PEGGY GREB (K11449-1)

Mustard for Pest Control, Not For Your Sandwich

A cover crop of mustard like the one shown above can be disked into soil as "green manure" to act as a natural fumigant for weeds and diseases.

Got nematode troubles? Fungi? Too many weeds in a field? Spread some mustard on 'em.

Agricultural Research Service and university scientists are experimenting with mustards as an alternative to chemically fighting crop pests.

But scientists aren't smearing pests with mustard that comes in a jar. Rather, they're biofumigating pests with stands of white mustard, brown mustard, and rapeseed—members of the *Brassica* plant family. "Biofumigation" refers to natural substances plants release while decomposing that make surrounding soils toxic to some weeds, nematodes, and fungi.

The experiments, in Washington State, dovetail with increasing grower interest in mustard crops for pest control and as "green manure"—meaning it can be disked into soil to improve tilth, organic matter, aeration, and water filtration.

Despite such benefits, there's still much to learn about how mustards control pests and under what conditions they work best, notes ARS agronomist Rick Boydston, study coordinator since 2000.

Much credit for mustard's biofumigant effect against soilborne pests is given to isothiocyanates (ITCs), chemical byproducts of the plants' decomposition. But scientists suspect ITCs are only one piece of the pest-control puzzle.

"There's a lot going on there that we don't know about," says Boydston, at ARS's Vegetable and Forage Research Unit, Prosser, Washington. A chief question is whether nematodes, weed seeds, or fungi die from direct contact with ITCs or as a result of other chemical or biological changes in soil.

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In autumn, technician Dallas Spellman buries nylon packets containing weed seeds to evaluate their survival with various fall-planted cover crops.

To find out, Boydston is collaborating with the multidisciplinary team of Ashok Alva, a soil scientist who leads the Prosser lab; Harold Collins, an ARS microbiologist there; Steve Vaughan, a chemist at ARS's National Center for Agricultural Utilization Research, Peoria, Illinois; Ekaterini Riga, a nematologist at Washington State University (WSU) in Prosser; and Andy McGuire, an agricultural systems educator with WSU's Center for Sustaining Agriculture and Natural Resources, in Ephrata.

With such wide-ranging expertise, the team can examine many facets of mustard cover crops that growers have neither the time nor resources for.

"Growers are probably more focused on nematode suppression and wind erosion control. But our group can measure disease incidence, nematodes, weeds, and soil microorganisms," he says. "We're looking at multiple problems and benefits."

The resulting information could lead to new cropping systems that use mustards better—or pinpoint their limitations. Another possible spinoff could be development of new mustard cultivars custom-bred for specific uses, such as anchoring soil or biofumigating it.

The following experiments are under way at several Washington locations:

- Weed-seed bank: In this study, small nylon bags were filled with 500 redroot pigweed seeds and buried at 1 or 8 inches deep. The plots were then overseeded with white mustard, sorghum-sudangrass, winter wheat, or a mix of oat and hairy vetch. Other plots, left fallow, were either fumigated with metam sodium and 1,3-dichloropropene or were not treated.

In spring, sacks were dug up and the seeds removed and replanted to see whether they'd germinate. "If the seed doesn't sprout, this suggests presence of toxins, such as ITCs, from the cover crop we used," explains Boydston. Citing 2003 results, he adds, "We're not seeing a big effect on buried seed, though we do see a delay in germination." By comparison, 99 percent of seed from fumigated plots didn't sprout.

• Mustard mulching: This Prosser greenhouse study pits three biofumigant crops (white mustard, brown mustard, and rapeseed) against small-seeded weeds—redroot pigweed and barnyard grass. When mixed into soil, the three mulches cut weed germination by 20 percent to 95 percent. Reductions of 5 percent to 95 percent in growth of seedlings from surviving seeds were also observed.

• Potted ornamentals: This greenhouse study evaluated the biofumigant effects of crushed seed meal from brown mustard and field pennycress. The targeted pests were chickweed, prickly lettuce, and root-knot nematode.

First, scientists mixed the seed meal at 0.2 percent to 0.4 percent by weight into potting soil and then planted irises. They then added 100 chickweed seeds, 100 prickly lettuce seeds, and 400 nematodes. As a chemical control, other pots were sprayed with the nematicide ethoprop. At 2, 4, and 6 weeks, they checked the pots for diminished seed germination and sprouting. Nematodes were extracted and counted at the experiment's end.

In pennycress-treated pots, about 80 percent fewer chickweed seeds and 55 percent fewer prickly lettuce seeds sprouted. Brown mustard seed meal reduced chickweed emergence by 65 percent and prickly lettuce by half. The irises were unaffected. Early results revealed a 70 percent to 80 percent nematode decline in pots containing the seed meals. The scientists are now testing higher seed-meal concentrations and expect to see even fewer nematodes.

• Crop rotation: Since 2000, the researchers have preceded potato or sweet corn crops with fall-planted cover crops of mustard, winter wheat, sorghum-sudangrass, or oat plus hairy vetch. Another plot, left fallow, is fumigated for comparison. "We have a 4-year rotation in place and are using these covers in 3 of the 4 years," says Boydston. "We hope to detect any cumulative effects of the cover crop's continued use." Throughout, the scientists are monitoring the covers' effects on weed emergence, seedling growth, species distribution, and density.

• Biomass: Using mustards costs about $90 per acre, notes McGuire. Growers can generally recoup by rotating mustard with a high-return crop like potato. To help them get the most bang for their buck, the researchers are studying the best mustard-seeding time for producing the most biomass, which is thought to be important for many of the crop's benefits.

They also want to determine the best time to disk mustard into the soil to unleash its biofumigants. Current thinking is that disking live, green mustard will trigger the greatest release of glucosinolates, which break down into ITCs. But other compounds or soil factors may contribute as much as or more than ITCs to suppressing weeds and diseases. To find out, researchers are comparing weed densities after mustard is disked into the soil in fall while it is still alive and in spring after it has died.

In still other studies, Collins is looking at how microbial soil communities may change in response to mustards and their decomposition. He and Alva are also using isotopes of nitrogen to trace how much of this nutrient mustard returns to soil for other crops to use.

McGuire evaluates various mustard cultivars, including some from Italy and Germany, for their ease of growth, flowering times, biomass, and glucosinolates. Meanwhile, WSU colleague James Dobrowolski is testing wind-erosion resistance of mustard-amended soil by blasting it with gusts from a wind machine.—By **Jan Suszkiw,** ARS.

This research is part of Integrated Farming Systems, an ARS National Program (#207) described on the World Wide Web at www.nps.ars.usda.gov.

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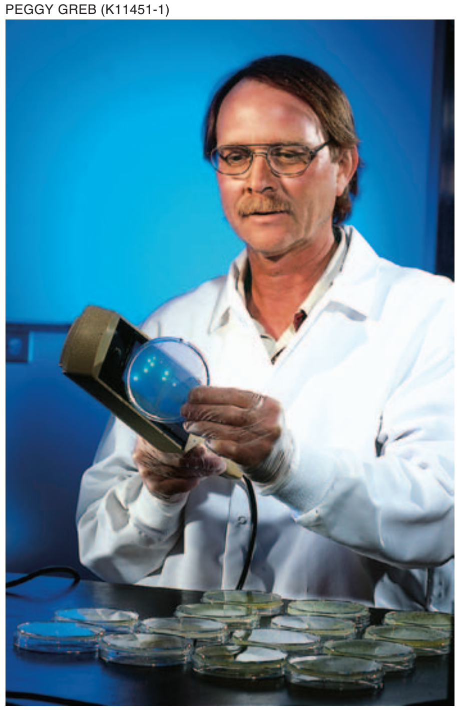

Microbiologist Harold Collins evaluates soil bacterial diversity under various cover crop treatments.

PEGGY GREB (K11450-1)

Agronomist Rick Boydston and Harold Collins record weed density in potatoes after cover crop treatments.