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In focus

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Can Fungi Replace Conventional Pesticides?

This week's Biotech in Focus came from a paper written by Adria Daniels, a University of Hawaii at Manoa student who recently enrolled in TPSS 416 (Introduction to Social, Ethical, and Political Issues Associated with Biotechnology). Designed for non-majors, this class is offered by the Department of Tropical Plant and Soil Sciences in UH Manoa's College of Tropical Agriculture and Human Resources.

Synthetic pesticides have been applied to crops since the post-World War II era and have been highly successful in increasing crop yields by reducing losses from insects, plant pathogens, and weeds. However, since their introduction, research has shown that pesticides can cause detrimental effects on humans and our environment. Some pesticides can disturb the human nervous system or affect our hormone and endocrine systems. Some may be carcinogenic. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species; this can harm non-target species on farms and in the surrounding environment. Finding less toxic alternative pesticides can promote human health, preserve biodiversity, and protect the ecosystems on which we depend.

Fungi that are used as bio-control agents in agriculture are known as myco-pesticides, a category that includes herbicides, fungicides, and insecticides. Various myco-pesticides have been shown to be suitable replacements for synthetic pesticides, and there is potential that biotechnology could enhance the effectiveness of fungi as bio-control agents.



There are estimated to be over 8000 plant pathogenic fungi, of which perhaps 100 are at various stages of research and development as potential myco-herbicides. In 1981, the first myco-herbicide, DeVine, was registered in the United States for use in Florida's citrus groves to control milkweed vine (*Morrenia odorata*, also called strangler vine). DeVine, which is based on the fungus *Phytophthora palmivora*, infects the roots of the milkweed vine and that starts to kill the vine six to ten weeks after treatment. The citrus trees remain unharmed. Another example of a myco-herbicide is the fungus *Colletotrichum gloeosporioides*, which has been successfully used in rice production to control the weed Northern jointvetch (*Aeschynomene indica*).



Phytophthora palmivora
photo: Fred Brooks



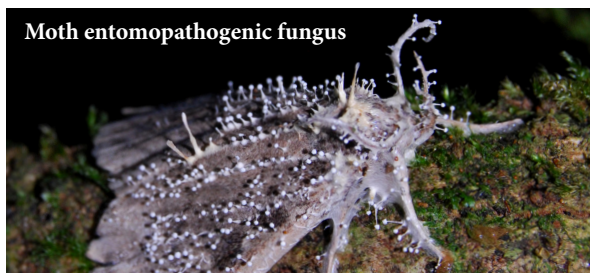
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When Fungus Attack

Mycoparasitism is the direct attack of a fungus on the mycelium (vegetative, non-reproductive tissues) of another fungus; the attacking fungus then captures nutrients from its target. Several mycoparasitic fungi are currently being used as agricultural fungicides. One of these, *Trichoderma harzianum*, can be applied to plant roots, leaves, and seeds to protect against destructive fungal pathogens.



Entomopathogenic fungi infect and kill insect hosts; some of these fungi can be used as myco-insecticides. The infected insects provide a constant reservoir of new fungal strains, slowing the development of insect resistance to the fungus, and the spores provide long-term protection of treated sites because they repel future invasions. One entomopathogenic fungus, *Metarhizium acridum*, has been used in Africa and Australia to control locusts.

Advantageous Traits

Mycopesticides have several advantageous traits. Their range of target species is typically limited and their toxicity to non-targets is low, so they pose less threat than many synthetic pesticides to soil, groundwater, the atmosphere, wildlife, and human health. As noted above, some mycopesticides persist at the treated site, providing long-term protection. Additionally, mycopesticides increase efficiency of plant root nutrient and water uptake resulting in superior growing plants.



Slower Acting



At the same time, mycopesticides are considered less efficient than chemical pesticides. The success rates of mycopesticides are more strongly dependent on environmental conditions. Because they are slower acting, in some cases mycopesticides may be more useful for maintaining pest control than for establishing control during an acute pest infestation.

More Research

Their high degree of host specificity, while helpful in limiting their toxicity, can render mycopesticides harder to use and less effective compared to broad-spectrum synthetic pesticides. Mycopesticides can also be difficult to apply and have a limited shelf life. Further research and development are needed to overcome these drawbacks and take full advantage of the potential benefits of mycopesticides.

