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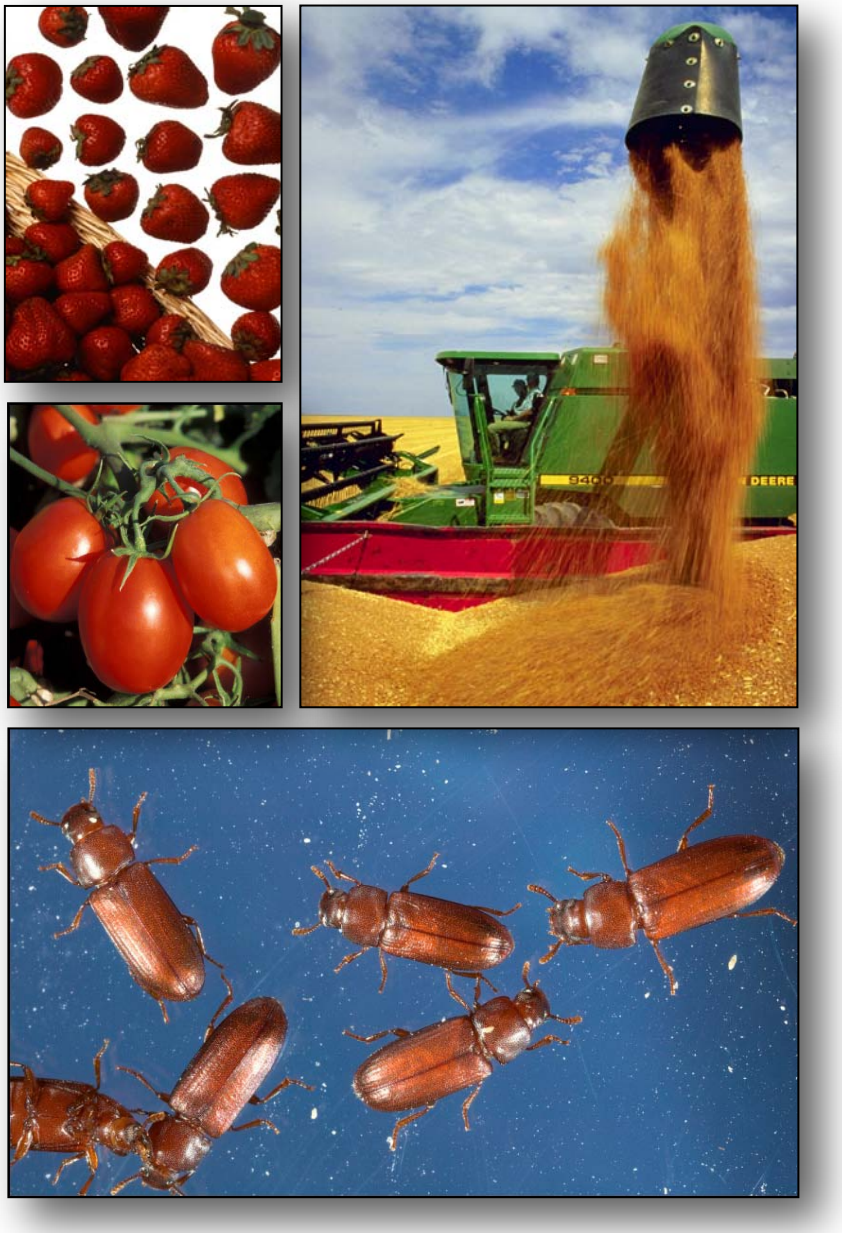
NATIONAL PROGRAM 308
METHYL BROMIDE ALTERNATIVES

ANNUAL REPORT FY 2010



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Introduction

The Methyl Bromide Alternatives National Program encompasses research to determine alternatives to this pesticide. Methyl bromide has been officially phased out as of January 1, 2005 due to scientific evidence that it contributes to the thinning of the stratospheric ozone layer. In addition to quarantine uses, which are currently exempt from the phase out, a limited amount of methyl bromide is used where no technically and economically feasible alternatives are available for specific uses and where the members of the Montreal Protocol have granted year by year exemptions. In the United States and world-wide, methyl bromide remains an extremely important pesticide where practical, economical, and commercially available alternatives have not been identified. Methyl bromide has been used to rid the soil of pests before crops are planted, as well as, kill pests on postharvest commodities to protect product quality. Pre-plant use controls soilborne pathogens, nematodes, insects, and weeds. Postharvest 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 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 postharvest uses. In the near term, much of the U.S. domestic food production of fruits, nuts, and vegetables will be severely impacted if suitable alternatives are not found. In the long term, systems approaches must 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
- Postharvest Alternatives

During fiscal year (FY) 2010 this program produced several important discoveries and advances. Those advances and others are described on the following pages, grouped by national program component:

Component 1: Pre-plant Soil Fumigation Alternatives

Effective methyl bromide alternatives demonstrated in production of raspberry nursery stock. Raspberry nurseries have relied on pre-plant fumigation with methyl bromide to produce approximately 7 million plants annually for an annual fruit crop worth about $278 million. Methyl bromide is used to control plant pathogens, weeds, and nematodes which would severely reduce the quantity and quality of the crop, but use of this fumigant is being phased out worldwide under the Montreal Protocol. ARS researchers in Corvallis, Oregon, and collaborators in at Washington State University tested fumigant alternatives to methyl bromide, including Inline® (1,3-D+chloropicrin formulated for drip application), Telone C35® (1,3-D + chloropicrin, shank-applied), Midas® (iodomethane + chloropicrin, shank-applied), and plastic mulch sealing films at an experiment station and three commercial nurseries in California and Washington state. These combinations emerged as effective alternatives to methyl bromide + chloropirin and matched the methyl bromide standard for plant production and pest and pathogen control. Virtually impermeable film (VIF) generally improved efficacy of the alternative fumigants, compared to standard high density polyethylene, but solarization was not effective. Transition from methyl bromide to Midas®, although technically feasible, may be complicated by uncertain registration status and relatively high material cost. However Telone C35®, especially in combination with VIF, was validated as an effective methyl bromide alternative for raspberry nursery stakeholders.

Methyl bromide alternatives for gladiolus production demonstrated. Methyl bromide soil fumigation has traditionally been used for gladiolus production in California to control soil pathogens detrimental to the crop. However, use of this fumigant is being phased out worldwide under the Montreal Protocol. Field trials were conducted by ARS scientists in Parlier, California, to test methyl bromide alternative chemicals in gladiolus production. All chemical treatments reduced the pathogen populations in both the drip and shank injected trials compared to the untreated controls, except for Telone C35®, which did not perform well for control of the pathogen *Fusarium oxysporum* in the shank trial. Bulb yield from the alternative treatments was generally comparable to the standard methyl bromide/chloropicrin treatment. Overall, pathogen and yield seemed to be slightly better in the shank treatments compared to the drip treatments. From these results, it appears that a successful gladiolus bulb crop can be grown with these alternative treatments.

Accurate identification of pathogens causing brown patch disease in turfgrasses. Rhizoctonia species, which cause brown patch disease in turfgrasses, are considered one of the most important pathogens on turf. The traditional method of identifying *Rhizoctonia* species, by hyphal anastomosis reactions, is often unreliable and time consuming. An ARS scientist in Beltsville, Maryland, and cooperators analyzed DNA sequences of *Rhizoctonia* isolates from Maryland and Virginia to develop an efficient molecular detection assay of the pathogens causing brown patch disease of turfgrasses. Development of more accurate molecular

identification of *Rhizoctonia* sp will help in developing resistant turfgrass cultivars and in proper management of brown patch disease.

New information for the management of nematodes and other soilborne pests in floriculture production systems discovered. Root-knot nematodes are a major pest for cut flower production in the southeastern United States. ARS researchers in Fort Pierce, Florida, in collaboration with faculty at the University of Florida, developed new information on the susceptibility of a variety of important cut flower species to two common species of root-knot nematodes in Florida. Experiments evaluating the susceptibility of selected flower cultivars to the root-knot nematode species *Meloidogyne incognita* (race two) and *Meloidogyne Javanica* (race one) revealed that snapdragon and nasturtium were susceptible to and supported high populations of both species, while marigold, zinnia, salvia, and carnation cultivars were not susceptible nor good hosts. Knowledge of crop nematode susceptibility is useful for managing nematode populations with crop rotations.

A Web site to support research on Phytophthora was developed in collaboration between ARS and university scientists. The fungal genus Phytophthora is responsible for many diseases of crop plants worldwide and consists of approximately 106 species, which are difficult to identify. The Web-based database for Phytophthora will enhance the understanding of the genus, simplify species identification, and stimulate further research on the genus. The database includes complete morphological descriptions, information on host range and geographical distribution, a comprehensive molecular phylogeny using seven nuclear genes (four mitochondrial genes will soon be added), and a section on molecular identification and detection. This database will serve as a resource for researchers working on the genus as well as a repository for future work. Expansion of the database Web portal was initiated to include the related Oomycete pathogens Pythium, downy mildews, and Albugo.

Alternatives to methyl bromide demonstrated in key crop systems and regions formerly dependent solely upon methyl bromide. Key crop systems have relied solely on fumigation with methyl bromide for pest and pathogen control, but use of this fumigant is being phased out worldwide under the Montreal Protocol. ARS scientists in Fort Pierce, Florida, along with university collaborators, conducted 48 large-scale field demonstration trials, using the best available, industry-appropriate alternatives to methyl bromide. The alternatives included substitute fumigants and supporting integrated pest management practices. Trials were conducted in partnership with commercial growers at sites adequately representing the biological and environmental diversity of the production systems of tomato, pepper, eggplant, strawberry, forest nursery seedlings (loblolly pine), sod, ornamentals (caladium), and cut flowers (delphinium). Grower demonstration trials were performed on all of those commodities and turf and cucumber in Alabama, Florida, Georgia, South Carolina, and North Carolina. The size of each grower demonstration trial ranged from one-half acre to 58 acres. These trials demonstrated that technically feasible alternatives to methyl bromide soil fumigation are

available and can control pests adequately without the environmentally damaging effects of methyl bromide.

Low permeable films reduce fumigant emissions. In comparison with the use of standard polyethylene films, the use of low permeability films allows lower doses of fumigant to be used and also reduces the amount of fumigant, which might cause unintended environmental damage, released to the atmosphere. A new low permeable film, referred to as totally impermeable film or TIF, effectively reduced fumigant emissions in laboratory tests, though no field data was available. ARS scientists in Parlier, California, conducted a large field trial to test the new film for reducing fumigant emissions. The TIF peak emission rate was as much as 10 times lower than that from standard polyethylene (PE) film. Over a 6-day field-covering period, the total emission loss with TIF was reduced below 2 percent of total fumigant applied, compared to 30 percent emission with the PE film. However, the emission surge upon cutting the TIF tarp was much higher than with the PE film, indicating that a longer waiting time would be needed with TIF to reduce potential exposure risks. The research showed that using this new film will help improve buffer zone restrictions and enable many fields to be fumigated under the newly amended U.S. EPA regulations.

Component 2: Post-Harvest Alternatives

Oxygen increases toxicity of phosphine to insect pests. Phosphine is a slow-acting fumigant in controlling insects, and treatment time can last over 10 days for some insects, limiting the usefulness of this fumigant as a quarantine treatment. For low temperature phosphine fumigation of fresh commodities, treatment is even longer as the toxicity of phosphine decreases at lower temperatures. Shortening treatment would increase turnover time of fumigation chambers and reduce fumigation cost. ARS researchers in Salinas, California, found significant synergistic effects of oxygen in increasing the toxicity of phosphine against all life stages of various insect pests which resulted in significant reductions in treatment time for pest control. The synergism may have significant practical implications in developing more effective and shorter fumigation treatment for postharvest pests especially for low temperature phosphine fumigation on perishable commodities.

Impact of season and structural fumigation on red flour beetle trap captures in flour mills evaluated for use in integrated pest management. Red flour beetle management in flour mills has relied on fumigation with methyl bromide, but use of this fumigant is being phased out worldwide under the Montreal Protocol. Data on the impact of fumigation on pest populations is limited, and this has hampered the adoption of alternative treatments. ARS scientists in Manhattan, Kansas, and Gainesville, Florida, analyzed red flour beetle monitoring data, which was collected over multiple years from two flour mills, to determine the impact of fumigations on pest populations as well as the influence of season on efficacy. Average percentage reductions were calculated and it was shown that allowing high pest populations before

fumigations resulted in greater abundance after treatment because percentage reduction rates were similar. Also, reduction in beetle captures was not significantly affected by season. Results provide baseline information on pest populations and fumigation efficacy to which methyl bromide alternatives can be compared and information that can be used to help optimize fumigation and integrated pest management programs.

Novel red flour beetle trap developed. The red flour beetle is a major pest of stored food products, such as flour. Effective pest monitoring is critical to pest management systems, such as those proposed as alternatives to methyl bromide, because they provide necessary guidance for timing and targeting to the application of control measures. ARS researchers in Gainesville, Florida, have developed a new trap for monitoring the red flour beetle that uses ultraviolet light, a chemical attractant, and a physical configuration that guides beetles into a pitfall. In small scale experiments, trap efficiency was estimated to be about 33 percent, i.e., the trap captured one third of the flour beetles present. This is a comparatively high efficiency, indicating promise as a monitoring tool for use in flour mills and other food processing plants.

Attraction of redbay ambrosia beetle to host wood and essential oil lures evaluated for use in detection and monitoring. The redbay ambrosia beetle is the vector of laurel wilt, a lethal vascular disease of avocado that seriously threatens the avocado industry. Development of attractant-based trapping systems for this pest is a critical need for both growers and regulatory agencies. ARS researchers in Miami, Florida, conducted laboratory and field tests to compare the attraction of the redbay ambrosia beetle to bolts of wood from avocado, manuka lures, and phoebe lures (manuka and phoebe are two types of essential oil lures recommended for this pest) in the three avocado horticultural races. There was no strong preference among avocado cultivars representative of the three horticultural races, and ambrosia beetle preferred to bore into cut/wounded surfaces of host wood. Redbay ambrosia beetle captures with phoebe lures were comparable to captures with host wood, but captures with manuka lures were very low. This information has been used by action agencies in monitoring programs to improve detection and monitoring for this important new pest.

Quarantine strategies to control Hessian fly in exported hay developed. United States and foreign regulatory agencies are seeking new methods to ensure that the Hessian fly is not accidentally introduced to new areas through hay shipped from the western United States. ARS researchers in Parlier, California, examined different methodologies to control this insect pest. Hay harvesting and drying practices increased mortality of Hessian fly puparia in warm and arid climates where export quality hay is grown. In addition, fumigation with a phosphine and carbon dioxide gas mixture completely controlled this pest in laboratory tests. This work supports the concept that the occurrence of Hessian fly in harvested, processed, and fumigated hay bales is negligible and protects a $660 million annual foreign market.