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

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Chemical alternatives to methyl bromide were tested in replicated field experiments at a coastal site near Watsonville, CA. Strawberry was grown each year, *Verticillium dahliae* and *Phytophthora* spp. were present in the soil, and bed fumigation treatments were applied to the same ground in early October of each of the last 3 years. 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. Beds were subsequently fumigated and covered with standard black polyethylene mulch or black virtually impermeable plastic film (VIF) (Hytibar, Klerk=s Plastics). Shank-applied treatments included methyl bromide/ chloropicrin (MBC) 67/33 at 325 lb/a, chloropicrin at 200 and 300 lb/a, and Telone C-35 at 283 and 425 lb/a (rates per unit treated bed area). Treatments applied to beds under plastic in water emulsions through drip lines were chloropicrin at 200 lb/a and Telone C-35 (InLine) at 283 and 425 lb/a. Inoculum pouches were recovered and Selva was transplanted through the plastic mulch one month after fumigation. Conventional practices for annual strawberry production and pest management for the area were followed. Berries were picked for fresh market at least weekly for several months by normal grower practice.

Unlike the previous years when much higher levels of control were achieved, none of the fumigation treatments was fully effective in controlling buried inoculum of *V. dahliae* or *P. cactorum*. Although the results were variable, the use of VIF plastic as compared to standard plastic improved pathogen and disease control in some treatments. All fumigation treatments effectively controlled weed growth through plant holes in the plastic mulch.

Fumigation treatment effects on yield were also variable. For example, with standard plastic only MBC and shank applied Telone C-35 at 425 lb/a increased yield significantly; with the VIF plastic, Telone C-35 shank applied at 283 lb/a and InLine at 425 lb/a also increased yield. When all chemical treatments are considered, use of VIF plastic increased yield by an average of 30%. This VIF effect is similar to those obtained in 1997-98 and 1999-2000 when VIF mulch improved yields significantly in a variety of bed fumigation treatments, but differ from those obtained in 1998-99 when VIF effects were small. The results suggest that the use of VIF plastic rather

than standard plastic is more likely to be beneficial under marginal conditions for soil fumigation and/or with lower rates of fumigants.
As part of a large cooperative project, the effectiveness of various fumigation treatments at controlling inoculum of *V. dahliae* buried at several depths in field soil was examined. In shank applied nursery fumigations, a 50/50 mixture of methyl iodide and chloropicrin (350 lb/a) was as effective as the standard MBC at depths of 15, 30, 60 and 90 cm; chloropicrin (250 lb/a) and Telone C-35 (360 lb/a) followed by Basamid (250 lb/a) were also effective at 15 and 30 cm, but were less effective at depths of 60 and 90 cm. In berry production beds, drip applied chloropicrin (300 lb/a), InLine (400 lb/a), and methyl iodide/chloropicrin (400 lb/a) were nearly as effective as the standard MBC at depths of 15 and 30 cm, but were sometimes less effective at 45 and 60 cm. Drip applied propargyl bromide (180 lb/a) generally gave the most complete control of *V. dahliae* at all depths tested.

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). Bare-root runner plants were inoculated with some of these bacteria in the fall of 2000 and transplanted into field plots treated with MBC, chloropicrin (200 lb/a), or not treated. All of the inoculations in MBC-treated soil decreased yield. While only one isolate increased yield in chloropicrin-treated soil, three isolates did so in nontreated soil, and two reduced the incidence of Verticillium wilt. Periodic reinoculations during crop growth did not increase growth or yields over those obtained following one inoculation at transplanting.

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 2000-2001 season, however, neither blood, fish, nor feather meal applied to beds at 2-8 tons/a of treated area reduced Verticillium wilt significantly in the susceptible cultivar Camarosa in an experiment where disease pressure was high. Nevertheless, some of the amendments did increase berry yield. Repeated broadcast applications (i.e., ground treated once in 1999 and 2000) of blood or fish meal at 4 tons/a or feather meal at 3 tons/a before bed shaping reduced Verticillium wilt development during 2000-2001 without causing phytotoxicity in the less susceptible variety Aromas. Although current California strawberry varieties are all susceptible to Verticillium wilt, some (e.g. Camarosa) were significantly more susceptible and have a lower inoculum threshold for disease than others (e.g. Selva).

Reference 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).
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