Plant-Parasitic Nematode Management through Diagnostics & Host Resistance

S-1046 (2009-2014)

Plant-Parasitic Nematodes are a Widespread Threat to Crops in the Southern U.S.

Plant-parasitic nematodes are tiny worm-like animals that feed on plant hosts. They can also transfer viruses that weaken or kill the plant host. Plant-parasitic nematodes cause estimated yield losses of 10% to 60% annually. They are especially threatening to crop production in the southern U.S., where the warm climate and sandy soils provide an ideal environment for the pests. Cotton, peanut, soybean, turf, and many vegetable crops are among the most highly impacted.

Historically, nematode management has relied on the use of nematicides; however, many existing nematicides have been banned or greatly restricted due to environmental and human health concerns. In the last 30 years, only three new nematicides have been developed. Other nematode management options, like crop rotation and biological control, are difficult to practice effectively and have had limited success. Nematode-resistant crops are a promising strategy for sustainable management of these pests. Using resistant crops can improve yields and lower production costs by reducing losses to nematodes without expensive nematicide applications. However, as new nematode species are discovered, better ways to detect and correctly identify nematodes are needed. There is also increasing need for a wider variety of sources of genetic resistance to prevent outbreaks of more virulent races of nematodes. For example, the Bedford soybean was widely used for resistance to race 3 soybean cyst nematodes. This resistance was compromised in just one growing season as race 14 became more prevalent, overcoming the particular resistance genes in Bedford soybeans. Crops with multiple resistance genes could maintain resistance longer.

The top photo shows a carrot plant with root-knot nematode damage. Root-knot nematodes form knots, or *galls*, on plant roots (as shown above on cucumber roots). Galled roots have limited ability to absorb and transport water and nutrients to the rest of the plant, causing infected plants to wilt. Root-knot nematodes are particularly destructive because of their extensive host range--they are able to parasitize nearly every crop grown in the U.S. Photos courtesy of Don Dickson, University of Florida.

Multistate Research Project Develops New Tools to Detect Nematodes, Improves Crop Resistance to Ward off Infestations

In 2003, Multistate Research Project S-1046 formed to improve nematode management by developing new diagnostic tools and crop varieties with new sources of resistance to plant-parasitic nematodes. The multistate approach has allowed scientists to share resources and avoid duplicate studies during long-term crop breeding efforts. The multistate framework has also facilitated partnerships with industry and growers associations.

S-1046 researchers advanced a new molecular technique that has increased the accuracy of detecting and quantifying the presence of nematodes in soil. S-1046's characterizations of the diverse array of nematodes has made identifying economically important species easier and more certain. Earlier detection will help farmers take action against the pests before a serious and costly outbreak. For example, S-1046 scientists described a new species of root-knot nematode that is parasitizing bentgrass on popular golf courses in the mid-Atlantic states. Proper identification of this pest means golf course managers can target control strategies to quickly and effectively protect the courses from damage.

Groups of scientists from Alabama, Georgia, Mississippi, and Texas screened different collections of germplasm (the living genetic resources such as seeds or tissue maintained for breeding, preservation, and other research uses) for resistance to nematodes. The scientists identified and characterized the best sources of resistance to root-knot and reniform nematodes in peanut and cotton. Scientists also identified sorghum hybrids with good field tolerance to root-knot and lance nematodes and soybean varieties with resistance to root-knot nematodes. As a result, private sector seed companies have been able to develop new crop varieties with resistance to parasitic nematodes. S-1046 scientists also noted that specialty melons can be successfully grafted on African horned cucumber rootstocks, which are highly resistant to root-knot nematodes. Alternative control methods like this are urgently needed to keep up with growing melon demand since methyl bromide, a broad-spectrum soil fumigant, was banned.

S-1046 also made significant advances in stacking genes (crossing plants that each have a different nematode resistance gene, and then identifying offspring possessing both of the desired genes) to increase resistance to root-knot nematodes. Stacking different sources of genetic resistance lowers the risk that a more virulent race of root-knot nematode will be able to take over. Increasing the durability of new crop varieties protects crop yields and profits while reducing the need for pesticides.

To proactively control emerging nematode species, researchers developed diagnostic tools for rapid identification of new nematode species, surveyed crops for the prevalence of these new nematodes, and tested resistant crops to make sure resistance extends to the new species. An online database was created to catalog newly described nematode species and their virulence.

S-1046 researchers also quantified how soil texture and irrigation affect yield losses caused by plant-parasitic nematodes. Using this information, the team designed new crop management tactics that work well when integrated with resistant crops. By ensuring that the nematode-resistant crops produced by U.S. farmers are compatible with changing cropping practices, production technologies, and environmental concerns, S-1046 is securing agricultural productivity now and in the future.

Want to know more?

The S-1046 project was supported, in part, through USDA's National Institute of Food and Agriculture by the Multistate Research Fund established in 1998 by the Agricultural Research, Extension, and Education Reform Act (an amendment to the Hatch Act of 1888) to encourage and enhance multistate, multidisciplinary research on critical issues that have a national or regional priority. Additional funds were provided by contracts and grants to participating scientists. For more information, visit http:/saaesd.ncsu.edu.

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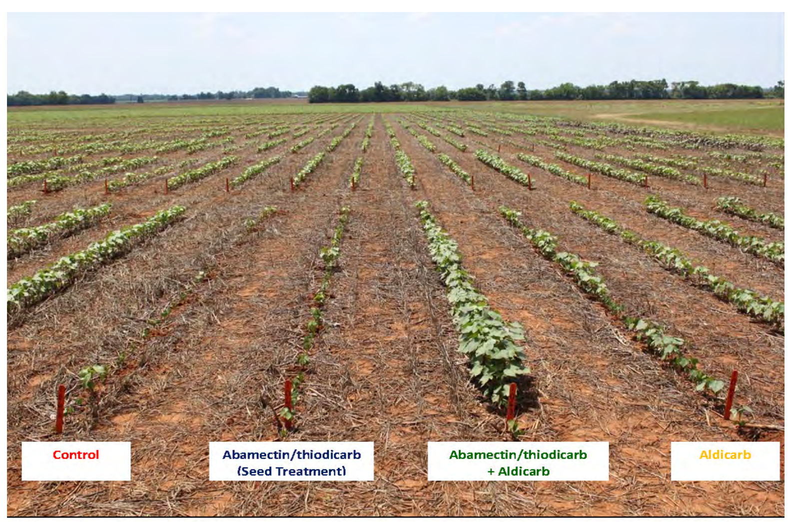
List of Participating Institutions:
- University of Arkansas
- Auburn University
- Clemson University
- University of Florida
- Louisiana State University
- Louisiana Cooperative Extension
- University of Minnesota
- Mississippi State University
- University of Missouri
- North Carolina State University
- University of Tennessee
- Texas AgriLife Research
- USDA-ARS, Georgia
- USDA-ARS, Mississippi
- Virginia Polytechnic Institute and State University

This Impact Summary was compiled and designed by Sara Delheimer.

S-1046 test fields showed improved growth of cotton lines with resistance to reniform nematodes compared to susceptible lines at mid-season and harvest. Photos by Kathy Lawrence, Auburn University.



In S-1046 test fields, rows of cotton showed that nematicides enhanced growth of both resistant and susceptible cotton genotypes. Photo by Drew Schrimsher.