Methyl Bromide Alternatives
FY 2001 National Program Annual Report

Introduction

The Methyl Bromide Alternatives National Program seeks to find alternatives to replace methyl bromide which is being phased out because of its deleterious effects on the ozone layer. Methyl bromide is one of the most important pesticides in the United States and the world. It is used to fumigate soil before crops are planted to control soilborne pathogens, nematodes, insects, and weeds. Tomato, strawberry, and perennial crop production rely heavily on methyl bromide soil fumigation for profitable crop production.

Methyl Bromide is also used to fumigate postharvest commodities to kill insects and other arthropods to protect product quality. Another postharvest use is as a quarantine fumigation treatment to allow movement of commodities that might accidently serve to move quarantined organisms to areas where they don't presently exist. Methyl bromide fumigation is required by many countries as a condition for the importation of certain crops that could carry new pests into their country.

Selected Accomplishments (Listed by Component)

Alternatives to Methyl Bromide for Preplant Soil Fumigation

Identification of a gene important in biocontrol of soil pathogens. A major impediment to widespread use of plant-beneficial bacteria in agriculture is inconsistent suppression of soilborne plant pathogens in different soil environments. The rpiA gene, from the plant-beneficial bacterium *Enterobacter cloacae*, was determined by ARS scientists at the Sustainable Agricultural Systems Laboratory, Beltsville, Maryland, to be important for colonization of seeds and roots and for suppression of the important soilborne plant pathogen *Pythium ultimum*. This is one of the first documented studies where a gene important for colonization and for disease suppression has been identified. Understanding how plant-beneficial bacteria colonize plants and suppress disease will allow us to develop strategies to enhance disease suppression and biocontrol performance.

Telone and chloropricrin replaces methyl bromide for perennial orchards. Tree and vine growers will likely lose productivity when methyl bromide is phased out between now and 2005 unless alternatives are found to control soil pests and reduce the effects of the "replant syndrome." Several methyl bromide alternatives were tested by ARS scientists at the Water Management Research Laboratory, Parlier, California, in replanted peach and plum orchards, vineyards, and grapevine nurseries. Emulsified formulations of alternative fumigants Telone and chloropicrin applied through subsurface drip irrigation systems produced tree growth equal to methyl

bromide. Vineyard replant plots remained virtually free of plant parasitic nematodes 3 years after treatment with drip-applied Telone or shank-injected iodomethane. This application method combined with these materials can provide growers an alternative soil treatment that provides control similar to that achieved with methyl bromide.

Alternatives to methyl bromide to meet nursery certification requirements. Methyl bromide is the primary treatment used by nursery growers to meet regulations mandating that materials grown for commercial plantings must be nematode free. A grapevine nursery field trial was conducted by ARS scientists at the Water Management Research Laboratory, Parlier, California, to determine efficacy and phytotoxicity associated with short plant-back intervals. Shank and drip applied iodomethane and propargyl bromide and drip-applied sodium azide, chloropicrin and Inline (Telone + chloropicrin) each provided nematode control equivalent to methyl bromide at all depths down to a depth of 5 feet; phytotoxicity varied with material, application method (drip vs. shank), and grapevine variety. These materials have the potential to provide nematode control for the nursery industry similar to that achieved with methyl bromide.

Determination of strawberry germplasm susceptibility to Phytophthora, crown and root rot diseases. There is a need to develop non-chemical alternatives to preplant soil fumigation with methyl bromide to effectively manage soilborne diseases of horticultural crops, such as strawberry, in California. Strawberry germplasm was evaluated by ARS scientists at the Crops Pathology and Genetics Research Unit, Davis, California, for susceptibility/resistance to infection by *Phytophthora* species, and development of strawberry crown and root rot diseases. University of California strawberry germplasm ranges from highly resistant to highly susceptible to *Phytophthora cactorum*, while all cultivars tested were susceptible to *Phytophthora fragariae* var fragariae. This information will contribute to development of disease resistant commercial strawberry varieties based on genetic host resistance for part of integrated disease management strategies as alternatives to preplant soil fumigation with methyl bromide.

Wheat plants induce suppression of *Rhizoctonia* root infections in apple replants. Studies were conducted by an ARS scientist at the Physiology and Pathology of Tree Fruits Research Unit, Wenatchee, Washington, to determine whether induction of a *Rhizoctonia*-suppressive soil microbial community could be induced through wheat cultivation, and, if so, whether the response was cultivar-specific. Prior cultivation of any of three orchard soils with "Lewjain" or "Penawawa" wheat cultivars suppressed the incidence of apple root infection by an introduced isolate of *Rhizoctonia solani* AG 5. Soils cultivated to "Eltan," "Hill-81," or "Madsen" wheat were not suppressive to R. solani. These findings demonstrate that the manipulation of microbial communities to induce a disease-suppressive soil environment does possess potential as a tool in the management of soilborne plant disease, and also demonstrate the importance of host genotype in determining genetic composition of the saprophytic microbial community. This finding will have significant implication in the development of our understanding of beneficial plant microbe interactions and implementation of ecologically sound strategies for the control of soilborne plant diseases.

Telone C35 effectively replaced methyl bromide in tomato trials in Florida. Field-scale demonstration/validation studies were conducted by ARS scientists at the U.S. Horticultural Research Laboratory, Ft. Pierce, Florida, in collaboration with growers and university scientists,

on nine commercial tomato production farms during the spring and fall production seasons in 2000. Application technology was improved and compliance with worker protection safety issues was addressed through the use of a deep placement coulter system to broadcast the fumigant. Pest control was equal to or greater than methyl bromide in seven of the nine trials.

Alternatives to Methyl Bromide for Postharvest Fumigation

Cold treatment prevents spread of olive fruit fly from quarantine area. Non-chemical, pre-harvest and post-harvest methods to control olive fruit fly were needed to prevent further spread and damage to the olive industry in California caused by the newly introduced pest. Investigations were conducted by ARS scientists at the Horticultural Crops Research Laboratory, Parlier, California, and in olive fruit fly infested regions of California, with funding from the California Olive Committee, and in collaboration with the California Department of Food and Agriculture. A cold treatment of 0-1^{o}C for 2 weeks was found to provide: a high level of post-harvest pest control; an olive variety with a high flesh to pit ration was more suitable for olive fruit fly development; and a cold tolerant parasite was discovered in infested fruit form areas with established olive fruit fly populations. The data was provided to the California Olive Committee for consideration of future action.

Research to allow oriental fruit moth host commodities to Mexico and Canada without quarantine restriction. Research is needed on the number of oriental fruit moths (OFM) required to establish a population in a previously non-infested area. Laboratory and field tests were conducted by ARS scientists at the Horticultural Crops Research Laboratory, Parlier, California, to study the capacity of OFM to establish a new population on peach seedlings. More than one pair (female and male) of adults was needed to readily establish a new population on a suitable host, an event that would require a high level of infestation in exported stone fruits, and one which does not occur under export conditions. The research supports the systems approach to regulatory pest control and the export of stone fruits to Mexico and Canada and could impact export treatment certification requirements for U.S. exporters.

Pheromone traps provide improved timing for insect control measures. Before new insect control procedures can be tested, the seasonal phenology of the pest insects should be elucidated. Pheromone traps for three *Carpophilus* spp. were placed in three fig orchard blocks and monitored weekly; traps were baited separately and jointly for the three species. Trap captures for all three species increased dramatically approximately 3-4 weeks prior to fig maturation, and these increases were synchronous among the widely separated test blocks. This outcome will guide us in developing trap-out and attracticide technologies for these insects that are of major concern for fig growers and processors, for fruit quality and insect control in storage.

Insecticidal treatment developed to prevent spread of olive fruit fly. Pre-harvest and post-harvest chemical methods to control olive fruit fly were needed to prevent further distribution and establishment of the pest in major production areas of California. Investigations were conducted by ARS scientists at the Horticultural Crops Research Laboratory, Parlier, California, and in infested areas of California with funding from the California Olive Committee, and the cooperation of the California Department of Food and Agriculture. Field research determined the efficacy of attract-and-kill traps against adults prior to harvest and a 1 percent acidic brine to

prevent olive fly larvae from emerging from olives following harvest greatly reduced the population of adults and prevented larval emergence from olives during transit through uninfested areas on the way to processing plants. Data collected and collated will provide the California Olive Committee with a basis for initiating a program to prevent the spread of the olive fruit fly.

All but the greenest lemon fruit are hosts of Mediterranean fruit fly after harvest. The Mediterranean fruit fly (Medfly) host status for lemons was studied to determine the need for quarantine fumigation of lemons coming from areas infested with Medflies. ARS scientists at the ARS Horticultural Crops Research Laboratory, Parlier, California, the Pacific Basin Agricultural Research Center, Hilo, Hawaii, and a University of California scientist at UC-Riverside exposed fruit of different maturities to Medflies. All but the greenest stages of the harvest fruit became infested with Medflies. Of the chemical and physical properties of the fruit peel, peel pressure gave the best correlation with infestation rate and was a useful indicator of infestability.

Development of a bait station for killing Mexican fruit fly. A toxic-laden SolGel was developed for bait stations by ARS scientists at the Kika de la Garza Subtropical Agricultural Research Center, Weslaco, Texas, to kill Mexican fruit flies, but no information existed on its efficacy in the field. A test was conducted in citrus orchards in the McAllen, Texas, area to determine the efficacy of SolGel over time. It was found that the attraction of SolGel was as good as or better than the standard torula yeast pellet for 5 months in the field, and the killing efficacy of the toxins lasted up to 6 months. The results support further development of a bait station to inhibit fruit fly population growth in backyards, sensitive areas, and orchards under biologically-based integrated pest management.