1-2013

New Technology for Harvesting the Power of Beneficial Fungi

Mark Jackson
USDA-ARS, mark.jackson@ars.usda.gov

Jan Suszkiw
ARS

New Technology for Harvesting the Power of Beneficial Fungi

Biopesticides containing beneficial fungi are often grown on grains or other solids, but Agricultural Research Service scientists have found that a liquid diet might be cheaper and better.

The approach, known as "liquid culture fermentation," offers several advantages, including lower material costs and increased yields of certain forms of pest-killing fungi like *Isaria* or *Metarhizium* that can be sprayed directly onto crop plants or applied to soil as a biological alternative to using synthetic pesticides.

For decades, biopesticide makers have cultured fungi like these on moistened grains or other solid substrates to prompt them into churning out billions of specialized cells called "conidia," or spores, which latch onto and then penetrate the cuticles of silverleaf whiteflies, aphids, and other soft-bodied insect pests, killing them within a few days.

Over the past several years, however, ARS microbiologist Mark Jackson and colleagues have sought to improve on the approach using liquid-culture fermentation methods in special tanks called "bioreactors."

"We've made good strides," reports Jackson, who is in ARS's Crop Bioprotection Research Unit in Peoria, Illinois. "Optimizing fermentation conditions has increased the yield of spores, and we've identified low-cost nutrients that reduced production costs by 80-90 percent."

One of the greatest reductions has been in costs associated with nitrogen as a primary fungal nutrient. One source, hydrolyzed forms of protein, is typically derived from agricultural commodities like milk casein, which can sell for more than $6 a pound. Jackson used less-expensive nitrogen sources, including soybean flour or cottonseed meal, which cost 30-50 cents a pound.

Conidia have long been the spores of choice for biopesticide uses, but other fungal cells can be just as effective, including yeastlike structures called "blastospores" and clumps of pigmented fibers known as "microsclerotia." The latter can be easily and cheaply formulated as granules of almost any size for most application needs.

In the case of *M. brunneum* (formerly *M. anisopliae*), for example, Jackson, together with Stefan Jaronski, an entomologist in ARS's Pest Management Research Unit in Sidney, Montana, demonstrated that the soil-dwelling fungus performed best when cultured and applied as microsclerotia. Fungi in this intermediate survival stage only produce conidia in soil when conditions are optimal. In laboratory tests, conidia resulting from microsclerotia treatments killed 100 percent of sugarbeet root maggots in 1 week versus 25 percent killed in 3 weeks using a conidia-only, corn-granule formulation. (See "Multiplying *Metarhizium*," September 2008, pages 4-5.)

Jackson has also used the system to formulate microsclerotia of the fungus *Mycoleptodiscus terrestris* to biologically control hydrilla, a noxious aquatic weed that's infiltrated lakes, ponds, canals, and other water systems in the southern and western United States. In aquarium- and pond-scale trials conducted by collaborator Judy Shearer at the U.S. Army Corps of Engineer's Engineer Research and Development Center, in Vicksburg, Mississippi, hydrilla plants showed significant reductions in growth after being dusted with granules containing the fungus's microsclerotia.

Jackson says an advantage of the liquid-culture fermentation technology is that it isn't limited to mass-producing one particular fungal species or even one particular form of fungus. Blastospores can be cultured for use in sprays to control leaf-feeding pests like aphids as easily as microsclerotia for use in granular formulations to control soilborne insects, like root maggots.

"This flexibility opens all kinds of doors in terms of where and when you can apply the fungi," says Jackson. "Regardless of the fungal species or the requirement for sprayable blastospores or microsclerotia granules, the production platform we've developed for these biopesticides is the same."—By **Jan Suszkiw,** ARS.

This research is part of Crop Production and Quarantine, an ARS national program (#304) described at www.nps.ars.usda.gov.

Mark Jackson is in the USDA-ARS Crop Bioprotection Research Unit, National Center for Agricultural Utilization Research, 1815 N. University St., Peoria, IL 61604; (309) 681-6283, mark.jackson@ars.usda.gov.

Microbiologist Mark Jackson (foreground) inspects pure cultures of an insect-killing fungus growing in petri dishes as lab technician Angela Payne inoculates a 100-liter fermenter with a liquid culture of the fungus.

STEPHEN AUSMUS (D2711-7)