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 - [College Sports](#)
 - [High School Sports](#)
 - [MU Football](#)
 - [MU men's basketball](#)
 - [MU women's basketball](#)
 - [Youth Sports](#)
- [Lifestyles](#)
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 - [Cover Story](#)
 - [Faith](#)
 - [Features](#)
 - [Health](#)
 - [Muse](#)
- [Opinion](#)
 - [Dear reader](#)
 - [Five Ideas](#)
 - [Letters to the Editor](#)
 - [Local Columnists](#)
- [Keeping Tabs](#)
 - [Crime](#)
 - [Obits](#)
 - [Marriages](#)
 - [Volunteer](#)
 - [Events](#)
 - [Restaurants](#)
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[Home](#) » [2008](#) » [11](#) » [21](#) »
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Roots of deception: Researchers work to nix the nematode

Friday, November 21, 2008 | 1:00 p.m. CST



These Soybean cyst nematodes are being studied by at the Bond Life Sciences Center at MU. Last year this parasite destroyed \$751.8 million of the U.S. soybean crop. | ANGIE CIPPONERI
BY Sananda Sahoo

COLUMBIA — Plants can be deceived, too. And deception at the molecular level has been costing U.S. soybean farmers millions of dollars in losses every year at harvest time.

The soybean cyst nematode, an abundant parasitic roundworm, has been adapting to natural resistance of the soybean plant, using what an MU researcher calls "molecular mimicry" to feed off soybean roots.

Testing for nematodes

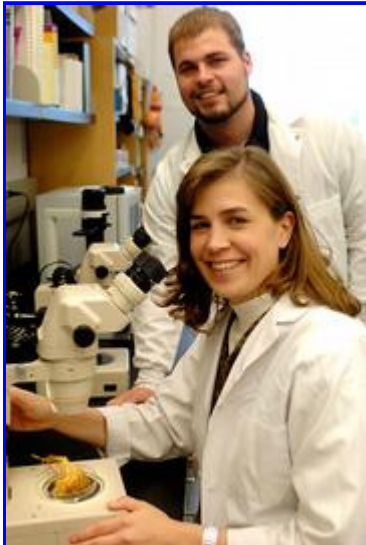
Dig up and examine roots. Soybean cyst nematode juveniles are microscopic, but the adult female cyst nematodes are visible to the naked eye as small white balls on the roots.

Farmers can send soil samples to MU's Extension Nematology Laboratory if they suspect an infestation of soybean cyst nematodes. The samples are usually taken after harvest,, so farmers can prepare against nematodes for the next growing season. Farmers can take soil samples any time of the year, however, if

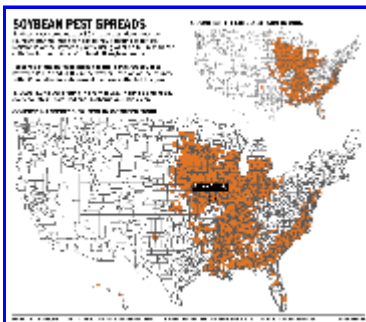
they want to determine whether nematodes are present. Experts at the lab can suggest ways to manage the parasites.

To visit the lab's Web site is, go to, go to <http://soilplantlab.missouri.edu/nematode>, or call (573) 884-9118.

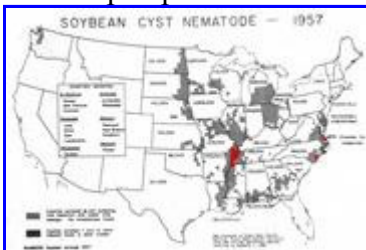
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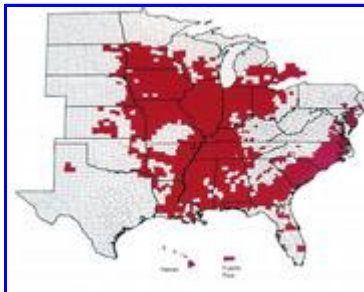
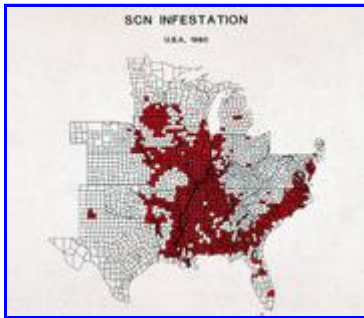
- Melissa Mitchum, front, an assistant professor at MU, and Greg Yeckel, an undergraduate research assistant, are both members of the team studying soybean cyst nematodes at the Bond Life Sciences Center at MU.



- This map depicts the U.S. counties where the soybean cyst nematode is present.



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Melissa Mitchum, an assistant professor in the MU Division of Plant Sciences, is studying the dramatic changes that soybean cyst nematodes can induce in a soybean plant.

"One aim is to understand the molecular basis of host resistance so that a resistant soybean crop can be designed in the future," Mitchum said.

This part of her research, which she is conducting with Iowa State University, recently received a \$2.1 million grant from the National Science Foundation. The research is also being funded by the Missouri Soybean Merchandising Council.

Soybean cyst nematode is present in all U.S. soybean-growing states except West Virginia. The financial loss caused by the nematode during 2007 in the United States was estimated at \$751.8 million, using a benchmark of \$8 per bushel. MU professor Allen Wrather, who studies the impact of nematodes

on soybean production, said the parasite suppressed soybean yield in the United States by about 76 million bushels in 2005, 124 million in 2006 and 94 million in 2007. Missouri lost 2.6 million bushels during 2007 because of the parasites, he said.

Soybean production in Missouri is forecast at 187 million bushels this year, according to a report from the National Agricultural Statistics Service, but soybean cyst nematodes annually reduce yields by an estimated 1.5 percent — even when farmers plant resistant varieties, Wrather said.

Soybeans were selling this fall for about \$9 per bushel. At that price, a 1.5 percent yield reduction could cost Missouri soybean farmers \$25.2 million this year, Wrather said.

Without varieties of soybeans resistant to the cyst nematode, yield reductions could reach 50 percent or higher, said Dale Ludwig, executive director and chief executive officer of the Missouri Soybean Association.

Ten percent of the parasitic nematodes live on plants and are major agricultural pests.

"Plant nematodes feed off both roots and shoots, leading to wilting and stunting of plants, and some can kill a pine tree in a month," Mitchum said.

Some soybean varieties are resistant to soybean cyst nematodes. Ninety percent of the soybean varieties used by farmers derive resistance from a single type of source plant, Mitchum said. Farmers usually rotate the resistant soybean variety with crops such as corn, which is a nonhost to soybean cyst nematode, to get rid of the parasites in the soil.

"But these nematodes constantly adapt to the natural resistance of the soybeans and over time breaks it down," Mitchum said.

The constant adaptation by soybean cyst nematodes makes any research on plant resistance against the nematodes a battle against a shifting target.

"These nematodes use molecular mimicry to obligate intimate association with the soybean roots, deceiving the plant into forming feeding sites from where it gathers nutrition, causing reduced crop yield," Mitchum said.

On a molecular level, mimicry can be achieved when the nematode acquires a protein with structural and functional similarity to a host protein.

"Alternatively, a nematode protein with little or no sequence similarity to a host protein may evolve similar structural and functional activity that can mimic host cellular activities," Mitchum said.

Recent research at Mitchum's laboratory suggests that cyst nematodes are equipped with the ability to directly modulate cellular activities of cells in the host plant for their own benefit. The nematodes secrete proteins that mimic small signaling peptides in the plant that normally regulate growth and development. "This is an extraordinary adaptation by a plant parasite," Mitchum said.

A major aspect of Mitchum's research is focused on studying these and other proteins the nematode secretes into host plant roots that make the plant vulnerable to the parasites.

"The goal is to identify the nematode targets that can be used to engineer resistance in the plant,"

Mitchum said. "We are trying to find out what changes the nematode-secreted proteins induce in root cells that enables it to form the feeding sites for the nematode.

This area of her research was recently funded by \$300,000 from the U.S. Department of Agriculture's National Research Initiative Competitive Grants Program.

"If we can find out which genes in the nematode are required for parasitism and how are these functioning, we can use the information to devise a resistant variety," she said.

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