**Solarization and biofumigation for field-grown flowers**

C. L. Elmore, J. Roncoroni, J. MacDonald, L. Bolkin, I. Zasala, H. Ferris and S. Tjosvold

Weed Science Program, Department of Plant Pathology, Department of Nematology, University of California, Davis, CA 95616 and Farm Advisor, Santa Cruz Cooperative Extension, Santa Cruz CA 95076

Soil solarization has been proven to control pest organisms in many locations around the world. Biofumigation is a relatively new method of using biomass from Brassicaceae family plants to reduce pests in soil. Broccoli, a member of this family has been shown to affect soil pathogens and nematodes after cultivating the harvest residue into soil. In initial field studies, weed seedlings and tubers of Zantedeschia sp. have been suppressed. The objectives of these studies were to evaluate soil solarization with or without additives of broccoli (Brassica oleraceae) in microplots and field tests. Determine if additions of broccoli could increase soil temperature under soil solarization and thus improve pest control with the combination of treatments. These treatments were compared to a treatment of clear bubble wrap with clear polyethylene or chopped and rototilled or spaded broccoli at 5 or 15 cm in depth. Two study sites were selected in the Central Valley of California at Davis and one on the central coast near Watsonville, CA.

Methods: Study 1.
This study was conducted about 100 yards from the Pacific ocean, preplant to *Zantedeschia aethiopica* (white calla) bulbs, with the primary weed being the rhizomes of the calla lily. The soil was cultivated, then 1.2m inch bed-top beds were formed. Soil pathogens *Fusarium oxysporum*, and *Rhizoctonia solani* were placed into satchets and buried at 5, 15, and 30 cm depth. Where broccoli was applied the sachets were buried after spading in the freshly chopped broccoli. The broccoli was harvested from crop residue after floret harvest and was chopped using a commercial chopper/mulcher. Temperature was measured using Onsett Stowaway microloggers and an external thermistor buried at 5,15, and 30 cm depth. Three one-foot wide strips of large bubblewrap was placed on the bed and a single layer of 1.1 mil polyethylene was pulled tight over the treatments. A clear tarp was used as a solarization control as well as an untreated block. All treatments were replicated four times in a randomized complete block design.

Study 2. This study was established in microplots using 76 L plastic pots at Davis. The pots were buried to 16 inches, soil was filled in the bottom until 30 cm depth from the top. Pest organisms of *Convolvulus arvensis* (field bindweed), *Amaranthus retroflexus* (rough pigweed), *Malva parviflora* (Cheeseweed), *Portulaca oleraceae* (common purslane) and *Poa annua* (annual bluegrass), *Tylenchulus semipenetrans* (citrus nematode), *Rhizoctonia solani*, *Fusarium oxysporum*, *Sclerotium rolfsii* and *Verticillium dahlae* were placed on the soil. Similar back-filling occurred for 15 and 5 cm and then it

filled to the top. An equivalent of 0.5 acre inch of water was applied over the top with a sprinkler container. Broccoli was chopped using a commercial chopper/mulcher. When broccoli was applied as a treatment, it was mixed into the soil before placement into the pot to achieve a depth of either a 0-2 or 0-6 inch broccoli/soil mix to the top. Temperature was measured using Onsett Stowaway microloggers with an external thermistor at 5,15, and 30 cm.
The organisms were removed at intervals of 2, 4 or 6 weeks in the soil and returned to the laboratory for the appropriate analysis. All treatments were replicated four times in a completely randomized design experiment.

Study 3. This study was conducted in the field at Davis, CA. The soil was a clay loam with 2.1% organic matter. The soil was cultivated and 1.5m inch beds formed. They were pre-irrigated with sprinklers with 2 inches of water. The broccoli was either incorporated mechanically with a power tiller two directions or chopped with a spade and spaded into the top 5 cm of soil. Weed seed (*Amaranthus retroflexus*, *Poa annua*, *Portulaca oleraceae*, and *Convolvulus arvensis*) was spread onto the soil before incorporation of all plots. Soil samples for nematode community analysis were taken from each treatment. Three sheets of large bubblewrap were placed side-by-side then a clear tarp of 1.1 mil polyethylene was placed over all treatments. Soil pathogen or nematode samples were not placed in this study. All treatments were replicated four times in a randomized complete block design. Soil temperature was measured with Onsett Stowaway microloggers with an external thermistor at 5,15, and 30 cm depth. After removal of the tarps, the surface of the bed was knifed about 0.5 inch deep and planted to speedlings of *Clarkia amoena* (Godetia) and *Antirrhinum majus* (snapdragon).

Results: Soil solarization controlled greater than 90% of all weeds at 5 cm depth at Davis in the pot tests. Incorporation of broccoli in the top 2 or 6 inches of soil followed by tarping controlled more than 95% of all weeds at 5 cm after 2 weeks of treatment. Though broccoli residue plus solarization decreased weed seed germination at 15 and 30 cm, it was not as effective as metham as a standard treatment which gave complete control to 30cm depth. Similar results were obtained with pathogens and citrus nematode. Soil temperature was increased significantly with soil solarization and the addition of broccoli (part of this increase is probably due to the added moisture from 25 or more tons of fresh broccoli.

At the coastal site 5 dry tons of broccoli reduced the number of calla lily regrowing from rhizomes by 66% without significantly increasing soil temperature. Weeds were reduced with the combination of broccoli incorporated followed with soil solarization for 6 weeks.

In the Davis field site, rough pigweed, common purslane and annual bluegrass were controlled with the soil solarization treatments or with 35 T wet broccoli biomass either spaded into the top 5 cm of soil or rototilled into the top 13 cm of soil and covered with clear tarp for 6 weeks. Soil temperature was increased at the 5 cm depth from a maximum of 48 C to over 60 C. Soil temperature at 5 cm under clear polyethylene with 35T of wet

broccoli biomass spaded into the top 5 cm of soil was 70C. Temperatures at 15 and 30 cm were increased over the untreated soil, but not to the extent of the surface soil.