Current Microbiology
https://doi.org/10.1007/s00284-021-02744-x

Analysis of Biodegradation of the Synthetic Pyrethroid Cypermethrin by *Beauveria bassiana*

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Received: 16 July 2020 / Accepted: 7 December 2021

Abstract
Entomopathogenic fungi like *Beauveria bassiana* play a crucial role in natural control of arthropod pests which are being used in Integrated Pest Management programs. Assessing the compatibility of biological and chemical counterparts used in IPM programs is essential to achieve successful results in pest management. Behavior of four isolates of *B. bassiana* (ITCC 913, ARSEF 2860, ARSEF 1166, and ARSEF 3041) was tested in the presence of the pyrethroid insecticide cypermethrin. Spore germination and growth bioassays were conducted to assess the impact of cypermethrin on germination and growth. Though growth was not totally inhibited, there was retardation in the germination of spores and growth of the mycelium. Under this condition, ITCC 913 showed highest tolerance toward cypermethrin. Further analysis of the culture crude extracts by GC–MS revealed degradation of the insecticide by *B. bassiana* and putative intermediates of the degradation pathway were identified. This study reveals the potential of the entomopathogen *B. bassiana* in degradation of the pyrethroid insecticide cypermethrin. In conclusion, this potentiality of the studied fungus may help in the IPM strategies and find its role in degradation of such chemical pesticide compounds for utilization as a biodegradation agent further.

Introduction

Insect pests cause enormous loss to the produce hence pest management makes an essential component in agriculture. A significant role is played by several entomopathogenic fungi in the natural control of pest arthropods [1] and as vector controlling agents as they are novel and environmental friendly [2]. *Beauveria bassiana* is an entomopathogenic fungus and a registered biopesticide used in Integrated Pest Management (IPM) programs [3]. IPM regarded as a reasonable approach for managing pests by bringing together biological, cultural, physical, and chemical tools in a way that reduces economic and environmental risks. *B. bassiana* is an important biological control agent for a variety of insect pests, including both agricultural pests and vectors for human pathogens [4]. Biological control is most effective when used with compatible pest control practices in an IPM program. In an IPM strategy, the combined use of chemical pesticides often forms a part [5]. During combined use along with other chemical pesticides, their effect on the biological organism or vice-versa creates an interest to study. It is essential in IPM to know the influence of the compatibility between entomopathogenic fungi and the pesticide used in crop protection [6]. Chemical pesticides can show adverse effects on entomopathogenic fungi in several ways. In addition to direct toxic effects on the fungi themselves, the chemicals may kill the potential fungal hosts [7]. Incompatible insecticide usage may inhibit the development and reproduction of these pathogens affecting IPM [8].

Pyrethroid insecticides are among the worldwide used synthetic insecticides due to their potent toxic activity against various insect pests. These have become dominate insecticides in the retail market [9]. Pyrethroid insecticides are one of the chemical pesticides used in IPM programs which affect nerve impulse transmission in insects mainly through their action on voltage-sensitive sodium channels [10]. Cypermethrin 10% [(Cyano-(3-phenoxyphenyl) methyl)3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane-1-carboxylate] is one of the synthetic pyrethroids which are used in agriculture, horticulture, and homes for the control of insect pests, which are analogs of naturally occurring pyrethrins of botanical origin [11]. This group is a major class of insecticides, used as a replacement for more toxic

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Published online: 04 January 2022