frontiers | Frontiers in Agronomy

TYPE Editorial
PUBLISHED 12 October 2022
DOI 10.3389/fagro.2022.1052181

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Pest Management, a section of the journal Frontiers in Agronomy

RECEIVED 23 September 2022
ACCEPTED 29 September 2022
PUBLISHED 12 October 2022

CITATION
Punja ZK and Scott-Dupree C (2022) Editorial: Cannabis IPM – insect pests and diseases.
Front. Agron. 4:1052181.
doi: 10.3389/fagro.2022.1052181

Editorial: Cannabis IPM – insect pests and diseases

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KEYWORDS

cannabis pest management, plant pathogens, insect pests, disease management, biological control

Editorial on the Research Topic
Cannabis IPM - insect pests and diseases

Cultivation of *Cannabis sativa* L. has increased significantly in North America in recent years. It is represented by plants grown for medicinal and recreational uses (eg. containing psychoactive cannabinoids - cannabis or marijuana) and plants grown for fibre, seed and oils, in addition to non-psychoactive cannabinoids (hemp). The legalization of cannabis in Canada and the passage of the Farm Bill in the USA, both of which occurred in 2018, has spurred the cannabis and hemp industries into large-scale production in both countries. For cannabis, production is mostly indoors while for hemp, it is mostly outdoors. With this increased cultivation acreage has appeared an array of insect pests and plant pathogens that require integrated pest management (IPM) approaches to ensure they are managed within the guidelines imposed by regulatory agencies in Canada and the USA. Research on these crops has lagged due to restrictions imposed on the growing and studying of these plant species prior to 2018. Therefore, it is now imperative to conduct the necessary research that will ensure that sustainable and efficacious IPM programs are available to growers.

In this collection of research articles from six different laboratories and research groups, the latest developments in the understanding of insect pests and plant pathogens of cannabis and hemp are presented. Britt et al. describe results from a survey conducted on arthropod pests found on hemp plants grown in California during the summer season of 2021. Sampling was done in the Central Valley and Central Coast regions using three different methods for sampling. Among 13,000 specimens collected and analyzed, close to half were whiteflies. The most representative order of insects was Hemiptera (including whiteflies), followed by Thysanoptera and then Hymenoptera. Very few pest species were recovered, the most common being the cannabis aphid. These results provide insight into insect populations during one season of sampling. Additional sampling conducted over multiple years and in different localities should shed additional light on the populations of insects, including pests, that build up in hemp production areas.

Insect pest occurrences are also very common on indoor-grown cannabis plants and present challenges to producers with regard to their management. Lemay et al. review the literature on various ways in which these pests can be managed using biological approaches i.e. with predatory insects that are released into the growing environment. Interestingly, the unique growing conditions and plant morphology of cannabis can present challenges for the establishment and efficacy of the biological control agents. The inherent characteristics of the cannabis plant that include its unique biochemical composition, the prolific production of trichomes that contain the important cannabinoids, and the artificial supplementary lighting conditions in indoor cultivation all pose challenges that need to be further addressed through research. Insect biological control agents may need to be "tailored" to thrive in these specific growing environments.

An important group of plant pathogens that affect cannabis and hemp plants are species of the genus *Fusarium*. In the article by Gwinn et. al., the 16 species that have been found to be associated with *C. sativa* are described from the viewpoint of morphological characteristics and symptoms they cause on affected plants. The authors delve into details of the most concerning aspect of *Fusarium* infections, which in addition to plant debilitation and mortality, is the potential for mycotoxin production on and in affected plant tissues. These mycotoxins have been extensively studied on other agronomically important crops, but little research has been conducted on *C. sativa* to assess their impact. The authors provide details of each of the common mycotoxin groups, presenting interesting information that is not found elsewhere. The challenges in the management of *Fusarium* spp. on cannabis and hemp are discussed and the need for research emphasized.

A second group of important pathogens that remain poorly characterized in *C. sativa* are the viruses and viroids. In a leading-edge article by Chiginski et al., the authors examined the extent to which hemp fields in Colorado were affected by viruses and viroids using next-generation sequencing. They report the widespread distribution of Beet Curly Top virus, in addition to five other viruses and Hop Latent Viroid. These results shed light on the prevalence of these pathogens in hemp that could potentially be used to investigate the occurrence of these pathogens in cannabis. The challenges to management of these fast-spreading obligate pathogens are discussed.

Another group of obligate pathogens affecting cannabis and hemp plants is powdery mildew which can cause severe losses if not managed properly. Mihalyov and Garfinkel addressed the need to search for sources of genetic resistance to powdery mildew by identifying a PM1 resistance gene in *C. sativa*. Using 10,000 single nucleotide polymorphism markers, this gene was located on one of the largest chromosomes in *C. sativa*. Additional characterization studies showed that the gene was likely a member of the nucleotide-binding site (NBS) and leucine-rich repeat (LRR) protein groups. This is the first report of the successful identification of genetic loci in *C. sativa* that can govern resistance to a plant pathogen, paving the way for further studies in this important area.

A final group of important plant pathogens affecting *C. sativa* are the Oomycetes which are described by McGehee and Raudales as affecting cannabis plants in Connecticut. These root-infecting pathogens, together with *Fusarium* spp., are widely distributed in North America and can cause severe losses during production through destruction of the root system. The authors identified the pathogens in the growing substrate using a series of molecular tools and demonstrated pathogenicity to plants.

In summary, this collection of articles is a timely glimpse into the challenging world of insect pests and pathogens affecting cannabis and hemp, and highlights the importance of research as well as illustrating the progress that has been made in a relatively short time-frame. The hope would be that other researchers interested in this topic would find ways to advance the current state of research to benefit the producer and consumer alike. We hope these research articles stimulate additional research in the respective areas.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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