GROWING KNOWLEDGE

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Here comes the sun

Researchers continue to evaluate soil solarization as a weed management technique

BY CAROL MALLORY-SMITH, JENNIFER PARKE AND NAMI WADA

IN 2017, NURSERY AND greenhouse producers added $947.7 million to Oregon's economy, according to the Oregon Department of Agriculture.

And for this very valuable Oregon industry, and all agricultural systems, weeds are a major issue impacting bottom lines. Weed control is often rated as the most expensive cost in field production.

There are few herbicides that can be used in nursery crops, so hand weeding is often required, with an estimated cost of $900 to $3,380 per acre, per year. Labor shortages also contribute to the problem (see **www.diggermagazine.com/may-2016/**).

One of the main reasons there are so few herbicides registered for use in nursery crops is the diversity of the nursery species being produced. It is difficult to identify a herbicide that can be used on such a wide variety of crops (without causing injury).

In addition, the economic risk for a pesticide company to register a herbicide for use on high-value crops such as nursery stock limits the number of herbicides available. Soil fumigants — which were once widely used in the nursery industry — also reduced the weed seed bank, but buffer restrictions and environmental concerns have reduced their use.

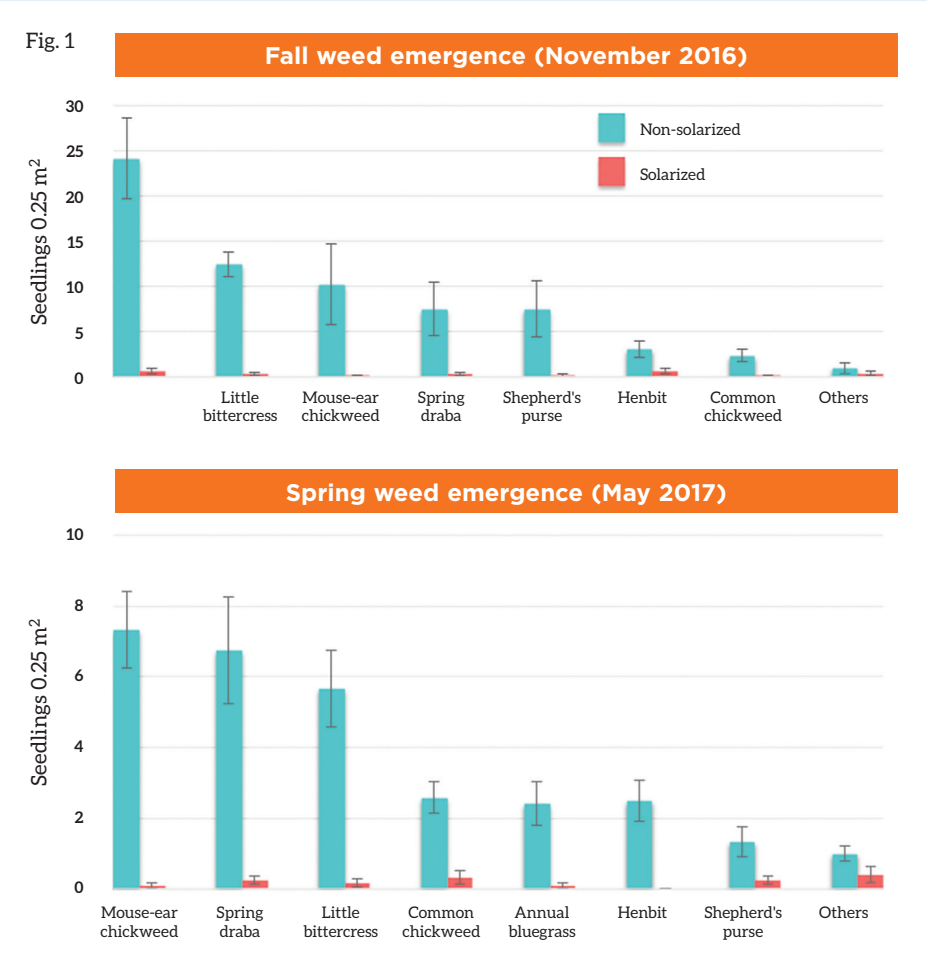

Fig. 1. Fall and spring weed emergence in the Clackamas Co. nursery after soil solarization in summer, 2016.

What is soil solarization?

Soil solarization is a pre-planting technique in which clear plastic is laid over fallow soil to heat it with solar radiation. The increased soil temperatures can kill certain soilborne pathogens as well as weed seeds.

Soil solarization has been used successfully in Israel, Spain, and California, where hot and sunny conditions exist. Less is known about the effectiveness of this technique in the Pacific Northwest, where environmental conditions are more variable.

OSU soil solarization trials

The Western Sustainable Agriculture Research and Extension (W-SARE) program funded a project by Oregon State University (OSU) plant pathologist Jennifer Parke, weed scientist Carol Mallory-Smith, and soil

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Fig. 2. Comparison of weed emergence in May, 2018 at the Clackamas Co. nursery 9 months after the solarization trial. Beds were solarized for 6 weeks or were not solarized. Seeds of Mazzard cherry were sown in fall, 2017.

physicist Maria Dragila to determine the effectiveness of soil solarization for managing weeds and soilborne pathogens in tree seedling nurseries in the Pacific Northwest.

Solarization trials were conducted in two Oregon commercial horticultural nurseries, one in Clackamas County and one in Yamhill County, during the summers of 2016 and 2017. In all experiments, we used 1.5-mil anti-condensation, infrared-optimized clear plastic (C-790, Ginegar Plastics, Inc., Santa Maria, California).

In one experiment conducted at both sites for both years, beds 4 feet wide by 100 feet long were solarized for six weeks or non-solarized (left uncovered). There were three replicate beds per treatment. Soil temperature and soil moisture at 2-inch and 6-inch depths were monitored throughout the trials, as were solar radiation and air temperature.

All remaining weeds were killed or removed in preparation for planting seeds of Mazzard cherry or apple in the fall. We took fall weed emergence counts six weeks after planting and in the following spring after the tree seedlings emerged.

The time needed for the nursery's laborers to hand-weed each bed was recorded. Data was collected on weed seed packets buried in the beds, as well as soil-borne pathogens, soil nutrients, soil microbial communities, and crop parameters (stand density, stem caliper, and height),

but these results will be reported in subsequent *Digger* articles.

Results

Fall and spring weed emergence were reduced in solarized beds as compared to non-solarized beds.

In fall, emergence of the most common weeds was significantly reduced by soil solarization. These species included annual bluegrass (*Poa annua*), little bittercress *(Cardamine oligosperma)*, mouse-ear chickweed *(Cerastium vulgatum)*, spring draba (*Draba verna)*, and shepherd's purse *(Capsella bursa-pastoris)* (Fig. 1).

Weeds were then removed by hand from all plots. A similar spectrum of cool season weed species were observed in spring (Fig. 2).

There were significantly fewer weeds in solarized vs. non-solarized plots in both locations and years. In 2018, both nurseries kept track of time required for crews to hand-weed each plot. Data were collected for the growing season (May through August) until the trees were harvested.

At the Clackamas County location, total season-long hand-weeding times in 400 square feet non-solarized plots averaged 53:01 minutes as compared to 24:11 minutes for solarized plots — a reduction of 54 percent. At the Yamhill County nursery, total weeding time was reduced from 15:52 to 7:34 minutes (52 percent) (Fig. 3).

A second experiment addressed how soil moisture and the duration of solarization affect weed emergence. This experiment was conducted for two years at the Clackamas County nursery. Nursery beds 4 feet wide by 50 feet long were either not solarized, or were solarized for three, six or nine weeks. Initial soil moisture was adjusted with drip irrigation to achieve low, medium, high, or very high soil moisture conditions. There were four replicate beds for each duration and soil moisture combination.

The effect of soil moisture and the duration of solarization differed between years. Data from 2016 (Fig. 4) indicated that at low and medium soil moisture levels, solarization for at least six weeks was required for reducing weed emergence, while with »

Fig. 3. Average total time required to hand weed 400 sq. ft. beds that were nonsolarized or solarized in 2017. Asterisks indicate statistically significant differences.

Fig. 4. Fall weed emergence after the 2016 soil moisture and solarization duration trial.

Fig. 5. Soil solarization at J. Frank Schmidt and Son, Co.

high or very high soil moisture conditions, 3 weeks was sufficient.

These results support other research showing that weed seeds are more sensitive to heat damage when seeds are moist. In 2017, which was warmer and sunnier than 2016, a three-week solarization period was sufficient to reduce fall weed emergence regardless of soil moisture level.

Variation in initial soil moisture and soil temperatures from year to year may explain these differences. The results suggest that adequate soil moisture and longer durations help ensure solarization effectiveness under suboptimal conditions. Controlled experiments are underway to examine the interaction between soil moisture and temperature on specific weed species as well as plant pathogen species.

Sunny days ahead

Experiments like these allow us to determine optimal conditions for soil solarization in the Pacific Northwest, where summers are shorter and cooler than in California. To help growers determine the best time to solarize and the length of time necessary for their location, they can access the OSU soil solarization program at **http://uspest.org/soil/solarize.**

Initially developed to predict soil solarization effects on soilborne *Phytophthora* spp., additional soilborne pathogens and weed species are being added to the program. Growers will be able to select their target species and determine if it is feasible to use solarization as a management tool in their cropping system.

Drawbacks to soil solarization include the initial cost of equipment (around $6,000) for laying the plastic on a large scale, the cost of the plastic itself (approximately $490 per acre, for beds only) and environmental considerations associated with the manufacture and disposal of plastic. Fortunately, solarization film can be recycled into agricultural plastics.

Benefits of soil solarization include a reduced need for herbicides and reduced labor costs for hand-weeding, a reduced need for tillage (which should improve soil quality over the long term), and improved crop growth. If soil were solarized every few years, we expect to see a long-term reduction in the weed seed bank requiring fewer management inputs in the future.

Soil solarization will not solve every weed problem, but it offers an alternative management strategy that could be useful in cropping systems with a summer fallow period of at least three weeks.

Soil solarization appears to be an especially good fit for fall-planted nursery crops in Oregon (Fig. 5). One of the state's largest producers of shade, flowering, and specialty ornamental trees, J. Frank Schmidt & Son, Co. now routinely solarizes 100 percent of their fall-planted seedling beds.

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Fig. 3

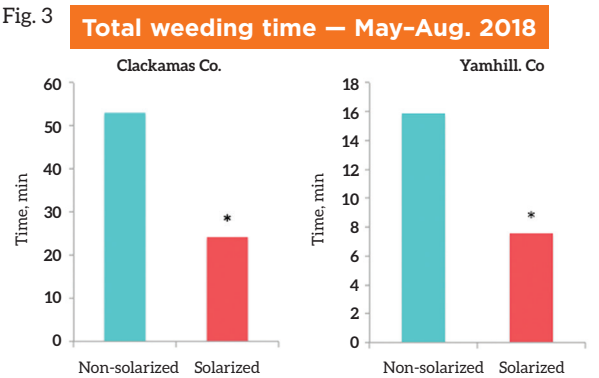

Fig. 4

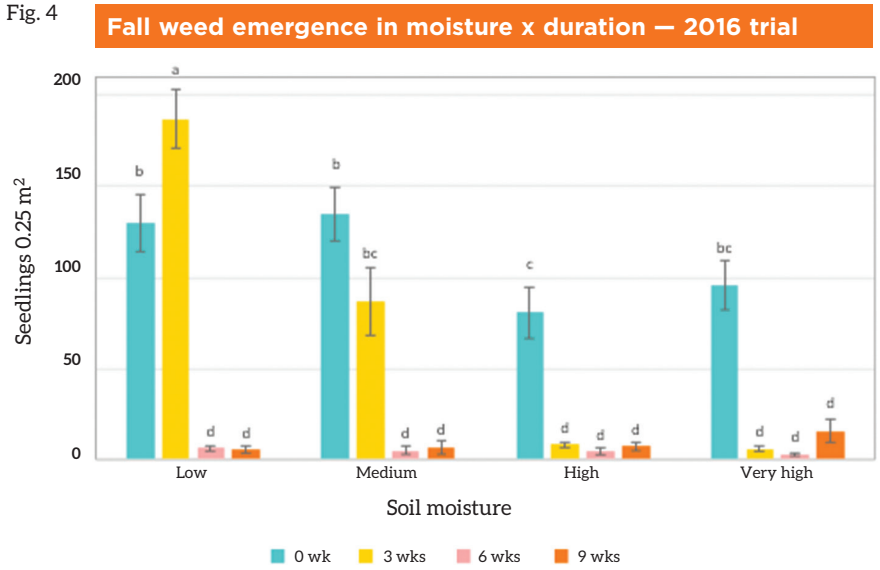

Fig. 5