Developing Alternative Heat Treatments for Disinfestation of Soil and Planting Media©

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A "double-tent" solarization (passive solar heating) technique was recently approved by the California Department of Food and Agriculture (CDFA) as a nematicidal treatment for container nursery soil. The treatment currently stipulates exposure of soil to a temperature of 70°C for 30 contiguous min, among other considerations. Due to the need for broad-spectrum pest control in container nursery settings, the technique also was tested to confirm its usefulness as an herbicidal treatment. Laboratory-derived thermal death dosages (temperature 5 time) for six weed species important in California [*Portulaca oleracea* (common purslane), *Amaranthus albus* (tumble pigweed), *Sonchus oleraceus* (annual sowthistle), *Sisymbrium irio* (London rocket), *Solanum nigrum* (black nightshade), and *Echinochloa crus-galli* (barnyardgrass)] were determined and used as guidelines for devising treatment periods. Two field experiments were conducted in 1999 and 2000 to confirm the laboratory thermal death data; no seed germination occurred in any of the solarized treatments, in accordance with the laboratory results. Germination data were confirmed by performing squash tests and/or tetrazolium assays on nongerminated seeds. The approved "double-tent" solarization technique can be useful to producers of containerized nursery plants.

INTRODUCTION

Clean soil and planting stock are essential for profitable nursery, greenhouse, and field production of high-value horticultural crops. In the case of nursery stock for farm planting, California law makes it mandatory that it be free of economically important nematodes. Producers of containerized nursery stock in the San Joaquin Valley (SJV) of California currently use different methods for obtaining pest-free planting substrate. Some obtain "virgin" soil or organic media from off-site locations, while others use various methods of soil disinfestation, primarily methyl bromide fumigation or steam. Methyl bromide has been used by nursery producers for many years. An alternative to fumigation is steam treatment, that necessitates investing in expensive steam-generation equipment. This paper reports on the development of a simple, "double-tent" method of solarization [capturing solar radiation that can raise soil temperatures to more than 70°C (158°F) for pasteurizing soil] (Stapleton, 2000) in containers or shallow layers of soil or potting media in warmer climates.

Because of the high summer air temperatures in the SJV, the relatively small volumes of soil requiring disinfestation, and the positive results reported in several previous studies, this solarization technique appeared to have excellent potential as a replacement treatment for use in container nurseries. Therefore, solarization was tested during the summer months of 1995-98 for its potential to disinfest heavily-

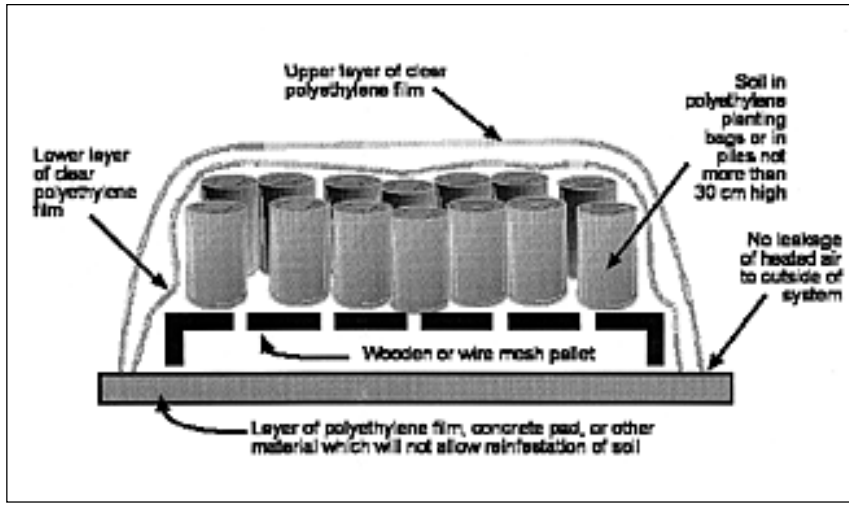

Figure 1. Diagrammatic representation of the "double-tent" solarization treatment for container nursery soil and planting media.

infested nursery soils of major nematode pathogens and weed pests. The solarization treatments were tested both in black plastic planting sleeves and soil in piles placed into sleeves after treatment. Soil infested with very high populations of pests was used to provide a "worst case" situation. Commercial nurseries would not use such contaminated soil for producing containerized planting stock.

RESULTS AND DISCUSSION

Soil temperatures during mid-summer treatments in the center of the bags routinely reached 70°C or higher in the double-tent solarization treatment. Spring and late summer/fall treatments in the SJV were less successful in raising soil temperature above 70°C. *Tylenchulus semipenetrans*, *Pratylenchus vulnus*, *Meloidogyne incognita*, and other nematode species were undetectable in soil and/or bioassay plant roots after treatment in double-tented bags (Stapleton et al., 1999).

In other studies, laboratory-derived thermal death dosages (temperature × time) for six weed species important in California [*P. oleracea* (common purslane), *A. albus* (tumble pigweed), *S. oleraceus* (annual sowthistle), *S. irio* (London rocket), *S. nigrum* (black nightshade), and *E. crus-galli* (barnyardgrass)] were determined and used as guidelines for devising treatment periods (Stapleton et al., 2000a). In two field experiments conducted in 1999 and 2000 to validate the laboratory data, moist soil in black polyethylene (poly) planting bags (3.78 liter volume), artificially infested with seeds of the six test species were subjected to 0 to 24 h of solarization. Other samples of weed seeds were placed into poly bags and incubated under ambient temperature (ca. 23°C). Apart from the nonsolarized control treatment, no weed seeds germinated at any of the sampling periods, in accordance with the laboratory thermal death data. Germination data were confirmed by performing squash tests and/or tetrazolium assays on nongerminated seeds (Stapleton et al., 2000b).

Destruction of the experimental pests in these studies using heavily-infested soil indicated that the "double-tent" solarization method may be used commercially in nursery operations in the SJV and other warm climatic areas. The technique was recently approved by CDFA as a nematicidal treatment for containerized nursery plants (Stapleton et al., 1999). Further tests are underway to develop supplemental methods that will extend the technology to currently nonconducive time periods and climatic areas, as well as to validate the method for disinfestation of contaminated nursery pots and containers.

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