

Propane-Powered Heat for Soil Nematode Control

A safe, low-cost method for controlling pests and improving crop yield

Nematodes are microscopic parasites that feed on other organisms and inhabit agricultural soil. While some are harmless to plants, others invade the plant roots or surrounding soil and steal nutrients, which reduces crop yield and quality. Many producers manage these pests by injecting the chemical fumigant methyl bromide into the soil prior to planting. However, the chemical is no longer a viable method of control.

Methyl bromide is a noxious substance that the U.S. Environmental Protection Agency (EPA) has identified as ozone depleting. EPA regulations have phased out use of the chemical and farmers are actively seeking alternative pest control measures.

While some chemical alternatives to methyl bromide are less effective or dangerous to use, propane-powered steam offers a safe, viable method for nematode control. This technology utilizes clean-burning propane to superheat steam, which is then applied directly to the soil. Raising the soil temperature for a brief time can successfully kill nematodes in the crop root zone. Research is currently under way to determine the best propane-fueled heat application methods for commercialization.

Agricultural producers, particularly organic producers, could substantially benefit from a chemical-free, low-cost alternative to methyl bromide. Commercialization in early entry markets (warmer climates with longer growing seasons) could increase off-peak propane sales by approximately 10 million gallons per year. There is great potential for market growth if propane-powered steam becomes a recognized alternative to methyl bromide.

Project Description

To help develop a cost-effective heat technology, the Propane Education & Research Council launched *Develop and Test a Propane-Fueled Means to Control Soil Nematodes (Docket 12203)*, a research effort headed by the Gas Technology Institute (GTI). Researchers will:

- Determine design requirements for an effective propane-fueled heat transfer system.
- Evaluate the efficiency of current propane-fueled equipment.
- Design equipment to maximize cost-effectiveness and utility based on test findings.
- Identify market potential.
- Fabricate a prototype and test it in the field.
- Develop a high-level commercialization plan to bring the heating process and system to the U.S. market.

* Courtesy of U.S. Department of Agriculture (USDA):
<http://www.ars-grin.gov/ars/SoAtlantic/fp/stpp/burelle/nematode.html>

Market Potential

The initial target markets for propane-powered steam are California, Florida, and other states with warmer climates and long growing seasons that can produce a variety of crops.

Researchers have targeted high-value crops with short growing periods, like tomatoes and strawberries, as entry markets. These are easiest to treat and will see immediate benefits.

California has 357,000 acres of strawberries and tomatoes, and Florida cultivates 49,000 acres. About 90 percent of this acreage has historically been treated with methyl bromide.

Organic producers in other geographical areas also stand to benefit from this technology because they face few alternatives for nematode control.



Magnified View of a Soil Nematode*

Horizontal Pipe Injection of Steam



Project Implementation

Researchers conducted 16 laboratory and field tests to investigate propane-fueled means to heat soil to 130° F for at least one hour. The experimental program characterized the performance using the following parameters:

- Method of heat application — Six different technologies were tested, including rigid horizontal pipes, rigid vertical pipes, flexible horizontal hoses, vented cylinders, rubber, Temp-Air HydroThaw® hoses, and a full contact blanket.
- Steam-Air Mix Ratios — Researchers tested steam only, hot air only, and various mixes of steam and hot air that produces high-temperature aerated steam, which when injected into the soil quickly condenses and heats the soil around it.
- Soil — Tests were performed in loamy sand, representative of soil consistencies in California and Florida.

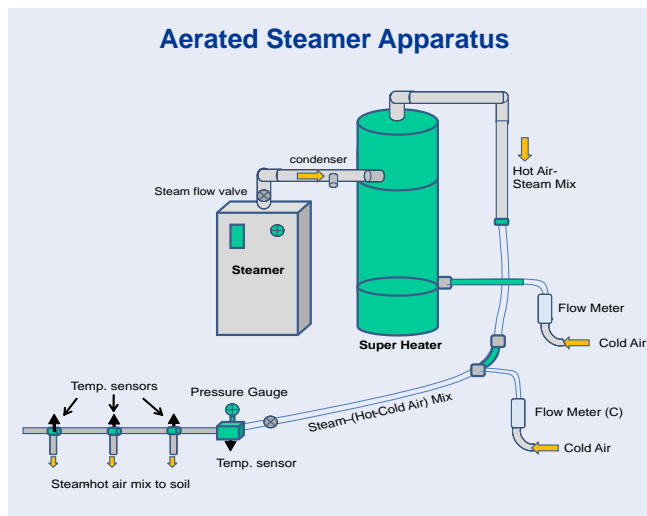
By placing temperature sensors in the soil at various depths and distances from the equipment, researchers determined heat distribution for each method.

Preliminary Results

Preliminary results show that aerated steam was the most successful for heat transfer using a steam to hot-air ratio of one-to-one. Two of the application methods tested were able to uniformly heat an area 24 inches wide and 10 inches deep:

- Two rigid horizontal steam-filled pipes placed 8 inches apart and 8 to 10 inches deep heated the area to 130° F in one hour.
- A surface blanket containing steam-filled pipes heated the area to 130° F in 14 hours.

Blanket Distribution of Steam



Based on these preliminary results, GTI will develop a prototype aerated steamer apparatus using rigid subsoil pipes with holes. The prototype will consist of:

- A low-pressure steam boiler
- A high-pressure fan or air compressor
- Manual controls (steam-air mixing, on-off cycle)
- An underground 1- to 5-inch pipe with holes designed for 500-foot rows
- System sizes based on desired coverage

A cost analysis showed that treatment cost per acre varies depending on the depth and width of the area and the initial temperature of the soil. Pipe size also affects treatment cost; smaller, shorter pipes are less costly, but transfer heat more slowly.

Project Status: In Progress

GTI will design a novel heat distribution system focusing on a subsoil steam-air injection design. The team will build a prototype with commercially available parts using the specifications described above in 2008. Lab and field tests in Florida and California will determine crop compatibility and efficacy of nematode control, as well as the effect on weeds and other pathogens. The team will then develop a high-level commercialization plan in 2009.

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