Greenhouse Solarization — An Alternative to Chemical Fumigants©

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Chemical fumigants such as Basamid and methyl bromide are becoming increasingly restricted. Reports of their eventual removal from the tool chest of growers continue to swirl and appears imminent. Their use creates chemical and employee conflicts with lengthy re-entry intervals in greenhouses and concerns about the possible health risks to applicators, employees, and the public alike. Suspicion of the environmental hazards of such material is frequent and concerns can arise quickly when "marine pollutant" is stated on the Basamid label. The use of steamers, while effective, can be expensive and difficult to implement on a large scale. Alternatively, greenhouse growers who propagate in beds may find solarization as an effective, nonchemical means of sterilization.

Capturing the sun's radiant energy to control or suppress weed seeds and soilborne pathogens has long been a tool by farmers throughout the world. As far back as 1939 farmers in India were trapping the sun's heat to control *Thielaviopsis* in the sand. Other work was presented to the Phytopathological Society of Israel in February 1975. In 1976 California scientists at U.C. Davis reported control of *Verticillium* in cotton with solarization techniques. Many California pistachio farmers relay on solarization to control *Verticillium* today. With an increasing interest in organic production and the shift towards more environmentally conscious farming, solarization has gained popularity and is continuing to pique the interest of many growers.

Bailey Nurseries, Inc., began using solarization or "hydrothermal soil disinfestation" to trap solar radiation in our Minnesota greenhouse beds sufficient for the control or suppression of weed seeds and soil borne diseases. Investigating and employing this method of greenhouse sterilization proactively addresses the issue of chemical fumigant availability, its costs and the concerns of employees, and environmental exposure before EPA restrictions prevent or severely limit their use.

After the greenhouses are emptied following the spring bedding plant season, ground cloth is removed from the sandbeds and prepared for the propagation of softwood cuttings (June, July, and August). Sandbeds are leveled, watered thoroughly, and then covered with a single sheet of transparent, 3-ml infrared polyethylene plastic (AT Films Inc., Edmonton, Alberta, Canada). Placing the plastic as close to the surface of the propagation beds ensures better heating of the bed and not a layer of air in between the bed and the poly. Sufficient moisture within the propagation beds is helpful for two reasons. Heat is transferred more efficiently through wet soil than dry soil, and many weed seeds can be heat resistant when dry. Imbibing these seeds and initiating the germination process can make them more vulnerable to the solarization process. When this has been completed all vents, air intakes, and doors are closed tightly for a minimum of 2 weeks; preferably longer. Successful solarization is achieved by exposing weed seeds and soil-borne pathogens to temperatures and exposure times sufficient for their inactivation. Lengthening the time in which the greenhouses remain closed increases the likelihood of sunny weather

and increases cumulative temperatures within the sandbeds. Higher temperatures within the propagation beds are more dependent on bright, sunny days than by warm outside temperatures. When the desired high temperatures and exposure times have been recorded the house is opened and the poly covering the sand beds is rolled and stored for future treatments. We expect a single sheet of poly to be useable for approximately four to five times before light transmission and physical integrity are compromised. Unlike chemical fumigants there is no re-entry interval to observe and planting can begin immediately.

When done correctly the amount of weeds that grow and incidence of soil-borne diseases during the season appears similar to those that escape our Basamid treatments. The most common soil-borne pathogens that we are targeting are *Phytopthora, Rhizoctonia*, and *Pythium*. We have not seen an increase in plant heath problems in houses that have been solarized. The common weeds we are targeting in Minnesota are hairy bittercress (*Cardamine hirsute*), purslane (*Portulaca oleracea*), various grasses, prostrate spurge (*Euphorbia maculata*), and common groundsel (*Senecio vulgaris*). Patterns of weeds growing after solarization have occurred where shadows were cast on the sand beds. Lines of seedlings have been observed below cooling tubes, knee walls, and greenhouse ends. Covering every area within the greenhouse and to removing any cooling tubes and/ or other features inside the house that restrict the transmission of light to the beds has limited these escapes. Effective soil solarization is dependant on the combination of soil temperatures and exposure time. Examples reported by Jarvis (1992) include: Most bacteria 60–70 °C for 10 min, thermotolerant bacteria 90 °C for 30 min, *Phytophthora* 50 °C for 30 min, *Pythium* 53 °C for, 30 min, and most weed seeds 70–80 °C for 15 min.

Using sensors has given us a much better view of the temperatures we are getting underneath the poly. We placed data loggers (Watchdog Data Loggers, Spectrum Technologies, Plainfield, Illinois) directly underneath the poly and approximately 2 in. beneath the surface of the sand. Temperatures were recorded every 6 min for 2 weeks and are presented graphically below (Fig. 1). Because effective soil solarization is dependant on reaching adequate soil temperatures for certain lengths of time, it is important to understand when temperatures sufficient for controlling weed seeds and soil-borne pathogens have been achieved (Fig. 1).

Geography and time of year may reduce the likelihood of successful solarization in the greenhouse. Latitude will affect average daily temperature as well as day length. Local weather, including the percent of days with cloud cover, can be factors that may limit this as a viable technique for growers. Achieving temperatures in a Phoenix greenhouse during the month of April is probably more realistic than during the same time in Seattle.

Bailey Nurseries, Inc. is committed to understanding how solarization fits into the control of weed seeds and soil-borne pathogens in the greenhouses. Following the steps described above has shown us that it is a tool in which we can safely, economically and repeatedly use to control or suppress weed seeds and soil-borne pathogens in our greenhouses during the summer, similar to chemical fumigants. Restrictions on these chemicals are becoming stricter. It is expected that in a short time these tools will no longer be ones that are available to us. There is a great need to develop and refine alternative options for reducing weed seeds and soil-borne diseases in the greenhouse; solarization just may be that option.

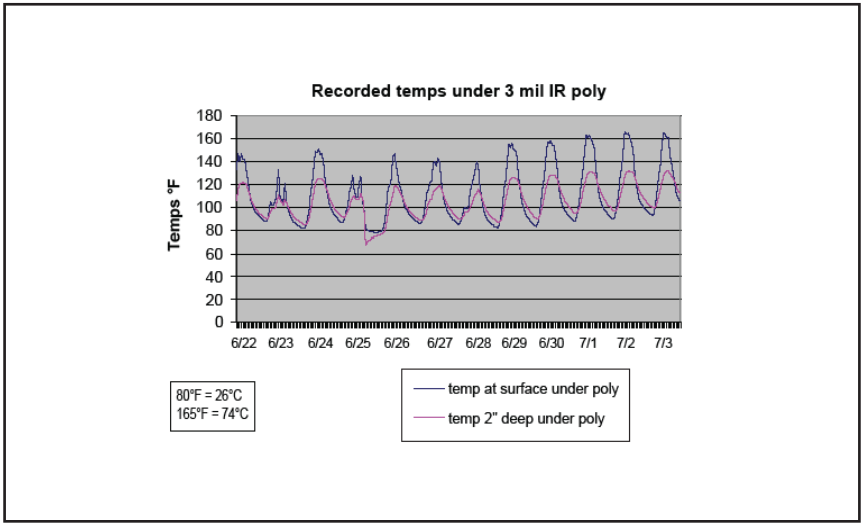

Figure 1. Temperatures recorded over a 2 week period.

LITERATURE CITED

Jarvis, W.R. 1992. Managing diseases in greenhouse crops. Amer. Phytopathol. Soc. Press, Inc., St. Paul, Minnesota.