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GRANT AMT: $442,068 **GRANT YR:** 2022
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PULSE ELECTRICITY: A NON-CHEMICAL APPROACH FOR THE MANAGEMENT OF NEMATODES, PATHOGENS, AND WEEDS IN NURSERIES

NON-TECHNICAL SUMMARY: This project is an integrated project considering pulse electricity's performance, safety, and costs as an alternative to methyl bromide in nursery seedling beds. The Pacific northwest leads tree seedling production in the US. Tree seedling nurseries often rely on a combination of fumigation and hand weeding to control soil pathogens, nematodes, and weeds. This practice is unsustainable due to increased regulation, costs, and environmental safety. This project will explore alternative approaches to soil fumigation using soil-applied energy pulses to control the target organisms or a continuous electrical current to heat the soil, Ohmic heating. Both methods have documented efficacy in a broad-spectrum array of pests. However, whether direct energy or Ohmic heating will be more cost-effective for soil fumigation is unclear. The volume of soil treated and depth of treatment application also affects efficacy and costs. The optimum volume of treated soil will depend on the target species to improve the effectiveness of these tools. Economic analysis must be performed to determine if either of these practices are cost-effective pest management tools. A multi-disciplinary approach using standard scientific methods will be used to evaluate both strategies in commercial field studies, and findings will be published to help advance the use of both technologies. The goal is to identify environmentally sound alternatives to the management of yield-limiting soil pests with one or both strategies and to reduce labor demand and production costs. This research will support the development of a novel and practical soil disinfestation alternative to methyl bromide.

OBJECTIVES: The specific objectives of this project are as follows:1) Determine the efficacy of pulse electricity and Ohmic heating against selected soil pests and weeds: Compare the effectiveness of pulse electricity field (PEF) and Ohmic heating (OH) to control selected nematodes, fungi, and weed species. Energy requirements will be compared using both methods to optimize field study design. These studies will allow us to optimize the performance of PEF and OH for the field study.2) Determine the ability of pulse electricity and Ohmic heating to reduce soilborne plant problems to acceptable levels in nursery seedlings fields. Field studies will compare the effect of pulse electricity applied at different soil depths and energy levels as PEF and OH and their impact on crop quality and labor demands.3) Assess the economics of pulse electricity to control soilborne pathogen and pest management. Compare inputs and profitability of electric energy to methyl bromide and other soil fumigants in the ornamental tree nursery.4) Disseminate findings to industry, nursery producers, and academic peers. Develop recommendations for using this novel technology in soil disinfestation and inform stakeholders on the risks and benefits of electric energy via face-to-face events, webinars, and published resources.

APPROACH: APPROACH:OptimizingPulse electricity for weeds, nematodes, and pathogens control. We will conduct greenhouse studies exposing the target organisms to increasing rates of electricity for the purpose of defining lethal rates.A native silt loam soil will be separately inoculated withP. cinnamomi(mycelia and chlamydospores),V. dahliaemicrosclerotia,Calonectria pseudonaviculatamicrosclerotia, eggsMeloidogyne incognita, seeds ofPoa annua, or tubers ofCyperus esculentus.Inoculated soil will be treated with three levels of PEF electric field strength designated as low (20 V.mm-1), medium (50 V.mm-1), or high energy (200 kV.mm-1), pulse frequency, width, and duration of treatment will be manipulated to achieve three energy inputs ranging from as low as 20, and as high as 150 J.cm-3, and a nontreated control The number and width of pulses will be recorded. Treatments will be applied for 0, 0.06, 0.12, 0.25, 0.5, 1, and 2 h . Following treatments, weed seeds andpropagules will be planted into a weed-free commercial potting medium and watered as needed for the following 28 d. Emergence and plant height will be recorded weekly.Pathogens: Survival of soilborne pathogens will be determined by plating soil on media semi-selective forP. cinnamomi(PARP media) andV. dahliae(NP10 media),or by baiting with boxwood leaf discs forC. pseudonaviculata.Nematodes: Survival ofM. incognitaafter treatment will be determined using a tomato bioassay.Briefly, treated soil will be added to a pot and a tomato seedling transplanted. After 6 weeks, the plant will be destructively harvested, eggs extracted from roots using bleach, and counted. Root tissues will be dried and data expressed asM. incognitaeggs/g dry root.The experiments will be organized as randomized complete block design with four replicates. Each problem species and treatment method will be treated as an independent study. A non-linear regression will be performed in R using a logistic model describing the relationship between tuber viability and energy requirement (J cm-3) for field strength for PEF or exposure time at each soil temperature for OH. Objective 2.Field experiments will be conducted in two commercial tree seedling nurseries located in the Willamette Valley of Oregon.This study will compare the efficacy of the most effective PEF and OH treatments based on Objective 1. As the amount of energy required is related to the volume of soil treated, we will compare the efficacy of PEF and OH aat wo depths.Tree seedling emergence and height will be recorded monthly after soil treatment.Survival of inoculated pests will be determined as described in Objective 1. Objective 3. The economics analysis will examinecosts associated with the three pest management strategies to define the costs forprofit maximation problem.Costs associated with the pest management approaches will be collectedand compared with production budgetson fumigation use. Materials will be developed to communicate the economic feasibility and possible environmental gains from switching tosoil-applied energy pulses and thermal control. Objective 4. All PIs involved in the project will contribute to extension and outreach activitiesfeatured this project as talks, field days, and discussion groups?