007) already pointed out the monitoring and proper use of agrochemicals as challenges to minimize negative environmental impacts. Currently, methods of controlling these pests have not advanced much, with chemical control still being the most used. However, new control forms alternative to the chemical have been studied, such as the use of entomopathogenic nematodes (Silva, 2020).

Another insect that has been worrying part of the sugar-alcohol sector is the *H. taltula*. This pest, according to Arrigoni (2007), was already a concern almost 20 years ago and seemed to become a primary pest in sugarcane plantations. The absence of bioecological studies that could guide control strategies was also a major concern, which today is still scarce.

Studies are also needed to increase understanding of potential effects of climate change and other factors on pests and their natural enemies, which can affect both animals and sugarcane itself. In this sense, De Bortoli et al. (2017) and Martins (2018) found important information to advance studies and develop new solutions for pest control.

Apart from treated points, there are several other challenges for sugarcane pest management and control, including: low efficiency of control measures available; pest resistance to pesticides; biological control compatibility with other agricultural inputs; production and logistics of biological inputs (micro and macro) to meet the market demand; control measures suited to irrigated, rainfed, drip fertigation, no-tillage or minimal planting systems in the face of challenges posed by shoot and in particular soil pests; new cultivars with different pest tolerance and resistance levels; and finally newly emerged pests. All this can be coupled with the little information in the literature on pests and mainly population dynamics at extreme temperatures and humidity (in parallel with drought, frost, and similar conditions).

Farmers who produce sugarcane and use biological control should pay attention to research recommendations, including: quality and age of individuals to be released in the field, form of transport and distribution, time of release in the field, and use of selective agrochemicals in the case of joint use with chemical control.

Biological control issues must be addressed and solved under a systemic view to provide efficiency and positive results. Currently many solutions are available but only a few

have connected complete and/or integrated practices for agricultural management and its various realities. Despite these solutions, little is known about pest biology or agroecology, or even how to time applications with storage and agricultural planning. Among the solutions, the use of drones has been proposed to spray products, release biological agents, and crop imaging; yet, little is known about its legality and correct use, as well as the reliability or accuracy of the data collected. Added to this, the relationships of pests with sugarcane farming, equipment restrictions, and aspects such as rainfall and connectivity are still poorly understood. In this sense, the urge to fulfill this unexplored market has made many companies forget a few important stages of biological control development, and solutions end up being launched unfinished, with some or many “buts”, doubts, and low reliability. Fortunately, some companies understand this hindrance and have developed solutions jointly with customers and research institutions, seeking to resolve doubts and uncertainties in the face of the existing challenges, which is what the sector needs.

In general, challenges vary with crop species, cropping systems (perennial, semi-perennial, conventional, organic, mechanical planting, manual, ratoon, etc.), and amount of investment available. The latter varies with management type and final objective, especially those directly or indirectly related to pest control. End goals determine the line of work, the sugar and ethanol sector often tend to seek sustainable solutions that ensure profitable production over several crop cycles with less damage to the environment, besides greater cost-benefits. However, this is not always an option or possibility in the face of all scenarios that farmers or large companies and groups experience. Moreover, there is a “rooted” tendency towards more intensive use of agrochemicals, which is more behavioral than related to access to information.

According to Diógenes & Silva (2020), the conventional agriculture spread worldwide applies principles that do not respect major principles of nature. As a result, there are many invariably negative consequences for the environment. In this regard, Altieri (1999) stated that conventional agronomists have used dominant assumptions of modern science when it comes to “doing agriculture”, such as disregarding that one crop or lack of it can interfere with another. These professionals also often study physical soil properties separately from the biological ones and from the life that sustains them. Universalism is also noted when they propose, for example, plowing land using the same North American equipment and techniques, disregarding the different conditions in tropical countries. Another widely used assumption is objectivism, which assumes that agricultural production can be understood objectively, without considering the farmers and their way of thinking, the social systems, and agroecosystems surrounding plantation areas. For Altieri (1999), conventional agronomists based on such principles develop technologies for plant nutrition and pest management in

isolation, assuming that they can be transferred to farmers as new technologies since they believe that they may fit into any agricultural system.

Regarding pest control, sustainable solutions beyond the conventional agriculture paradigm include concepts of Integrated and/or Ecological Pest Management (IPM and/or EPM). These practices are based on strategic decisions after monitoring pests, aiming to develop control measures that typically combine more than one approach (e.g., chemical, biological, and cultural controls). For an Ecological Pest Management, biological, cultural, and ecological management practices based on applied agroecology are especially preferred.

In any case, challenges in their base and essence are very similar between conventional systems and those that use biological control. According to Parra (2019), it should be considered that agriculture in Brazil is different than in any other part of the world, with two to three annual harvests in certain regions. When stating that biological control in the Netherlands or Spain covers around 80 to 90% of plantations, it should be remembered that, in these countries, most of the cultivation is done in greenhouses. Therefore, like what has been done in Brazilian agriculture that has made it a leader in Tropical Agriculture in the last 40 years, a biological control model specific to tropical regions must be developed, especially for open fields. And, of course, there are great challenges ahead, considering the type of agriculture, including the logistics of storage and transport across Brazil's long territorial extension; legislation problems (legislation for agrochemicals); sampling for release of biological control agents; release techniques over large areas; how to properly manage areas with transgenics (currently occupying more than 50 million hectares in Brazil); availability of biological control agents to farmers; automated insect mass rearing techniques for macro-organisms; formulations for microorganisms, among others (Parra, 2014).

Thus, it can be understood that the pest control challenges in sugarcane crops are not exactly one-off or specific to each system/objective. They usually come from a lack of specific and broad knowledge about the entire production chain, causes and consequences, costs, logistics, and reality of farmers, thus requiring wide-range and efficient visions and solutions. Lastly, pest control challenges in sugarcane farming are numerous, complex, and are not just for farmers, but for the entire system, from academia, large groups, and companies, as well as the government, and the solution may come from the union of these components in actions and programs.

REFERENCES

- Allen, A.M.; Singh, N.J. Linking movement ecology with wildlife management and conservation. **Frontiers in Ecology and Evolution**, v.3, 155, 2016. 103389/fevo.2015.00155
- Altieri, M.A. **Agroecologia** – Bases científicas para una agricultura sustentable. Montevideo: Editorial Nordan-Comunidad. 1999. p. 31 – 33.
- Arrigoni, E.B. Pragas do solo. VII Workshop tecnológico sobre pragas da cana-de-açúcar. 2007. Available at:<<http://www.p.paper-Enrico Arrigoni-workshop Tecnológico Pragas-2007>>. Accessed on May 01, 2022.
- Carbognin, E.R. **Modelagem de previsão de *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Crambidae) em cana-de-açúcar (*Saccharum* spp.)**. 2019. 111f. Tese (Doutorado em Agronomia - Entomologia Agrícola), Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.
- CONAB - Companhia Nacional de Abastecimento (2022) Acompanhamento da safra brasileira de cana-de-açúcar, v.8, Safra 2021/22, Primeiro levantamento. Available at:<<https://www.conab.gov.br/info-agro/safras/cana/boletim-da-safra-de-cana-de-acucar>>. Accessed on Apr 24, 2022.
- CTC. Centro de Tecnologia Canavieira. Pragas e doenças da cana-de-açúcar - “roguing”. P.55, 2013. Available at:<<http://www.ctcanavieira.com.br/>>. Accessed on Dec 30, 2014.
- De Bortoli, S.A. et al. Efeito do aquecimento global sobre as pragas da cana-de-açúcar. In: Bettiol, W. et al. (Eds.). **Aquecimento global e problemas fitossanitários**. Brasília: EMBRAPA, 2017. p.348-379.
- Dinardo-Miranda, L.L. Pragas. In: Dinardo-Miranda, L.L.; Vasconcelos, A.C.M.; Landell, M.G.A. (Eds.). **Cana-de-açúcar**. Campinas: Instituto Agronômico, 2008. p.349–404.
- Diógenes, F.H.O.; Silva, V.R. Uso de agrotóxico ou controle agroecológico de pragas e doenças da agricultura? Uma reflexão a partir do município de Alvorada do Gurguéia-PI. **Brazilian Journal of Agroecology and Sustainability**, v.1, p.1-20, 2020. 10.52719/bjas.v1i2.2925
- Franco, F.P. et al. Fungal phytopathogen modulates plant and insect response to promote its dissemination. **The ISME Journal**, v.15, p.3522-3533, 2021. 10.1038/s41396-021-01010-z
- Leslie G. Pests of sugarcane. In: James, G. (Ed.). **Sugarcane**. Hoboken: John Wiley & Sons, 2007. p.78-100.
- Martins, L.F. **Atração de adultos de *Sphenophorus levis* Vaurie, 1978 (Coleoptera: Curculionidae) à vinhaça da cana-de-açúcar e identificação dos seus compostos voláteis**. 2018. 63f. Dissertação (Mestrado em Sanidade, Segurança Alimentar e Ambiental no Agronegócio.), Instituto Biológico, São Paulo.
- Oliveira C.M. et al. Crop losses and the economic impact of insect pests on Brazilian agriculture. **Crop Protection**, v.56, p.50-54, 2014. 10.1016/j.cropro.2013.10.022
- Parra J.R.P. et al. Controle biológico de pragas como um componente chave para a produção sustentável da cana-de-açúcar. In: Cortez, L.A.B. (Ed.). **Bioetanol de cana-de-açúcar: P&D para produtividade e sustentabilidade**. São Paulo: Blucher, 2010. p.441-450.

Parra, J.R.P. Biological control in Brazil: an overview. **Scientia Agricola**, v.71, n.5, p.420-429, 2014. 10.1590/0103-9016-2014-0167

Parra, JRP. Controle biológico na agricultura brasileira. **Entomological Communications**, v.1, ec01002, 2019. 10.37486/2675-1305.ec01002

Santos, F.S. et al. **Tecnologia de produção cana-de-açúcar & cachaça**. Londrina: Ed. Mecenas, 2018, 418p.

Seleglim, A.R. **Estratégias para o controle da broca peluda, *Hyponeuma taltula* (Schaus, 1904) (Lepidoptera, Erebidae), em cana-de-açúcar**. 2020. 58f. Dissertação (Mestrado em Agronomia - Entomologia Agrícola) – Faculdade de Ciências Agrárias e Veterinárias, Jaboticabal.

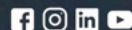
Silva, M.S.O. ***Steinernema rarum* para o controle de *Sphenophorus levis*, *Hyponeuma taltula* e *Leucothyreus* sp. na cultura da cana-de-açúcar e sua compatibilidade com vinhaça**. 2020. 60f. Dissertação (Mestrado em Sanidade, Segurança Alimentar e Ambiental no Agronegócio), Instituto Biológico, São Paulo.

LALLEMAND

Microbial by nature

BIOFUNGICIDAS
BIONEMATÓCIDAS
BIOINSETICIDAS
BIOINOCULANTES

agricultura RESPONSÁVEL MANEJO BIOLÓGICO



@lallemandplantcarebrasil
www.lallemandplantcare.com



ACCESSE O SITE LALLEMAND

+ DE

86

ANOS DE HISTÓRIA.

7 PLANTAS
INDUSTRIAIS
NO MUNDO,
4 DO AGRO.

1Bi

É A EXPECTATIVA DE
FATURAMENTO EM
2022 NO AGRO.

NO 3º ANO
DA COMPANHIA
NO AGRO, ESTAMOS
ENTRE AS

5 MAIORES
EMPRESAS DO
SEGMENTO.

AGRO.NITRO.COM.BR



OMBRO A OMBRO COM VOCÊ,
ENTREGANDO TECNOLOGIAS QUE AUMENTAM A
RENTABILIDADE DA LAVOURA DO PRODUTOR RURAL.

 **nitro**

A ESCOLHA MAIS SIMPLES PARA SUA PRODUTIVIDADE EVOLUIR



O Sistema Enlist® é a maneira **mais fácil** de manter o controle da sua operação para **maximizar o potencial produtivo** por meio de três pilares:

BIOTECNOLOGIAS

Conkesta E3
SOJA

Enlist E3
SOJA

HERBICIDAS

Enlist Duo®
COLEX-D[®]
HERBICIDA

Enlist®
COLEX-D[®]
HERBICIDA

GENÉTICA DE ALTA PERFORMANCE

Com variedades altamente produtivas dos principais parceiros



Enlist Certo

Boas Práticas Agrícolas

MAIS FACILIDADE PARA ALTA PRODUTIVIDADE

MAIOR CONTROLE

Redução no potencial de deriva e ultrabaixa volatilidade na aplicação, além da proteção contra lagartas.

CONVENIÊNCIA

Redução de odor, proporcionando comodidade aos aplicadores e comunidades vizinhas.

DIVERSIDADE

Sementes tolerantes às herbicidas Enlist® Colex-D[®] (nova 2,4-D sol colina), glifosato e glifosinato.

FLEXIBILIDADE

Compatível com diversos sais de glifosato, de acordo com a bula.





Os eventos de soja transgênica contidos nas variedades de sojas Enlist E3® e Conkesta E3® são desenvolvidos e pertencem conjuntamente à Corteva Agriscience e à M.S. Technologies L.L.C. Enlist® Colex-D[®] deve ser usado em dessecação da soja, em pré-plantio (aplique/plante) e em pós-emergência das sojas Enlist E3® e Conkesta E3®.

ATENÇÃO PRODUTO PERIGOSO À SAÚDE HUMANA, ANIMAL E AO MEIO AMBIENTE; USO AGRÍCOLA; VENDA SOB RECEITUÁRIO AGRÔNOMICO; CONSULTE SEMPRE UM AGRÔNOMO; INFORME-SE E REALIZE O MANEJO INTEGRADO DE PRAGAS; DESCARTE CORRETAMENTE AS EMBALAGENS E OS RESTOS DOS PRODUTOS; LEIA ATENTAMENTE E SIGA AS INSTRUÇÕES CONTIDAS NO RÓTULO, NA BULA E NA RECEITA; E UTILIZE OS EQUIPAMENTOS DE PROTEÇÃO INDIVIDUAL.

TOPICS IN

AGRICULTURAL ENTOMOLOGY

XIII

 www.atenaeditora.com.br
 contato@atenaeditora.com.br
 [@atenaeditora](https://www.instagram.com/atenaeditora)
 www.facebook.com/atenaeditora.com.br



TOPICS IN

AGRICULTURAL ENTOMOLOGY

XIII

-  www.atenaeditora.com.br
-  contato@atenaeditora.com.br
-  [@atenaeditora](https://www.instagram.com/atenaeditora)
-  www.facebook.com/atenaeditora.com.br

