Cleaning Used Media and Containers With Steam and Hot Water©

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INTRODUCTION

Over the past decade Heritage Seedlings production has moved significantly from a field operation to containerized production of both seedlings and grafts. High quality, expensive soilless media are readily available to facilitate this transition. So each year we found ourselves not only purchasing a mountain range of medium, but also producing one of used soil. We started with a very coarse mix and after a single growing season the structure of the mix was little changed. The mix would be perfectly functional for another year of our needs, but intuitively we knew the cast-off media were unusable. Like most nurseries there are weeds in our production system, though we wish there weren't. We work hard to remove them, but the used mix has weed seed in it and is a source for the next generation of nursery weeds; that's not something we wanted. Additionally, there were other problems that made a switch to using recycled potting media impossible.

Because we germinate seed in baskets of medium, we had a concern about dormant seed germinating the following year and potentially contaminating new seed lots. This would be a particularly dangerous problem with lots of source identified seed used for their specific genetics. Another of the obstacles to overcome was sudden oak death (SOD). During the same time period we began participation in Grower Assisted Inspection Program (GAIP), Oregon's pilot program aimed at preventing SOD in nurseries. This program forbids planting host and associated plants (HAP) in recycled media unless it is cleaned of potential *Phytophthora ramorum* spores through composting or steaming. Composting, though socially appealing, just wasn't a viable option for us. And the last problem was our medium mixing system: it required a change from switch controls to a computer so we could use all the hoppers simultaneously, mixing new and used soil by proportion.

STEAM TREATING USED MEDIA

The particular approach we took to recycling our medium is steam treatment. Accomplishing this required the purchase of a steam generator, in our case a Steam Flo manufactured by the Sioux Corporation. It is completely self-contained; all we had to do was hook up a hose and plug it into an outlet and we were generating steam. The larger job was constructing a trailer and piping system for the steam and the medium but even that was made to seem easy by our more than capable fabrication specialist, Mike Heater. He built a 10-yd dumping trailer with a steel manifold, four 3-in. pipes raised just above the floor and automatic tail gate. There are holes drilled along the bottom of the pipes, directing the steam down, every 12 in. The engineers at Sioux were very helpful answering design questions along the way.

We grow our crops in baskets of medium and to harvest we mechanically shake the media from the roots. That used medium is stockpiled about as close to the generation point as we can get it, and now equally close to the steam generator. Later,

when we begin planting we load the used soil into the steaming trailer, leveling the load with the tractor bucket (we are very careful to not cross contaminate the clean or new soil with equipment that has been into the used pile or the field where there are weed seeds or potential pathogens). Loading the trailer makes a huge mess and we have to make a point of cleaning off all the exterior trailer parts that can accumulate dirty medium, that is, medium contaminated with weed seeds that won't get steamed, but will fall from the trailer at dumping. This step is very important. We park the loaded trailer next to the steamer. It just so happens to be on a slight hill which works in our favor as there is a lot of water generated in the steaming process and the hill serves to drain it away a little quicker from the trailer than a flat parking space would. The Steam Flo is turned on and during cooler winter and spring weather we know we need to come back and start checking in about 3 ½ h.

For the GAIP program we are required to hit 50 °C for 30 min. But because our main goal is killing weed seeds, we shoot for 80 °C for 30 min. The trouble with our trailer (I think really with all soil steaming in a pile) is that the bottom is hot fairly soon while the top is cold for a long time. So, by the time the top of the trailer's load has been 80 °C for 30 min the bottom is really well done. We measure temperature with a 20-in. soil thermometer and a digital thermocouple. Because the medium density is not consistent in a load, the heat doesn't necessarily transfer evenly. However, we measure the load temperature in no less than six locations. On more than one occasion we have found a pocket of "cold" soil that took much more time than the surrounding soil.

We turn off the generator and disconnect it as soon as we know the soil is hot enough. The equipment is quite safe to handle while hot, there are no pressure concerns, and then we dump the medium. We have found that waiting to dump the medium is a mistake because it tends to hang up in the trailer a lot more. Ideally we could steam during the summer months as the work load is a little less crushing and there is a lot less tractor competition, but we don't have a very large concrete slab to accumulate soil. Cleaned soil must not be stored on the ground as that could contaminate it with pathogen spores and new weed seeds.

We know this system works because there are no weeds in the soil and no stray seedlings emerging. There really haven't been any problems with this system. We haven't had issues with salts in this steamed medium nor has it adversely affected medium porosity; however, I expect the condition of the medium to change as we recycle it again this year. We will have to make multiple mountains segregated by age in order to deal with this. Currently we incorporate the steamed medium as a 50% component in our coarse planting mixes.

Critical Control Points. Soil steaming is only one of several critical control points for weed control in the nursery; media, containers, water, and the production spaces are the others. Our water sources are pure, surface water sources are tested monthly, four times during the irrigation season, and the medium we purchase is weed-free and we can apply herbicides and use ground cloth to prevent weeds in the growing areas. Once we started to steam recycled medium that left but one weak point in our production system, the containers we plant into because, just like recycled media, we reuse containers over and over for many years.

Reusing our containers over and over became a nightmare situation. It felt good on the front end, but it would leave us very sleepless on the other. The weeds would

germinate simultaneously with the crop and the only thing we could do about it was plan the weeding labor or give up. We couldn't fix the problem of weed seeds sticking to the container wall with a homemade high-pressure flat washer and chemical cleaning had too many environmental concerns. Finally, we settled on steam and hot water treatments for cleaning our containers too.

HOT WATER DIP

At auction we purchased a hot water bath manufactured by Nothern (no longer in production) for the forestry industry where they commonly reuse their Styroblock® trays. This tank has thermostatic control. We run it at 76 °C and dip the trays for 10 min. This dip is a little longer than necessary if the temperature is really 76 °C, but to be sure we have good heat transfer into a dense stack of trays. This time works well for us to get other work done. We can dip a half pallet of trays at a time.

STEAM TREATING CONTAINERS

To steam our trays and heavier walled containers we purchased a used refrigerated shipping container (aluminum lined walls) and a Siebring Steamer. We can load and unload this unit with a forklift. The Siebring steamer is designed to treat only a couple of yards of soil at a time; it may be undersized for the shipping container but it works really well on the baskets as they don't have as much mass as occupied space. We run the system until the internal air temperature is 80 °C and then we turn the Seibring off. There is no thermostatic control on this machine and our truck can get so hot inside as to melt thinner walled polystyrene planting containers!

Both the hot water bath and steam truck do a great job, though they are a little more labor intensive than soil steaming. They are generally embraced by the staff. The only drawback to cleaned containers is that they look just like dirty ones. We attach ribbons to clean stacks and store them in designated areas, but even then there are mix ups as evidenced by an odd tray covered in weeds in an otherwise clean crop.

After a couple years of tray cleaning, you may ask if we will reduce the weed pressure enough to draw back from 100% cleaned trays. The answer is probably not. We still have weeds in our nursery, but now only a few and we can manage them.

QUESTIONS AND ANSWERS

John Low: I had a question about the hot water dip. Your plug trays are all nested together. What kind of penetration into the core of the stack did you see?

Eric Hammond: It penetrates in quite quickly. In my tests 3 min will work, but we go for a full 10 min to be sure. What we did find though is that the trays need to be upside-down. Our trays, and I imagine all trays, have a lip that can catch air and the air can't escape if they're right-side-up.

Bob Lovejoy: Is the steam saturating your soil with excess moisture?

Eric Hammond: Yes, it's very wet. The location where we steam is on a hill so that's very helpful for drainage. We don't have a large slab to stockpile soil.

Steve McCulloch: How has the steam changed the nutrient characteristics within the soil?

Eric Hammond: There has been some change; however, it's difficult for me to quantify. Generally speaking though, we're very satisfied with this solution.

Douglas Justice: I have two questions about the steamed soil. The first is, do you anticipate after doing this for 3 or 4 years that you'll have so many fines that you'll have to reduce the percentage? The second question is, are you concerned the high temperatures you're using are killing beneficial microorganisms?

Eric Hammond: Those are very good questions I've thought a lot about. I'll answer the second one first. I don't think our 10-yd trailer is the most ideal way to steam soil. I think the best way to do it would be to use a mixing machine that steams it very quickly and will also be more efficient. However, it's another moving part and another motor to break which concerns me. We inoculate all of our soils with mycorrhizae. As for the fines...I dread having to store another pile of soil, but I don't see any other way around it.