SOME CHEMICAL, BIOLOGICAL, AND CULTURAL ALTERNATIVES TO METHYL BROMIDE FOR STRAWBERRY

J. M. Duniway[a]*, J. J. Hao[a], D. M. Dopkins[a], H. Ajwa[b], and G. T. Browne[c]

[a]Department of Plant Pathology, University of California, Davis, CA 95616
[b]Dept. of Vegetable Crops, U. C. Davis, c/o USDA-ARS, Salinas, CA 93905
[c]USDA-ARS, Dept. of Plant Pathology, University of California, Davis, CA 95616

Chemical alternatives to methyl bromide were used in a replicated field experiment at a coastal site (Monterey Bay Academy) near Watsonville, CA. Strawberry had been grown for several years at the site and *Verticillium dahliae* and *Phytophthora* spp. were present in the soil. Starting mid-September, 2001, two-row beds were shaped, drip lines installed, and small cloth pouches containing soil with known populations of *V. dahliae* or vermiculite pieces of cultured *Phytophthora cactorum* were buried under plant row locations at four depths between 15 and 60 cm. Selected beds were subsequently fumigated with shank-applied methyl bromide/ chloropicrin (MBC) 67/33 at 325 lb/a (rates per unit treated bed area) and covered with standard black polyethylene mulch or clear virtually impermeable plastic film (VIF) (Hytibar, Klerk=s Plastics) overlaid with the standard black plastic. Chloropicrin at 200 and 300 lb/a and InLine (Telone C-35) at 283 and 425 lb/a were applied to beds under plastic in water emulsions through drip lines and there were nontreated controls. Inoculum pouches were recovered and five strawberry varieties were transplanted through the plastic mulch 4-6 weeks after fumigation. Conventional practices for annual strawberry production and pest management for the area were followed.

The use of VIF plastic as compared to standard plastic improved the control of buried inoculum of *V. dahliae* significantly where chloropicrin or InLine was used. The ranking of the five varieties used for the final incidence of plants with Verticillium wilt (low 15% to high 85%) on nontreated soil was Camino Real, Aromas, Diamante, Camarosa, and Ventana. Control of Verticillium wilt by InLine in the more susceptible varieties Camarosa and Ventana was superior to that obtained with MBC, especially where VIF plastic was used. Disease control by chloropicrin was generally less than that by MBC with standard plastic but was improved with VIF plastic. All fumigation treatments effectively controlled weed growth through plant holes in the plastic mulch.

The effects of fumigation treatments on berry yields varied with the time of harvest and variety. In general, the varieties giving the highest yields on MBC treated soil (Diamante, Camarosa, and Ventana) also had the largest yield responses to fumigation in comparison to non-fumigated soil. All the chemical fumigation treatments more than doubled total yields and the effects of the various chemical treatments on the yields of Camino Real, Aromas, and Diamante, were generally similar. For the variety Camarosa, the MBC treatment with VIF gave the highest total yield, while the lower rate of InLine gave the highest yield in Ventana. Ventana plants grown in soil treated with InLine at the higher rate tended to be more vegetative than those in other treatments. Additional research is needed to optimize methods of soil fumigation with chemical alternatives to methyl

bromide for some of the newer strawberry varieties in California.

As part of a large cooperative project, we also examined the effectiveness of various chemical alternatives to methyl bromide for controlling inoculum of *V. dahliae* and *P. cactorum* buried at several depths in field soils. Results will be presented for shank-applied nursery fumigations and drip-applied fumigations in berry production fields at several locations in California.

We are continuing to isolate bacteria from strawberry rhizospheres in fumigated soils that are beneficial when inoculated to strawberry transplanted into natural soils in the greenhouse (1,2). Recent isolates were tested for antibiosis in cultures with *Verticillium dahliae, Phytophthora cactorum,* and species of *Pythium, Rhizoctonia, Fusarium, Cylindrocarpon,* and *Colletotrichum* isolated from strawberry. Many bacteria, especially *Pseudomonas* spp. from rhizospheres, had antibiosis to one or more fungi, but few isolates inhibited *Pythium* sp. and *P. cactorum.* Among bacterial isolates, there was a correlation between antibiosis and growth promotion of inoculated strawberry in natural soil under controlled conditions. Bacterial growth promotion of strawberry following inoculation of bare-root transplants in the field was variable and depended on soil background treatment, strawberry variety and/or location, as well as isolate. Most of the inoculations of transplants in MBC-treated soils decreased yield, and none of the inoculations increased yield significantly in nontreated soils. In soils treated with chloropicrin (200 lb/a) or metam sodium, however, a few of the bacterial isolates increased plant growth and/or berry yield significantly.

Cultural methods for the management of Verticillium wilt in strawberry are also under investigation. In previous experiments, high-nitrogen organic amendments incorporated into nonfumigated soil several weeks before planting reduced the incidence of Verticillium wilt. In the 2001-2002 season, however, broadcast applications at only the highest rates used (i.e., 3 tons/a feather meal and 6 tons/a meat and bone meal) reduced Verticillium wilt development in the variety Aromas.

References Cited: 1. Xiao, C. L., and Duniway, J. M. 1998. Bacterial population responses to soil fumigation and their effects on strawberry growth. Phytopathology 88:S100 (Abstract). 2. Hao, J. J.,Duniway, J. M., Dopkins, D. M., and Xiao, C. L. 2002. Effects of rhizobacteria on inhibition of soilborne pathogens and growth of strawberry. Phytopathology 92:S34 (Abstract).
Acknowledgments: Research supported largely by the California Strawberry Commission, U. C. Sustainable Agricultural Research and Education Program, and CSREES-USDA.