In nurseries, plant pathogens can spread via water splash from the ground to container plants growing on benches. We used

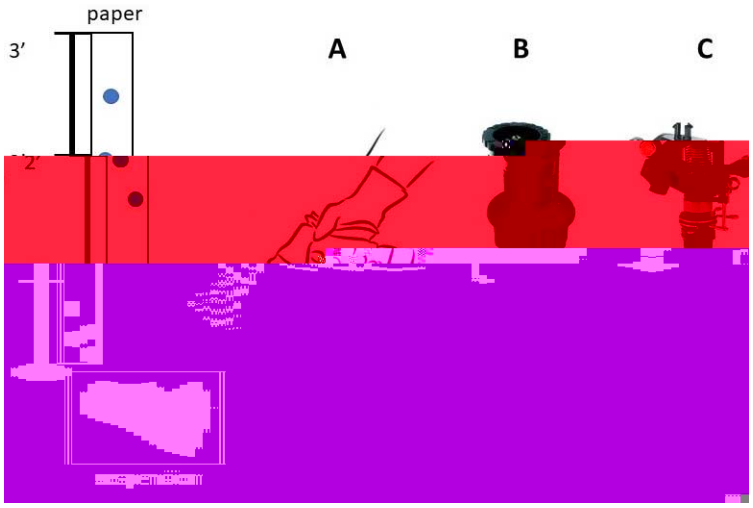

Figure 1. Detection of water splash o of common nursery surfaces with three di erent irrigation types. Blotter paper was placed at a 90° angle to each surface and 200mL of a uorescent suspension containing ~2 x106 microspheres were poured onto the surface, 1-1.5' in front of the blotter paper. Each surface was watered using three di erent irrigation types, separately (A: Hand wand, B: Spray sprinkler, C: Impact spray).

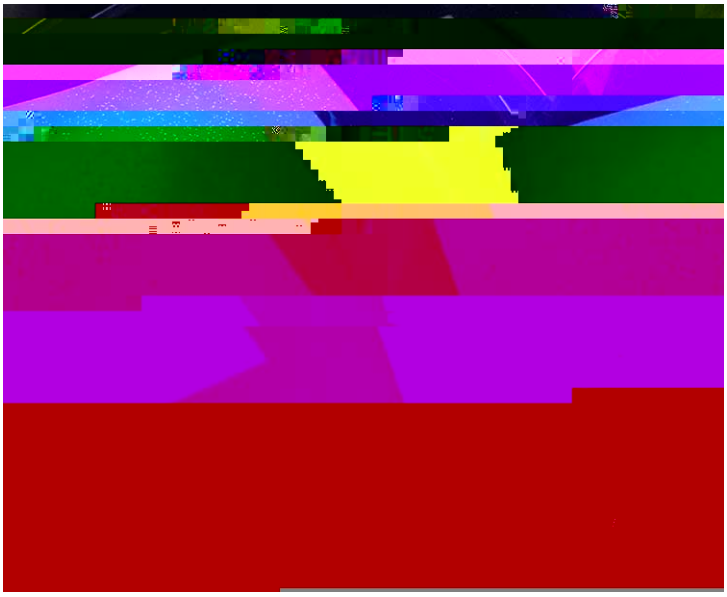

Figure 2. Detection of uorescent microspheres on lter paper using an UV-lamp.

continued

The suspensions, which contained approximately 2 million microspheres each, were poured onto the trial area at a distance of 1–1.5′ to the blotter paper. The surfaces were watered with each of the irrigation systems separately for 30 seconds at an angle of 45–60°.

continued next page

All surfaces except concrete were also tested with the spray sprinkler and impact spray, and weed barrier fabric was the surface type from which water splashes were detected most commonly.

...

The extent of vertical water splash (defined as highest average splash and number of droplets at a given height) differs based on surface and watering type. The fluorescent microspheres used in the experiment had a diameter of 53–63 microns, resembling the size of . propagules (sporangia: 46–65 x 21–28 µm, chlamydospores: 46–60 µm) and acted as surrogates for the spread of waterborne pathogens. Of the five surface types tested, concrete resulted in significantly higher droplet numbers above 2′ when tested with hand watering compared to bare soil, mud puddle, weed barrier fabric, and 3/4" gravel. Only a very small fraction of the microspheres used in the experiment was detected at a height of 2–3′ above surface level using all three irrigation types and no droplets were observed between 2.5–3′ when spray sprinklers were used. The spray sprinklers used in this experiment emitted significantly less water per minute than hand watering and impact spray (4 gal/min vs. 11 gal/min), which could explain some of the observed differences. However, the smaller droplet size released from the spray sprinkler resulted in a 'mist-like' irrigation pattern with decreased physical impact compared to the 'rain-like' irrigation typical for hand watering and impact spray. In laboratory experiments with . , an

continued next page

I T H B I

continued

inoculum threshold of 51 zoospores/mL was reported for infecting detached rhododendron leaves (Rollins et al., 2015). Consequently, smaller droplet sizes and low numbers of droplets reaching 2′ above surface reduce the risk of spreading waterborne pathogens.

Best Management Practices should be used in nurseries to produce healthy plants. We recommend to:

- Place plants on raised benches at a height of 3′ if possible (Figure 4)
- Choose an irrigation type with small water droplet sizes and low pressure, preferably overhead; when watering with a hose, keep the water on the plants soil surface and avoid aiming the hose at the ground to reduce splashing
- Choose a surface type which can be cleaned and drained easily, and from which droplets bounce back at reduced rates.

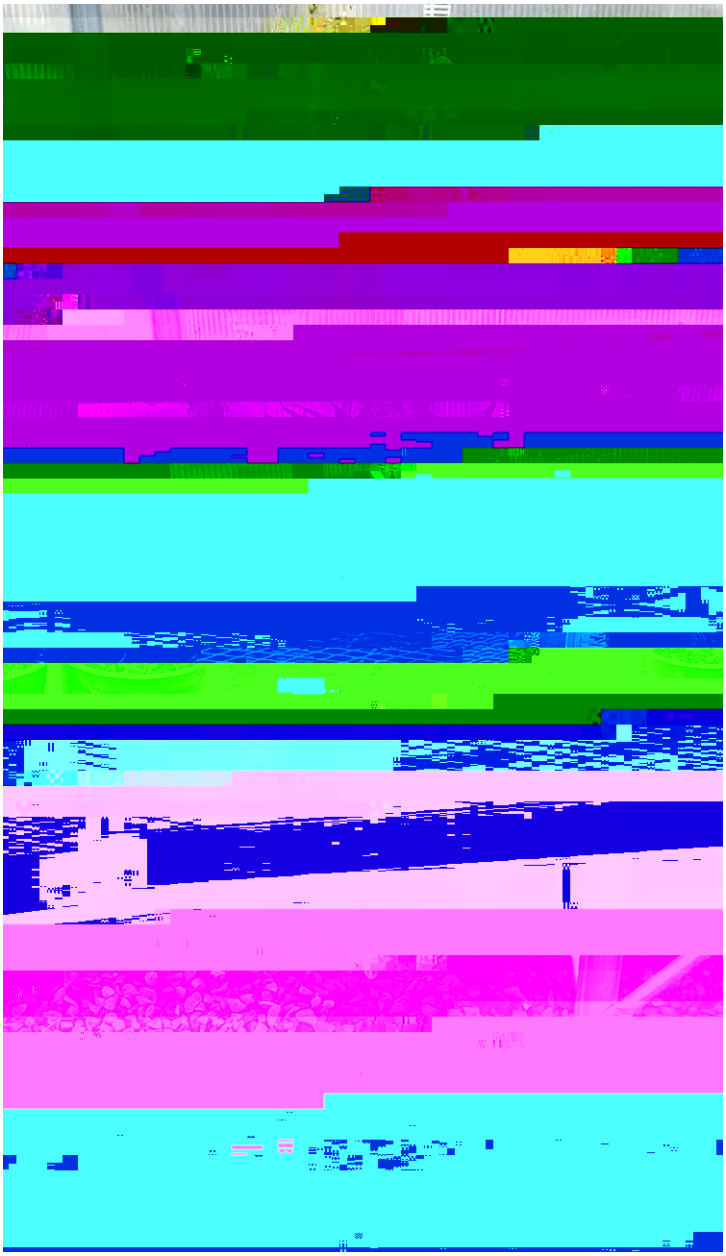

Figure 4: The risk of water splash transmitted plant diseases can be reduced by placing plants on a bench above a graveled surface irrigated with spray sprinkler.

Grünwald, N.J., M. Garbelotto, E.M. Goss, K. Heungens, and S. Prospero. 2012. Emergence of the sudden oak death pathogen . . 20: 131–138.

IBM Corp. Released 2019 IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.

Pastalka, T., S. Rooney-Latham, K. Kosta, K. Suslow, V. Huffman, S. Ghosh, and W. Schweigkofler. 2017. Monitoring using a sentinel plant system reveals very limited aerial spread of from infected ornamental plants in a quarantine research nursery. 18: 9–16.

Rollins, L., M. Elliott, and G. Chastagner. 2015. Applying inoculum to hosts: A new method that simulates overhead irrigation. 16: 100–106.

Rooney-Latham, S., C.L. Blomquist, K.L. Kosta, , Y.Y. Gou, P.W. Woods. 2019. species are common on nursery stock grown for restoration and revegetation purposes in California. 103: 448–455.

Schweigkofler, W., K. Kosta, V. Huffman, S. Sharma, K. Suslow, and S. Ghosh. 2014. Steaming inactivates , causal agent of sudden oak death and ramorum blight, from infested nursery soils in California. . doi.org/10.1094/PHp-RS-13-0111.

Schweigkofler, W., T. Pastalka, N. Abeysekara, V. Huffman, and K. Suslow. 2021. Transmission of the invasive pathogen from symptomatic to healthy host plants during a five-year period in California. . doi.org/10.1094/PHP-06-21-0089-RS.

Swiecki, T.J., E.A. Bernhardt, and S.J. Frankel. 2019. root disease and the need for clean nursery stock in urban forests: Part 3. Prevention and management. *A* 45: 40–49.

USDA APHIS 2020. domestic regulatory program manual. https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/phytophthora-ramorum/sod.

SERCAL, the California Society for Ecological Restoration, is a non-profit membership-based organization dedicated to advancing the science, art, and practice of restoring native California habitats.

sercal.org