

**Oregon Department of Agriculture and Oregon Association of Nurseries
Nursery Research Pre-proposal**

Date: October 16, 2023.

Project Title: Developing Pulse Electricity as a Fumigant Alternative in Nursery Seedling Beds

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Project background:

This project will initiate its second year. Our goal is to evaluate the performance of pulse electricity, safety, and costs as an alternative to methyl bromide in nursery seedling beds. The Pacific Northwest leads the US in tree seedling production. Tree seedling nurseries often use fumigation and hand weeding to control soil pathogens, nematodes, and weeds. This practice is unsustainable due to increased regulation, costs, and environmental safety. Although pulse electricity is currently used commercially in golf courses for weed control, we aim to develop it for soil disinfection. We will explore alternative approaches to soil fumigation using soil-applied energy pulses to control the target organisms, Pulse electric field (PEF).

The PEF efficacy is affected by soil and equipment parameters. The soil aspects can be explained by using the analogy of water moving in a pipe; the current is the water flow, the volt is the pressure, and the Ohm is the resistance of the pipe (Figure 1). The idea behind the increased effectiveness is that with high voltage, the current can overcome the soil and weed resistance (Ohm) and allow more current to pass through the media. Conversely, if the soil resistance is too low, one cannot sustain a voltage gradient. For instance, if the pipe was broken, the resistance (Ohm) would be too low, and the pressure (Volt) would drop. Low soil electrical resistance occurs when the soil is too wet. There is an ideal soil moisture content to operate the equipment. As a rule of thumb, the soil moisture ideal for tillage is likely also ideal for PEF applications.

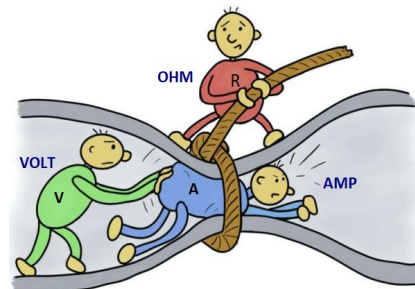


Figure 1. Relationship between resistance (Ohm), difference in potential energy (Volt), and current (AMP). Source <https://www.circuitbasics.com/ohms->

In addition to soil conditions, PEF efficacy depends on equipment parameters like field strength or voltage gradient between electrodes (V/mm), treatment duration (s), pulse frequency, number of pulses per time (Hz), pulse width, or duration of each pulse (us), and treatment temperature. We consider PEF a physical (electricity) and thermal (heat) method because the energy required to kill weed seeds and vegetative propagules will increase soil temperature. To date, it is unclear how these factors interact and affect PEF. For instance, by increasing the voltage from 50V to 150V, the energy required to kill yellow nutsedge tubers was nearly halved

in a pot study. However, we could not replicate these conditions in the field because of the lower soil electrical resistance.

Our goal is to identify optimum treatment conditions that will help minimize treatment costs and develop equipment suited for the nursery applications. The current proposal would secure the funds necessary for the required greenhouse and field work to develop the equipment and expand field studies beyond fall-planted species.

Project objectives:

- 1) **To optimize pulse electricity to control weed seeds in nursery seedling beds.** The long-term goal is to develop new ways to manage weeds and soilborne pathogens that will reduce costs and reliance on pesticides and soil fumigants, such as methyl bromide, and enhance the environmental sustainability of the nursery sector.

Methods & Timeline:

This work expands the collaborative work by USDA Horticulture and a private company (Lisi Global) that has documented the efficacy of pulse electricity in controlling nematodes and soil pathogens (Riga et al. 2020). A commercially available Direct Energy System unit (DES, Lisi Global, Inc.) will generate electric energy. This unit delivers energy via pins or electrodes inserted into the soil in a 2ft swath from the soil surface to a maximum depth of about 10 in. Here is a video of the experimental process (<https://www.youtube.com/watch?v=SV9zoXpvn84>)

Controlled conditions studies: We will evaluate the effect of field strength, pulse width, frequency, and number of pulses on the efficacy of controlling weed seeds and vegetative propagules. The weed species selected are yellow nutsedge, annual bluegrass, red sorrel, crabgrass, and horseweed. At least five energy levels will be included to compare each factor independently. Once we identify the best equipment configuration, we will compare the best setup to the worst at a constant energy level to validate the results.

Field experiments: A field experiment was initiated in Boring, OR (JF Schmidt), and a second study will be undertaken in McMinnville (Robinson Nursery) in the spring. The cooperating growers will prepare the site following the nursery's standard practices. This study will compare the efficacy of two energy levels (200 and 400 J cm⁻³) and two application depths (4 and 8 inches). A nontreated check will be included as a reference. The collaborating grower will plant tree seedlings. Weeds that emerge in the plot will be identified at the species level, and the percentage of soil coverage by weeds will be recorded monthly. Hand-weeding will be performed following the collaborating nursery practices. Total hand-weeding time per plot will be recorded to document labor and production costs. One commercially important species will be planted on each experimental plot. Tree seedling emergence and height will be recorded monthly after soil treatment. The trunk caliper will be recorded before harvest in the fall of the following year. Bare root operations will harvest seedlings and grade their quality according to plant height, trunk caliper, and root and shoot form

The benefit to the Nursery Industry:

This study addresses the need for non-fumigant alternatives for shade tree nurseries, a significant industry in Oregon valued at \$118 million yearly. Our proposal will develop a non-fumigant strategy to manage soilborne pests and pathogens. If successful, our project will reduce industry reliance on fumigants and pesticides, decrease labor demands, promote the longer-term economic viability of the industry, and enhance the sector's environmental sustainability. The public-private partnership allows us to adapt an existing and locally available technology for the industry. The research team has a proposal under review with the Horticulture Research Institute.

Budget summary:

	Description	Requested
Personnel		
Technician salary	0.15 FTE (\$55,000/ year)	\$ 8,497
Employee benefits (OPE)	72%	\$ 6,118
Supplies and expenses		
Equipment & supplies	Small equipment, DES replacement parts	\$ 3,500
Travel	\$0.57 mile	\$ 2,385
TOTAL REQUEST		\$ 20,500

References

Riga E, Crisp JD, McComb GJ, Weiland JE, Zasada IA (2020) Directed energy system technology for the control of soilborne fungal pathogens and plant-parasitic nematodes. *Pest Manag Sci* 76:2072-2078