National Program 308
METHYL BROMIDE ALTERNATIVES
FY 2007 Annual Report

Introduction
The Methyl Bromide Alternatives National Program encompasses research to determine alternatives to methyl bromide, which has been officially phased out as of January 1, 2005. This is the result of indications that it negatively impacts the stratospheric ozone layer. While there are a limited number of exceptions to the phase out, continued use of methyl bromide depends upon securing a Critical Use Exemption by providing economic and production information why currently available alternatives are insufficient for pest problems. Methyl bromide remains an extremely important pesticide in the United States and in the rest of the world. It has been used to rid the soil of pests before crops are planted and on post-harvest commodities to kill pests in order to protect product quality. Pre-plant use controls soilborne pathogens, nematodes, insects, and weeds. Post-harvest use, which kills insects and other arthropods, also includes quarantine treatment, which prevents accidental introduction of organisms into areas where they did not previously exist.

Appropriate alternatives must be found so that the United States can continue economically viable production systems that permit agriculture to maintain its role in domestic and international trade. Quarantine treatments are currently exempted from the phase out, thus the primary focus of research has been on pre-plant and post-harvest uses. In the near term much of the U.S. domestic food production, such as fruits, nuts, and vegetables, will be severely impacted if suitable alternatives are not found. In the long term, systems approaches will be developed using combinations of pest suppressing techniques.

The Methyl Bromide Alternatives National Program (NP 308) is comprised of two components:
- *Pre-Plant Soil Fumigation Alternatives*; and
- *Post-Harvest Alternatives.*

During fiscal year (FY) 2006 this program produced several important discoveries and advances. Some of these are described below, grouped by program component:

<u>Component I – Pre-Plant Soil Fumigation Alternatives</u>

Field trials conducted by ARS scientists at the Water Management Research Unit, Parlier, California, in commercial certified nurseries for tree crops demonstrated that drip application technologies that are comparable to standard shank-injection in coarse textured soils (sandy loams) are not as effective at controlling plant parasitic nematodes as shank-injection in fine textured soils (loam and clay loam). Growers of certified propagative material for orchards and vineyards must be able to produce crops that are free of plant parasitic nematodes at the end of 1- and 2-year crops. Distribution of some fumigants is not adequate following shank-injection in fine-textured soils and drip fumigation is suggested as a possible solution to obtain better distribution of fumigants in fine textured soils. Iodomethane + chloropicrin (pic), 1,3-

dichloropropene (1,3-D) alone, and 1,3-D + Pic were applied by standard shank-injection methods and as emulsified formulations through drip irrigation systems and compared to standard methyl bromide fumigation for nematode control in sandy loam, loam, and clay loam soils. Although nematodes at the 15 and 30 cm depths were killed by drip fumigation, nematodes at the 60 and 90 cm depths survived. Drip fumigation was shown to be inadequate for nematode control for certified nurseries grown on fine textured soils.

In greenhouse studies conducted by ARS scientists at the ARS Crop Protection and Management Research Unit, Tifton, Georgia, purple and yellow nutsedge growth was monitored in pots covered with black polyethylene mulch, clear polyethylene mulch, or not covered. Relative to the non-mulched treatments, mulches reduced yellow nutsedge tuber production 50 percent and shoot populations 96 percent, while there were no differences among the treatments for purple nutsedge. Polyethylene mulch can be an important component of a yellow nutsedge management system, while other factors will need to be explored for successful management of purple nutsedge. These results were validated in field trials and integrated into an alternative system of weed management in the absence of methyl bromide.

A lure mixture of ammonia, methylamine, and putrescine was developed into an attractant for the South American fruit fly. The South American fruit fly is a major pest of citrus and other commercial fruits in South America and ranges into Central America and Mexico, where it attacks various non-citrus fruits. Better lures are needed to detect, monitor, and eliminate this pest. The chemicals were put into a preliminary formulation that subsequently tested better than existing attractants for this fly in citrus orchards in Brazil. The work was accomplished through a cooperative project between ARS Crop Quality and Fruit Insects Research Unit, Weslaco, Texas, and ISCA Technologies, Inc., Riverside, California. An effective lure will result in more effective control of this fly in South America that will in turn help prevent its introduction into the citrus growing areas of the United States and aid in detection and eradication of the fly should accidental introduction occur.

Meloidogyne floridensis is a recently described species of root-knot nematode isolated in several Florida locations and of importance because it reproduces on certain root-knot nematode resistant rootstocks, including peach rootstocks Guardian, Nemaguard, Nemared, and Okinawa. Host range studies were carried out by personnel at the U.S. Horticultural Research Laboratory, Ft. Pierce, Florida, to determine the host status of five commonly used cover crops and five common weed species to M. floridensis. Good hosts included clover, rape, and cypressvine. Sunn hemp and sesame were poor hosts, while jimsonweed and sorghum sudangrass were nonhosts. This information will be useful to assist growers who have M. floridensis infestations in selecting cover crops and managing weeds for controlling this newly described nematode species in the absence of soil fumigation.

Correct identification of oomycete pathogens from strawberry can be a time-consuming task, encompassing the need to grow out the cultures and then correctly identify the species based on morphological features, which is often complicated by the levels of variation that are often observed for some species. Molecular markers (species-specific primers, as well as Restriction Fragment Length Polymorphism analysis) have been developed for identification of Pythium and Phytophthora spp. recovered from strawberry. Trials are in progress in a collaboration between

ARS scientists in Salinas, California, and Davis, California, to adapt this marker system for detection of Phytophthora spp. in strawberry nursery production, as well as development of specific markers for the three species causing disease in strawberry production systems. Collaborative projects with other ARS and university scientists to use the marker system with other Phytophthora spp. are in progress.

Two field trials in small plots were conducted by ARS scientists at the Water Management Research Unit, Parlier, California, on a sandy loam soil, and both showed that water seal (spraying water on soil surface following shank fumigation) can reduce Telone as well as chloropicrin emissions more effectively than standard high density polyethylene (HDPE) tarp and cost substantially less ($800/acre for HDPE tarp versus $300/acre for water seal). Fumigation acreage in California alone is more than 50,000 acres each year, making the cost savings substantial.

Previous research in this project found that *Fusarium oxysporum* strain CS-20 reduced the incidence of Fusarium wilt, caused by *F. oxysporum*, in tomato and other plants. Further, split-root and other tests demonstrated that the main mechanism of control is resistance in the plant induced by strain CS-20. In FY 2006, research was conducted to identify specific chemical changes induced by strain CS-20. Phenolic compounds are known to be involved in induced resistance in many plants, and four phenolic compounds (vanillic, caffeic and ferulic acids, and an unknown) were found to be produced by tomato roots in response to *F. oxysporum* strain CS-20 (biocontrol strain), but not plant pathogenic *F. oxysporum*. Experiments are in progress to establish the role of these in induced resistance of tomato to Fusarium wilt. Fundamental knowledge of induced resistance in plants will contribute to development of novel disease management strategies.

<u>Component II – Post-Harvest Alternatives</u>

Following success in controlling the lettuce aphid on lettuce and western flower thrips on broccoli using ultralow oxygen, ARS scientists at the U.S. Agricultural Research Station, Salinas, California, developed ultralow oxygen treatment protocol to control western flower thrips on iceberg lettuce that does not cause injury to the lettuce. Post-harvest control of western flowers thrips on iceberg lettuce addresses the phytosanitary barriers facing U.S. lettuce in overseas markets. The results of the ultralow oxygen treatments show they have good potential for development into a safe and effective alternative to traditional fumigation for control of western flower thrips and lettuce aphid on exported lettuce and could lead to increased exports of U.S. lettuce to overseas markets.

Black widow spiders are often found in table grapes and must be killed before the grapes are exported. Research conducted by ARS scientists at the San Joaquin Valley Agricultural Sciences Center, Parlier, California, showed that ozone could be utilized to kill the spiders in a short period of time and that the addition of CO_2 was not necessary to enhance the efficacy. These results show that the use of ozone could be an effective method to eliminate live Black Widow spiders from table grapes, making their importation more acceptable by foreign countries.