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Active Solarization as a Nonchemical Alternative to Soil Fumigation for Controlling Pests

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Deterioration of soil, water, and air resources by soil fumigants represents a serious threat to agricultural production in semiarid regions due to their high volatility and high emission rates. New pest control methods are needed that do not rely on fumigant chemicals. Soil heating via solarization has been proposed as a nonchemical alternative to soil fumigation but has not found wide acceptance due to limitations in soil temperatures and heating depth, especially in cooler environments. We have developed a new soil heating method, termed *active solarization*, to increase the soil temperature and heating depth in the root zone. An experiment was conducted to compare heating for bare soil, standard (i.e., passive) solarization, and active solarization methodologies. A cumulative heat stress index, CHT_{30}, was computed and has been shown to be related to plant-pest survival. After 15 d of heating, passive solarization increased at the 10- and 20-cm depths by 263 and 65°C h, respectively, compared with leaving the soil bare. For active solarization, CHT_{30} increased by 387 and 105°C h , respectively, compared with bare soil. After 30 d of passive solarization, CHT_{30} at 10 and 20 cm was 345 and 66°C h, respectively, and for active solarization CHT_{30} was 755 and 252°C h. The results indicate that active solarization increases soil temperatures and heat stress on plant pests. Based on published pest survival information, observed CHT_{30} after active solarization would provide better control of a plant pest (nematode) than passive solarization. Active solarization may offer a suitable nonchemical alternative to soil fumigation.

The availability of pesticides has been essential in the production of an abundant, nutritious, and low-cost food supply. The use of pesticides in agricultural production has also resulted in contamination of the atmosphere and soil and water resources. In particular, soil fumigants are highly volatile and are prone to rapid diffusion in soil. While this helps promote a uniform soil distribution and effective pest control, high volatility also leads to large atmospheric emissions (Yates et al., 2003).

Air emission inventories conducted in California have demonstrated that pesticides, and predominately fumigants, are a significant source of air pollution. In Fresno County from 1976 to 1995, about 17 Mg of pesticides were emitted into the atmosphere each day (Air Resources Board, 1978, 1997a,b). This represents 4% of the total organic gas emission and 16% of the reactive organic gas emission in this region. Ambient air quality problems caused by inappropriate application of an agricultural fumigant, 1,3-dichloropropene, prompted a 4-yr suspension in California between 1990 and 1994 (California Department of Food and Agriculture, 1990). Also, the agricultural fumigant methyl bromide was scheduled for phase-out in the year 2005 due to its potential for depleting stratospheric ozone (United Nations Environment Programme, 1992, 1995; Federal Register, 2000).

A primary environmental risk associated with the use of fumigants and other pesticides is the release of toxic volatile organic compounds into the atmosphere.

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