Topics in

Agricultural Entomology XIII

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Outros organizadores
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Matheus Cardoso de Castro
Sandy Sousa Fonsêca
Vinicius Ferraz Nascimento
Ricardo Antonio Polanczyk

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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

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CAPÍTULO 8

CHALLENGES IN INSECT PEST MANAGEMENT IN SUGARCANE CROP

Aimée Regali Seleghim

Sergio Antônio de Bortoli

Dagmara Gomes Ramalho

1 I 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 outdating 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, owning 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 I 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: Erebidae), 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; Seleghim, 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.

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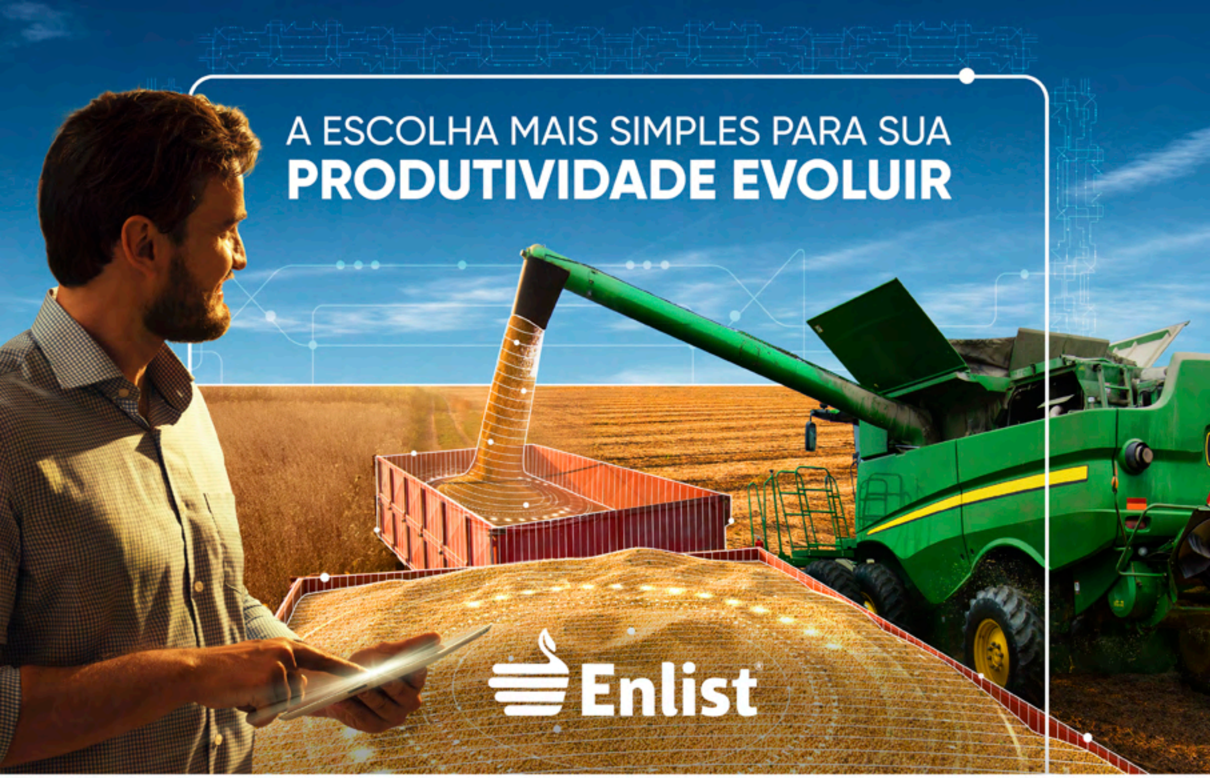

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