Movement of *Phythopthora ramorum* inoculum in the soil profile

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WSU UNDERGRADUATE EDUCATION SURCA 2017

Introduction:

Phytophthora ramorum, the causal agent of Sudden Oak Death, is an invasive, fungus-like plant pathogen. *P. ramorum* has a broad host range and could potentially cause devastating losses to forestry, agriculture and horticultural industries. It infects about 109 host species, including hardwoods, conifer, shrubs, herbaceous plants and ferns (Frankel, 2008). In the U.S., *P. ramorum* has been detected in California, Oregon and western Washington nurseries and has spread to forests in California and Oregon. *P. ramorum* can be spread by infested soil or plant material. Sanitizing soils, pots, tools, and media is essential to prevent and reduce the potential for *P. ramorum* spread. Steam treatment has shown to be effective at eradicating inoculum of the pathogen from soil pots and media when temperature is hold at 122 F for 30 minutes (WSU, 2017). Determining the depth that *P. ramorum* would move in the soil profile may give information about at what depth the stream treatment should be to eradicate the inoculum.

Figure (1) Distribution of *Phytophthora ramorum* in wildland in the United States. (Frankel, 2008)

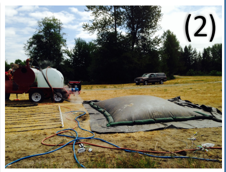

Figure (2) Steaming soil spot in WSU, Puyallup, WA

Objectives:

(1) Determine the depths that *P. ramorum* inoculum will travel in the soil profile;
(2) Provide information about the depth of steam penetration needed to remove *P. ramorum* inoculum from infected soil effectively;
(3) Provide data on the movement of *P. ramorum* inoculum.

Figure 3: Rhododendron leaves colonized with *P. ramorum*

Figure 4: Soil Columns set up

Materials and Method:

The experiment was conducted using colonized rhododendron leaves inoculum with isolate 886, Puyallup fine sandy loan soil and compost (organic matter).
The experiment was repeated twice. In each experiment, 4 trials were conducted. In each trial, soil with different levels of soil organic mater (OM) was used as followed: none 0% , low 1%, medium 5%, and high 10 % of OM. 16 columns (10 cm diameter x 60 cm high) were used in each trial. 1 cm of pea gravel was layered at the bottom of each column. 16 columns were divided into 4 treatments (4 columns per treatment). Soil was filled in to the columns to 4 levels of soil depths: 0 cm, 5 cm, 15 cm and 30 cm.
Soil weight and water flow rate through the soil columns were measured and recorded. The soil was saturated with water before 5 inoculated leaves were placed at the top of each of the soil column. Then 1 cm of water was added to cover the leaves. After 7 days, 2 litter of water was added in each column, let flow through and collected at the bottom of the columns. The collected water was tested for the present of *P. ramorum* by baiting and direct plating.
The 0 cm of soil columns, containing pea gravel only, served as control treatments to test for the movement of inoculum in the absence of soil.

Results:

Soil depth and percent OM had an effect on flow rate, especially in the 5 cm columns. Flow rates in 15 cm and 30 cm columns were significantly slower in comparison to those of 5 cm columns. In the 5cm depth columns, soils with higher levels of organic matter had slower flow rates through the columns (figure 6).

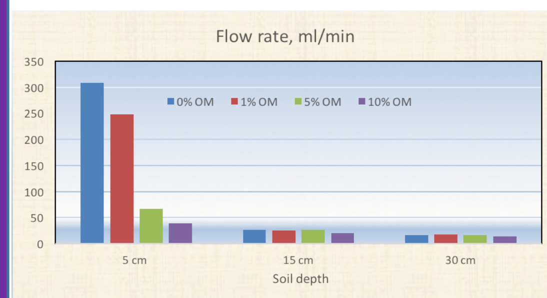

Figure 6: Flow rate of water through soil columns

Volumetric water content was negatively correlated with bulk density ($r=0.4459$, $p<0.001$). The relationship between flow rate and bulk density was not significant.

Acknowledgements:

This Project was leaded by Gary Chastagner and Marianne Elliott with the helps of Lucy Rollins and Travis Bonnette WSU, Research and Extension Center-Plan Pathology, Puyallup, WA

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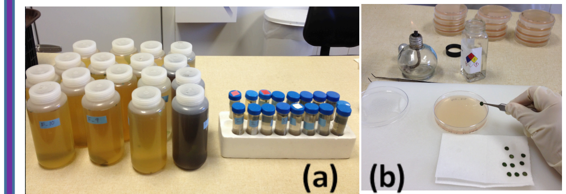

Figure 5: Baiting to test for the presence of *P. ramorum*. (a) Add rhododenron leaves into the flow-through water, then incubate for 28 hours; (b) blot dry then insert leaf baits into PARPH-V8 media plates.

Results:

Soil depth was the most important factor influencing the movement of *P. ramorum* inoculum through the soil profile (figure 6). Number of *P. ramorum* positive baits were not significantly different among the percent organic matter treatments ($p = 0.2983$, Kruskal-Wallis test). *P. ramorum* was not detected in flow-through water of the 30 cm soil depth columns in any of the organic matter concentrations, and only once in 15cm deep soil (figure 7).

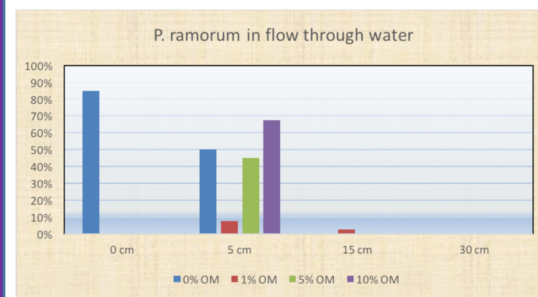

Figure 7: Percent of *P. ramorum* found in the flow-through water

Discussion and Conclusion

Based on the results, soil depth was the most important factor influencing the ability of *P. ramorum* inoculum to move through the soil profile. There was no significant difference in movement of *P. ramorum* between treatments of different levels of organic matter. For Puyallup fine sandy loan soil type , *P. ramorum* was not found in the flow-through water in the 30 cm-soil columns, and rarely found in the 15 cm-soil columns. The results suggested that the depth of steam penetration could be less than 30 cm to eradicate *P. ramorum* from infected soil. However, additional studies should be conducted with different soil types, under various environment conditions, and soil compaction levels. Soil properties, soil organism and the surrounding environment may affect *P. ramorum* and its movement.

Reference:

1. Frankel, S. J. 2008. Sudden oak death and Phytophthora ramorum in the USA a management challenge. Australian Plant Pathology. 37: 19-25.
2. WSU- Sudden Oak Death Research [Online]. Available at https://ppo.puyallup.wsu.edu/sod/research-projects/steam/. (accessed 15 March, 2017; verified 23 March, 2017). WSU, Puyallup, WA.