Entomopathogenic Fungi in IPM

A Conversation with Surendra Dara, Ph.D.

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Biopesticides based on entomopathogenic fungi (EPF) are increasingly becoming important tools in the use and adoption of IPM strategies in both organic and conventional production systems. EPF are pathogenic to a broad range of arthropod pests and ideal for use against a variety of soil, foliar, and fruit pests on a wide variety of crops. We ask for more information about these materials from Surendra K. Dara, Ph.D., Strawberry and Vegetable Crops Advisor, UCCE, San Luis Obispo and Santa Barbara Counties.

Q. What are entomopathogenic fungi or EPF?

A. The three most common EPF available in California and the U.S. are *Beauveria bassiana, Isaria fumosorosea* and *Metarhizium brunneum*. These fungi are naturally occurring, soilborne pathogens that infect a variety of arthropod pests. EPF are especially suitable for insects that have piercing and sucking mouthparts that are usually not targeted by other entomopathogens such as bacteria, nematodes, or viruses. EPF work more or less like contact pesticides where they infect insects and mites when their spores germinate upon contact with the cuticle of the pest. Spores breach the host cuticle through enzymatic degradation and mechanical pressure to enter and multiply within the host's body. After consuming the internal tissue of the host, the fungus grows out of the dead cadaver and produces new spores that are dispersed by wind and rain to infect new insects and mite hosts.

Q. EPF are formulated with different types of fungal spores? How is that important?

A. One of the reasons EPF are attractive biopesticides is that they can be mass-produced and formulated into wettable powders, granules, or flowable formulations for ease of handling and application. Each of these formulations contain fungal spores as its active ingredient. While *B. bassiana* and *M. brunneum* contain conidiospores or conidia, some *I. fumosorosea* formulations contain blastospores.

Each fungus can produce both types of spores depending on the environment in which it grows. Fungi sporulating on solid media, such as grain (or on agar in a Petri dish) produce conidia, which are meant for long-term survival and dispersal of the fungus between hosts. Blastospores are produced within the infected host or when the fungus is grown in submerged fermentation (a liquid environment that mimics the host). Blastospores are adapted to spread the infection within the host, survive temporary conditions unfavorable for fungal growth, and germinate rapidly when conditions become favorable. Conidia, therefore, tend to have greater long-term stability, while blastospores have the advantage of rapid germination and higher infectivity. Both conidia and blastospores cause infection via the cuticle of the host, but blastospores can also cause infection when they are ingested.

The type of spores can also vary the way they are suspended in the spray fluid. Since conidia are aerially dispersed and tend to be hydrophobic, they can be difficult to mix in water unless formulated in oil or surfactants are added. On the other hand, blastospores are hydrophilic as they are formed in an aqueous environment and suspend easily in water for spraying.

Q. Where can EPF be used? Are there specific requirements for storing and handling EPF?

A. The general perception is that EPF are ideal for cooler climates, but several studies showed their efficacy in warmer climates especially in areas with high relative humidity. Nighttime condensation on the foliage or higher relative humidity within the crop canopy favor the infection process in regions that are perceived to be less suitable for EPF. Other factors that influence the efficacy of EPF include storage and handling, application strategies, and tank-mix materials.

Since EPF formulations have live fungal propagules, it is very important to avoid storing in warmer conditions and exposure to high temperatures or UV radiation. Some formulations may require refrigeration until the time of application.

COMPARISON OF EPFs

Characteristic	EPF	
	Beauveria bassiana *Metarhizium brunneum*	*Isaria fumosorosea*
Spore type	Conidiospore or conidium	Blastospore
Germination	Relatively slower germination, but more environmentally more stable	Rapid germination and higher infectivity
Infection	Via cuticle	Via cuticle and through ingestion
Mixing in water	Require surfactants to suspend in water	Easily suspend in water
Host range	A wide variety of pests	A wide variety of pests

An Example From the Field: Use of EPFs to Control Bagrada Bug

When the Bagrada bug was on the spread from county to county, its control was a major issue especially for organic growers. There was no organically approved pesticide available that would successfully control Bagrada bug. EPF and their combination with azadirachtin or other materials appeared to bring pest populations to acceptable levels based on the feedback received from several growers. Pictured here: (a) Bagrada bug killed by *Isaria fumosorosea*, (b) Bagrada bug killed by *Beauveria bassiana* and (c) Bagrada bug killed by *Metarhizium brunneum.*
Source: Surendra K. Dara, Ph.D., UCCE.

a

b

c

Compared to daytime application, spraying EPF materials in the evenings will ensure several hours of ideal conditions, such as low temperatures, high moisture, and lack of UV radiation, for the fungus to cause infection. Thorough coverage of the canopy ensures sufficient inoculum or fungal propagules to be present on the plant surface even if the upper leaf area is exposed to UV radiation during the daytime. It is important to verify the product label for ideal pH of the spray fluid and compatibility of the EPF with surfactants, fertilizer materials, fungicides or other tank-mix materials. For example, *B. bassiana* is not compatible with captan or thiram, but is compatible with several other fungicides.

Q. How can EPF be used in IPM Programs?

A. In some crop and pest situations, using EPF in combination or rotation with botanical or chemical pesticides is more effective than their stand-alone applications. Such a strategy provides pest management without compromising environmental sustainability or pest control efficacy. Since the whole idea of IPM is to make a good use of all available tools, combinations in rotations of both chemical and biopesticides is important to improve the overall efficacy of the program and optimize the cost of pest management. Both chemical and biopesticides vary in their efficacy in a variety of crop and pest situations and understanding their mode of action and using the appropriate ones in the right combinations, rotations, rates, and times is critical for achieving desired results.

EPF play an important role in IPM programs and in some cases they are critical tools for certain pests. Since recent studies show their role in promoting plant growth and antagonizing plant pathogens, EPF can provide additional benefits when they are applied for pest management. Understanding their potential and using them in appropriate situations will support IPM programs in both conventional and organic farming systems. ■

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