Recycling used container media with solarization©

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INTRODUCTION

Underutilization of used potting media for crop production in environmental horticulture wastes money and resources. In conversations with growers, it is estimated that about 10% of plants with potting media are culled and disposed of in the industry. Many nurseries dump culled plants and media on site and this waste is generally not reused. In an effort to recycle this waste, a series of methods were tested to solarize the used potting media. Solarization is a sustainable, inexpensive, and effective method to reduce pathogens, nematodes, and weeds. Solarization works using the light energy of the sun and transforming it into heat. When temperatures reach a certain threshold over a certain critical time, pests can be eliminated. Different pests (i.e., weed seeds, insects, fungi) have different thresholds for being heat killed. Research has shown that if container medium is held at temperatures of 70°C (158°F) or higher for 30 min or 60°C (140°F) or higher for 1 h, solarization can completely eliminate plant pests (Stapleton et al., 2008). Methods have been developed for treating smaller quantities of medium such as in nursery pots on pallets with a "double tent" method (Stapleton, 2000). Research has shown the effective use of solarization to treat small bags of potting soil on benches (Zinati et al., 2002). What was lacking was a larger scale method to treat higher quantities of spent potting media.

MATERIALS AND METHODS

Solarization

To develop a large scale method, a series of small-scale solarization treatments were conducted to arrive at a final protocol to be scaled up (Steed, 2014). A 0.8 m^3 (1 ft^3) method was tried with different configurations using double tent methods, different medium depths, hydration rates, types of plastic, heights of spacing between plastic sheets, and materials used to suspend the top plastic sheet until a suitable method was developed. This final method consisted of a layer of ground cover that was first placed on bare ground to keep weeds from growing through the plastic. A layer of four mil, clear, polyethylene plastic was placed over the ground cover to prevent nematodes or disease pests from moving up through the soil to reinfest solarized medium. The area to be treated was 7.3×7.3 m (24×24 ft). Next, used potting medium [pine bark and peat, (3:1, v/v)] was moved from a nearby pile with a front end loader to the treatment area. The medium was spread over the plastic to a depth of 5.1 cm (2 in.) with shovels and rakes and large plant debris was removed by hand. The volume of medium treated was 2.7 m^3 (3.6 yd^3). Enough water was added to the medium to moisten but not saturate, since fully saturated medium does not conduct heat to the bottom well. This medium was then wrapped in clear 4-mil plastic and sealed tightly around the edges so that the plastic laid flat on top of the medium with the medium touching the plastic. A series of ridges and valleys were created using 5.1 cm (2 in.) galvanized pipes resting on stands above this plastic layer to slope rain water towards one edge. Polyvinyl chloride (PVC) pipes were originally tried but melted due to the extreme temperatures that are generated. A four mil, clear plastic sheet was placed over the pipes and wrapped tightly at the edges and underneath the bottom layer sheet and medium. The final configuration looked like a bag of soil within a bag (Figure 1). The solarization process for this study ran for 14 days and was started on 20 Aug. 2013. Three soil probes were located within the treatment medium. Samples of solarized and untreated soil were analyzed for physical and chemical attributes. Medium was collected and placed in seedling trays measuring 30.5×45.7×6 cm (1ft × 1.5 ft × 2.5 in.) for a weed germination comparison. Three trays of

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each of the following were filled with 2.5 cm (1 in.) of medium: solarized, untreated and new potting soil. Trays were placed in a high tunnel with 30% shade. Trays were watered daily with overhead irrigation and grown for 2 weeks. Weed seedling numbers were counted after 15 days of growth.

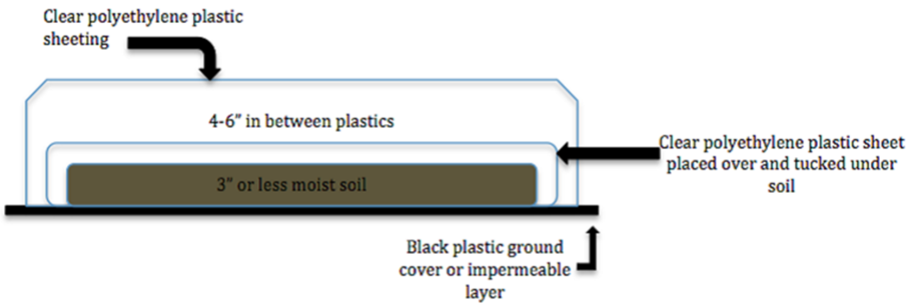

Figure 1. Schematic of solarization system. Illustration by Credit-Kallee Cook.

Growth study

Solarized medium was then tested in a growth study to find if there were any differences in producing plants or if the process might negatively affect plant growth (Steed, 2015). Fresh medium containing composted pine bark and peat (3:1, v/v) (Graco Fertilizer Co.) was used as the new medium comparison. Three different treatment soils were compared: 100% new soil as the control, and mixes of new and solarized soil at the proportions, respectively, 66:33 and 33:66. Treatments were replicated three times. The soil was added to #3 black plastic pots (9.5L). Time release fertilizer was added to the pots at 40 g of a 6 month time release, 14-5-11 (14N-2.1P-9.1K) with minors and 80 g of 12 month time release, 17-5-11 (17N-2.1P-9.1K) (Graco Fertilizer Co.). Rooted liners (60 cell) of *Viburnum suspensum* [10.2 cm (4 in.)] tall and *Lagerstroemia* 'Natchez' [25.4 cm (10 in.)] tall (ProGrowers, LLC, Plant City, Florida) were planted in pots on 30 Sept. 2013 and moved to the field. Irrigation was provided with overhead sprinklers. Weeds were hand-pulled. Plants were not pruned or staked during the growing season. The experimental design was a randomized complete block. Data was collected on 16 July 2014. Viburnum heights and widths were measured, while only 'Natchez' heights were measured. Means were compared with SAS JMP 11 Pro via Tukey's HSD test comparison.

RESULTS AND DISCUSSION

Solarization

The method developed worked exceedingly well with highest temperatures reaching 70.6°C (159°F), increasing the ambient outside temperature by 33°C (60°F). With this method, time and temperature thresholds were reached within 1 day to kill nematodes, plant pathogens, and most weed seeds. Most days exceeded the threshold unless there were afternoon rains for an extended time. This method demonstrates that medium can be sterilized and recycled with solarization at large capacities. It is only a matter of scaling-up to the size that can be effectively utilized. Our trials were done at a latitude of 36° 36' N, with daily temperatures that ranged between 20.7-33.6°C (69.3-92.5°F). It was not determined as to what range at higher latitudes the solarization would be effective, however, this could easily be tested in a small plot with the double tent method (Stapleton et al., 2000).

After 2 weeks in a greenhouse, the germination test of treated and untreated media produced some viable weed seeds compared to fresh, untreated soil. Three trays of newly purchased soil had zero weed germination. The solarized and non-solarized media averaged, respectively, 10.6 and 89 germinated weeds. Solarization reduced weeds by 88% compared to untreated, used media.

To enhance weed control an added step should be included which would hydrate used potting soil for about 14 days prior to solarization. Preferably, this should be done as a thin layer as in the solarization process. In fact, I recommend to prepare the soil for solarization then wet it for 2 weeks prior to wrapping the soil in plastic. This will allow for weed seeds to germinate prior to being solarized, thus eliminating weed seed that might be able to survive the heating process. Two small trials were done using this method with excellent results. All medium physical attributes did not change after treatment and soil chemical properties changed very little. Our test medium was a few years old, so fertilizer had long since been leached. This might not be the case if one uses fresh soil. Operationally, it appears that used medium will retain similar properties after the solarization process, except for pests. If using fresh soil with new, controlled release fertilizer — higher rates of nutrients can be released with elevated high temperatures.

Growth study

Among the different medium mix treatments 100:0, 66:33, and 33:66 (new soil: solarized soil) there were no significant statistical differences in viburnum height and width and 'Natchez' height (Table 1) (Steed, 2014). Hence, using solarized soil up to 66% of the soil mix caused no reduction of growth of these two woody plant species. This might not always prove to be the case depending upon the medium being used prior to solarization. Physical attributes of the medium are not greatly changed during the process of solarization so physical medium tests can be made on medium located in the pile to be treated. This will enable growers to determine the percentage of solarized soil that can be combined with new soil after the solarization process to grow plants. The on-farm cooperator used solarized soil and fresh soil (1:1, v/v) and had excellent results growing standard crapemrytle trees.

Table 1. Effects of large scale solarization on growth aspects of *Viburnum suspensum* and *Lagerstroemia* 'Natchez' (Steed, in press).

Treatment[1]	Measurement (in.)		
	Viburnum suspensum height	*Viburnum suspensum* width	*Lagerstroemia* 'Natchez' height
100:0	17.3 a[2]	29.5 a	66.1 a
66:33	21.1 a	26.9 a	66.8 a
33:66	19.9 a	24.9 a	65.6 a

[1]Proportion of new potting soil: solarized treated soil.

[2]Data are means calculated from three replications. Mean separation in columns by Tukey's HSD test, 5% level.

Cost of solarization

Costs for the large scale set up were $234 in materials and could be used for the entire solarizing season (Tables 2 and 3). Labor costs were $17 per solarization run, which included removing finished soil from the solarization pad. This also included costs of using a front-end loader at $65 h^{-1} as part of operating costs. Total costs per yard of soil was about $5 to treat used potting soil. This is a savings of about $39 m^{-3} ($30 yd^{-3}) of medium or about $108 per solarizing run with an estimated costs of $35 per yard used as the cost of fresh media. If soil was dumped directly into a solarizing pad material costs would break even in about 2.2 solarizing turns.

Table 2. Material costs for solarization project.

Materials	Costs ($)
3 plastic sheets	52.42
Pipes	150.00
Groundcover	31.20
Total	233.62

Table 3. Labor costs for solarization project.

Labor	Time (min)	Costs	Total vol.	Cost per yd^3
Tractor work $65 h^{-1}	10	$ 10.80		
hand labor $10 h^{-1}	35	$ 5.83		
		$ 16.63	3.56 yds	$4.67

A cable system could be used to suspend the top sheet of plastic, which would add an even greater cost savings to the system. In all likelihood, costs could probably be reduced to about $3 m^{-3} ($2 yd^{-3}) to treat media. We did not determine the longevity that the poly sheets could be reused with the system. We would be able get at least three turns of media and recoup the costs of all materials used each year.

MORE INFORMATION

To read more about this method here is a link to a factsheet. Methods and On-Farm Research Results 2013-2015. http://hillsborough.ifas.ufl.edu/documents/pdf/ornamental_production/A-Z_pubs/Soil_Solarization_Fact_Sheet.pdf

To watch a short presentation on the solarization process you can follow this link: http://hillsborough.ifas.ufl.edu/ornamental_production/videos.shtml.

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Literature cited

Stapleton, J.J., Prather, T.S., Mallek, S.B., Ruiz, T.S., and Elmore, C.L. (2000). High temperature solarization for weed control in container soil and potting mixes. Proc. California Weed Sci. Soc. *52*, 204–207. http://cwss.org/proceedingsfiles/2000/204_2000.pdf.

Stapleton, J.J., Wilen, C.A., and Molinar, R.H. (2008). Pest notes: soil solarization for gardens and landscapes. UC ANR Publication 74145. UC Statewide IPM Program (Davis, California: University of California). http://ucanr.edu/sites/Solarization/files/114635.pdf.

Steed, S.T. (2014). Developing a method for large scale solarization and recycling of used potting soil. Proc. Fla. State Hort. Soc. *127*, 194–195.

Steed, S.T. Solarized potting soil effects on growth of *Lagerstroemia x* 'Natchez' and *Viburnum suspensum.* Proc. Fla. State Hort. Soc. (in press).

Zinati, G.M., Bryan, H.H., and Codallo, M.M. (2002). Solarization as a potential approach for recycling wastes for potting media and as an alternative to methyl bromide for field-grown bedding plants. Proc. Fla. State Hort. Soc. *115*, 123–127. http://fshs.org/proceedings-o/2002-vol-115/123-127(Zinati).pdf.