GROWING KNOWLEDGE

Series content is coordinated by Dr. Jay Pscheidt, professor of botany and plant pathology at Oregon State University in Corvallis, Oregon.

Oregon State University | USDA

An ongoing series provided by Oregon State University in collaboration with the United States Department of Agriculture and in partnership with the Oregon Association of Nurseries

A shocking treatment

Overview of pulse electric field application in nursery beds near Boring, Oregon, in the fall of 2023. PHOTO COURTESY OREGON STATE UNIVERSITY

Pulse electric field technology may be a viable pest control alternative to methyl bromide

BY MARCELO L MORETTI, INGA ZASADA, JERRY WEILAND, TATIANA BENEDETTI, JASON CRISP

IN THIS ARTICLE, we will share some early results from our project that explores using a pulse electric field to disinfest soils in hardwood nursery beds. Here, we will focus on the effect of pulse electric field on weeds.

Methyl bromide is a broad-spectrum pesticide that disinfects soil, and eliminates weeds, soilborne fungi, and nematodes. It is also a potent ozone-depleting substance.

Over time, the uses of methyl bromide in agriculture have been phased out. Although limited methyl bromide applications can be deemed critical, and so still occur, costs and regulatory compliance standards make it a less viable pest control option.

Pulse electric field (PEF) employs bursts of high-voltage electricity to inactive microorganisms (see photo above). Primarily used in the food industry, some researchers have reported promising results in nematode and plant disease control (Riga et al. 2020). We are collaborating with Lisi Global to adapt an existing technology for a new use in the ornamental nursery industry.

It's not entirely clear how PEF kills organisms. It may involve cell membrane rupture accompanied by loss of metabolic activity. Alternatively, particular proteins may absorb energy and generate cell-damaging free radicals.

The structure of proteins may be altered and cause them to lose function. It may be some combination of any or all of these mechanisms that does the trick.

Pulse electric field is considered a non-thermal technology, but our experience tells us it depends on how much energy is applied to the soil.

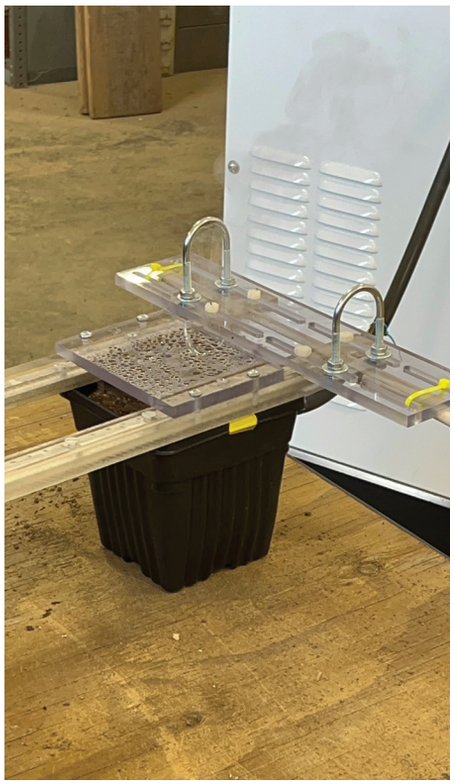
Treating soil with PEF involves placing soil between »

two electrodes for the time required to deliver the desired energy. The goal is to sustain a high voltage current between the two electrodes. In the short term, energy is shortly stored in a capacitor, while voltage, pulse number, duration, and frequency can be adjusted to control the energy delivered. The distance between electrodes also affects PEF performance, as soil offers resistance to current flow.

What are the effects of PEF on weeds?

Very little is known about the effect of PEF on weeds. For that reason, we started with pot studies to define effective rates. Controlled greenhouse studies eliminate the great variability found in the field, and can be a good starting place to define treatment control.

For reference, 25 J cm^{-3} (joules per cubic centimeter) controlled over 90% of nematodes in an earlier study (Riga et al.,



Pulse electric field application in a pot study with yellow nutsedge tubers. The PEF energy quickly warms the soil; notice the water vapor. PHOTO COURTESY OREGON STATE UNIVERSITY

2020). A series of 4-inch-long electrodes were placed in pots filled with sterilized silt-loam soil.

Weed seeds or tubers were soaked in water for a day, planted and later treated. An application of 480 J cm^{-3} was enough energy to produce heat, water vapor, and eventually melt the pots (See above photo). This counters the idea that PEF cannot be a thermal soil sterilant.

Electrical rates of 60 J cm^{-3} or more killed nearly all yellow nutsedge tubers (Page 36). A few crabgrass plants emerged after pots were treated with 125 J cm^{-3}.

We are expanding our testing to other weed species and looking for ways to increase efficacy. Our goal is to determine the lowest energy required to achieve consistent control of a mixture of weed species.

Next step: field validation.

Field studies in collaboration with Oregon nurseries will begin this fall. We are advancing multiple research fronts as we develop this new application for PEF. Development of a new technology is never easy or cheap.

The adaption of an existing technology to a new application presents multiple challenges. A major challenge we face

Yellow nutsedge plants 28 days after treatment with increasing rates of pulse electric field. PEF rates (L to R) were 0, 15, 30, 60, 125, and 250 J cm3..

PHOTO COURTESY OREGON STATE UNIVERSITY

is that the energy level we are delivering for soil disinfestation is far beyond the initial design limits for this equipment. The batteries, the cooling system, and the electronics are all challenged to their breaking points. This is not a figure of speech; breaking points have been a significant cost challenge for us to overcome.

This project is funded by the USDA-NIFA Methyl Bromide Transition Program (2022-51102-38259), the Horticulture Research Institute, and the Oregon Association of Nurseries. Finally, this work could only be conducted with the collaboration of J. Frank Schmidt & Son Co. in Boring, Oregon and Robinson Nursery in Amity, Oregon.

Marcelo L Moretti and Tatiana Benedetti work in the Department of Horticulture at Oregon State University. Inga Zasada and Jerry Weiland work for the USDA-Agricultural Research Service in Corvallis, Oregon and Jason Crisp works at Lisi Global in Richland, Washington.