A LARGE-SCALE DEMONSTRATION OF SOLAR INACTIVATION OF INVASIVE WEED PROPAGULES FOR REVEGETATION WITH CALIFORNIA NATIVE WILDFLOWER COMMUNITIES

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ABSTRACT

In warmer climates, solarization, a technique comprised of physical, biological, and chemical elements, may be useful for disinfesting soil of invasive weed propagules in native plant communities. During August-October 2004, the effectiveness of solarization for this purpose was demonstrated at the Fay's Wildflower Meadow area of the Rancho Santa Ana Botanic Garden in Claremont, CA. Of the 14 weed species documented in the area, only *Anagalis arvensis* (scarlet pimpernel) was not controlled or eradicated with solarization. This demonstration confirmed the utility of solarization as a tool for assisting native plant revegetation.

INTRODUCTION

The preservation of native flora is desired in many settings, including wildlands, various types of managed or semi-managed landscapes, and nurseries. In many cases, weedy, invasive plant species threaten or encroach on native flora, causing unwanted competition, poor aesthetics, environmental stress or toxicity, and other undesirable effects. There are many weed control strategies available for use in ecological restoration. In warmer climates, one or more of the solar inactivation (solarization) techniques for nonchemical destruction of soilborne weed propagules may be useful. Solarization may be done both in open field areas and in containerized nursery settings (California Department of Food and Agriculture, 2002; Stapleton et al., 2002). Modes of action of solarization include physical, biological, and chemical components (Stapleton, 2000). Biological control mechanisms are commonly observed, particularly when pest propagules are subjected to sub-lethal heating, followed by microbial colonization of weakened or damaged tissues (Stapleton, 2000). In California, solarization is particularly effective for control of winter annual grasses (Elmore et al., 1997).

The Rancho Santa Ana Botanic Garden (RSABG) in Claremont, CA is the largest and most diverse preserve of strictly California native plants in the world. At the Fay's Wildflower Meadow area near the Garden entrance, a noxious complex of invasive weeds, particularly winter annual grasses, had developed and was destroying the aesthetics of the California native annual wildflowers planted there each year. Due to the heavy and constant flow of visitors through the Garden, it was decided that chemical herbicides and fumigants were not a viable option for disinfesting the area of weed propagules. This paper describes the employment of solarization for revegetation of California native flora in Fay's Wildflower Meadow.

MATERIALS AND METHODS

The weed species present in Fay's Wildflower Meadow included *Cardamine oligosperma* (popweed), *Chamaesyce maculata* (spotted spurge), *Stellaria media* (chickweed), *Erodium cicutarium* (red stem filaree), *Conyza canadensis* (horseweed), *Galium parisiense* (bedstraw), *Anagalis arvensis* (scarlet pimpernel), *Senecio vulgaris* (common groundsel), *Medicago sativa* (bur clover), *Poa annua* (annual bluegrass), *Vulpia myruos* (rattail fescue), *Bromus madritensis* var. *rubra* (red brome), *B. diandrus* (ripgut brome), and *B. tectorum* (cheat brome).

As a method of reducing weeds for revegetation with annual native species, solarization of open ground was done. In August 2004, the entire Garden area of ca. 0.5 ac was prepared by removing all plant material and surface debris, mechanically tilling soil to a depth of 8 in., raking the soil smooth and pre-irrigating to ca. 8 inches depth with sprinklers. A single layer of transparent, UV-inhibited polyethylene film was then laid by hand in 72 inch-wide strips, with sand placed on the seams to create a solid barrier during the solarization process. The solarization treatment was conducted during August-October 2004. Soil temperatures were periodically monitored at a 6 inch depth using a soil thermometer. The film was then removed after an 11 week treatment period, and a mixture of native wildflower species, including *Lupinus succulentus* (arroyo lupin), *Clarkia amoena* (farewell to spring), *C. bottae* (punchbowl godetia), *Gilia capitata* (globe gilia), *G. tricolor* (bird's eyes), *Nemophila maculata* (fivespot), *Nemophila menziesii* (baby blue-eyes), *Eschscholzia californica* (California poppy), *Layia platyglossa* (tidy-tips), *Lasthenia californica* (goldfield), and *Castilleja exserta* (purple owl's-clover), were seeded in November 2004. Observations of weed and wildflower emergence and growth were periodically made during spring and summer 2005, and emergent weeds, when encountered, were removed by hand.

RESULTS

Visual observations made during spring-summer 2005 indicated that the solarization treatment was successful at reducing or eradicating all weed species present, with the exception of *A. arvensis* (scarlet pimpernel). The observations indicated that the native California wildflower population benefited by the reduction in exotic weeds, and the desired ambience of Fay's Wildflower Meadow was greatly improved (Jett, 2005). Soil temperature that was measured with a thermometer with a 6 in. probe inserted under the plastic during the solarization process, demonstrated a fairly consistent temperature, ranging between 101 – 106^{o} F throughout the length of the treatment.

DISCUSSION

The effective heat dosage for weed propagule destruction during solarization is a relationship of (temperature x time), and varies among species (Elmore et al., 1997). Advantages of solarization include ease of application and use, low cost, nonhazardous, and the elimination of the need for potentially hazardous or synthetic pesticides. Limitations include climatic and local weather conditions needed to sustain the required high temperatures, shading of the treated area, soil depth constraints, resistant weed propagules, possible mechanical damage to film and need for plastic disposal, and requirement for moist soil for best treatment effect (Stapleton, 2000; Stapleton et al., 2005). For resistant or deeply-distributed weed propagules, the solar techniques can be augmented by combining with other biological or chemical treatments (Elmore et al., 1997; Stapleton, 2000).

The successful demonstration of solarization for restoration of California native flora at RSABG has led to plans for expanded restoration work in 2006. An area of ca. one ac of alluvial soil currently infested with *Marrubium vulgare* (horehound), *Urtica urens* (stinging nettle), *Hirschfeldia incana* (short-pod mustard), *Brassica nigra* (black mustard), *Eremocarpus setigerus* (turkey mullein), *C. maculata* (spotted spurge), *Chenopodium album* (common lambsquarters), and *Amaranthus retroflexus* (redroot pigweed) will be disinfested with this technique.

This large-scale demonstration of solarization confirmed its utility as an option for non-chemical weed abatement preceding revegetation with native plant species. Solarization can be of value as a pest management tool in many parkland, urban greenbelt, and resource preserve settings.

REFERENCES

California Department of Food and Agriculture. 2002. Approved treatment and handling procedures against nematode pest infestation of nursery stock. Nursery Inspection Procedures Manual, NIPM Item 7. Plant Health and Pest Prevention Services, Pest Exclusion Branch, Sacramento. Available at URL: http://www.cdfa.ca.gov/phpps/pe/nipm.pdfs.nipm_7.pdf

Elmore, C.L., Stapleton, J.J., Bell, C.E., and DeVay, J.E. 1997. Soil solarization: A nonpesticidal method for controlling diseases, nematodes, and weeds. DANR Publication 21377, University of California, Oakland. 14 pages.

Jett, S. 2005. Solar power brings meadow blooms. Friends of the Rancho Santa Ana Botanic Garden Newsletter 20(2), 5.

Stapleton, J.J. 2000. Soil solarization in various agricultural production systems. Crop Protection 19, 837-841.

Stapleton, J.J., Prather, T.S., Mallek, S.B., and Ruiz, T.S. 2002. High temperature solarization for production of weed-free container soils and potting mixes. HortTechnology 12, 697-700.

Stapleton, J.J., Molinar, R.H., Lynn-Patterson, K., McFeeters, S.K., and Shrestha, A. 2005. Soil solarization provides weed control for limited-resource and organic growers in warmer climates. California Agriculture 59(2), 84-89. Available at URL: http://californiaagriculture.ucop.edu/0502AMJ/pdfs/Solarization.pdf