

Steam Use in Greenhouse and Nursery Systems

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In greenhouse and nursery systems, nearly every part of the physical environment must be purchased: the pots, the growing medium, the nutrients, and the greenhouse structures. This requires high up-front costs for materials that are sometimes only used once. It is estimated that about 10% of plants with their pots and soil media are culled and disposed of in the ornamental industry due to disease or pest damage.

Re-using pots and growing medium is one way to minimize costs and reduce waste. But pests, pathogens, and weed seeds can be passed on if these materials are not properly disinfested. Methods for pot and substrate disinfestation include fumigation, solarization, and steam application. The following will discuss one of these methods: steam as a plastic and substrate disinfestation tool.

Steam Disinfestation Basics

Steam has been utilized in agricultural settings for over a century to control soilborne pathogens, pests, and weeds, through the application of high temperatures. When applying steam, it has long been accepted that exposure to 149°F (65°C) for 30 minutes controls most pathogens. However, the time required to achieve sufficient control can vary depending on site conditions. For example, soil type will affect heat transfer. Heat applied to sandy soils can penetrate at a faster rate than heat applied to clay soils. When steaming plastic pots, temperatures will rise much faster than if you are trying to steam soil, due to abundant air space in the treatment chamber.

In addition, the pest, pathogen, or weed seed targeted can have varying heat tolerances. When considering weed control, it has been found that heat tolerance tends to be higher in large weed seeds compared to smaller weed seeds. Pathogens vary in heat tolerance too. For example, studies found that the lethal temperature and exposure time for *Sclerotinia sclerotiorum*, which causes white mold, is 122°F for 5 minutes. But *Phytophthora* sp. need exposure to 122-140°F for 30 minutes.

Steam in Greenhouse Production

Many greenhouse and nursery systems have found ways to effectively utilize steam as a pest, pathogen, and weed control. Talking with growers who use steam as a chemical alternative, I have learned that they appreciate this pest control tactic because it minimizes health hazards. They also feel that they need to find effective alternatives to chemicals, given the fact that fumigants are becoming more heavily regulated or restricted.

Steaming nursery pots and trays requires specialized equipment. Crafty growers have built their own steam room or cabinet. I have seen old fridges converted into steam cabinets for small quantities of seedling trays. Size and dimensions of makeshift steam rooms can be altered,

depending on a nursery's specific needs. For larger operations, purchasing a shipping container, insulating it, and installing a manifold that ejects steam evenly into the container is an option. The manifold must be attached to an outside steam generator through a steam-graded hose. Commercially available steam rooms or containers are also available.

The standard recommendation for steam temperature and application time is a minimum of 160°F (70°C) for 30 minutes. However, plastics can withstand varying temperatures, depending on the thickness of the plastic and materials used in the manufacturing process. It is recommended that if you decide to start steaming the plastic used in your nursery, you should run an initial trial to determine the temperatures your plastic can withstand. If plastic starts to soften or melt at 160°F after 30 minutes, try decreasing the temperature and running the treatment for longer (ex. 150°F for 60 minutes). Once you've determined the optimal temperature and length, keep in mind that it may change if you purchase plastic from a new company, as manufacturing processes may vary.

In addition to plastic, some greenhouse and nursery operations will treat and reuse substrate. One method involves piling substrate and covering it with a heat-resistant tarp. A steam sock or manifold attached to a steam generator distributes steam evenly under the tarp. "Bunker" steaming is another method, in which substrate is piled into a concrete bunker. Steam enters through the top of the bunker, and suction hoses at the bottom of the bunker pull steam through the pile of substrate.

Steaming is not restricted to plastic and substrate. Soil underneath hoop houses and tunnels can be sheet steamed. This process requires a heat-resistant tarp to cover the soil surface and be stabilized on the edges with sandbags or large chains. A steam generator on the edge of the house then injects steam underneath the tarp.

Steaming soil is more time-consuming and energy-intensive, compared to steaming substrate or plastic. This is due to many factors, including the energy and time required for high temperatures to reach sufficient soil depths. But new steam applicators have shown exciting progress for more efficient steam application. For example, a spot steam injector evaluated by University of California was able to reach 160°F at a soil depth of 10 inches after only 60-90 seconds of steam application.

Take-home message

Steam is one potential alternative to chemical use in greenhouse production settings. You can use it to disinfest plastic pots and substrate, or to treat soil under hoop houses and tunnels. Regardless of the material you are treating, most companies and researchers recommend maintaining temperatures of 160°F (70°C) for 30 minutes for sufficient disinfestation. The cost of steaming will vary, depending on the size, scale, and type of operation. Companies will have to determine whether the investment in steam treatment will outweigh the cost of purchasing new substrate and plastic over the long term.