

***“Field Scale Demonstration / Validation Studies of Alternatives  
For Methyl Bromide in Plastic Mulch Culture in Florida”***

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During the period 1996-2001, the USDA - ARS provided annual funding in the range of \$220,500 to \$243,750 to support methyl bromide alternatives research in Florida via a Specific Cooperative Agreement. The principal objectives of the funded research were to 1) conduct large scale field demonstration / validations studies within commercial fields so as to quickly optimize use parameters for next best alternatives for methyl bromide under a variety of grower induced production constraints and environmental conditions; 2) identify and evaluate potential chemical and nonchemical alternatives to methyl bromide in small, replicated plot, field screening trials; 3) to initiate and maintain a long term commitment to the collection of multi-crop, multi-year data from a single research site at the Gulf Coast Research and Education Center, Bradenton, FL; and 4) to allow for continued development and refinement of IPM strategies, reduced input, and/ or more sustainable crop production system alternatives to methyl bromide soil fumigation. During the five year granting period, over fifty projects, involving 21 University of Florida and USDA scientists, were separately funded.

**ALTERNATIVE CHEMICAL:** Since 1996, more than 40 USDA funded large scale field demonstration / validation trials and 35 small plot research experiments have been conducted to evaluate soilborne pest control and differences in tomato, strawberry, and pepper crop yield with a number of federally registered and nonregistered alternative fumigants. Depending upon spectrum of pest control efficacy, most of the fumigants included in these studies were evaluated individually or in combination with other herbicides and fumigants in hopes of achieving the same broad spectrum activity as that of methyl bromide. Most of the early demonstration trials focused on in-row applications of Telone C-17 or Telone C-35. More recent efforts have focused on comparison of broadcast applications of Telone in combination with other fumigants and herbicides to that of methyl bromide and chloropicrin for weed, disease, and nematode control, and for crop yield response.

In general, results of these studies indicate that Telone formulation and method of application are significant determinants of crop yield relative to that of methyl bromide. Overall, and irrespective of application method, tomato yields were greater following use of Telone C-35 compared to that of Telone C-17. Similarly, in-row applications of Telone C-17 or Telone C-35 were generally superior to broadcast applications. The higher yields obtained with in-row applications is likely the simple result of more uniform fumigant dispersion, distribution, and dissipation under the raised, plastic mulch covered beds compared to bare ground, broadcast applications made to undisturbed soil subjected to environmental flux. **Overall, the combined results of these trials suggest that if broadcast applications of Telone C-35 have to be relied upon to avoid regulatory issues regarding worker needs for personal protective equipment, then losses in crop yield of 6 to 7 percent will have to be accepted, including the recognition that some yield variability from season to season, field to field, is also unavoidable.** Even though tomato yields improved with in-row applications of Telone C-17 or Telone C-35, they were not always to the level of methyl bromide. In a number of broadcast

Telone trials, an additional application of chloropicrin (100-200 lb/a) was included as a separate soil injected treatment at the time of bedding. These results further suggest that improvements to crop yield potential and response consistency relative to methyl bromide can be achieved with broadcast Telone treatments, if additional chloropicrin is applied at the time of bedding.

Nematode control has generally been good to excellent with all in-row or broadcast treatments of Telone products. In general, disease control was always improved, but not always to the level of methyl bromide, with the addition of chloropicrin either in the formulation with Telone or as a separate treatment prior to bedding. The increase in disease incidence and plant mortality when broadcast application of any of the Telone products was not followed by additional chloropicrin to the bed, suggests that chloropicrin escape from untarped soil can significantly reduce overall disease control.

Metham sodium, applied either preplant incorporated or chemigationally via the drip irrigation system, generally proved to be ineffective for nematode control. There was some indication however, that metham sodium had the activity to perform as a bed-top herbicide component in combination treatments where the herbicide or methyl bromide alternative product could not be relied upon to provide effective weed control. Crop yields were generally intermediate to that of the untreated control and the methyl bromide chloropicrin standard. Metham sodium in combination with either chloropicrin or 1,3-D (Telone) generally improved overall pest efficacy and crop yield response compared to metham sodium alone. The reason for such inconsistency is not clear, however other research in Florida has shown it virtually impossible to wet more than 50-60% of the bed with a single drip tube per bed and that two drip tubes will likely be required to treat upwards of 85-95% of the entire mulch covered bed with any chemigational alternative, such as metham sodium.

Results of some demonstration trials have showed less than ideal performance of Tillam when the spectrum of weed species present in the field was broad, and when Tillam was applied alone for weed control. In those studies, various grasses, black nightshade, ragweed, pigweed, and purslane oftentimes were not controlled. Tank mixing Devrinol or Treflan with Tillam typically broadened the weed control spectrum, improving control of some weeds not controlled by Tillam alone. Treflan was especially effective against crabgrass and provided improved pigweed control in at least some locations. Results of this work also have shown that tank mix applications of various herbicides (Tillam, Devrinol, and Treflan) will likely be required to effectively broaden the spectrum of weed control to the near equivalence of that of methyl bromide. The large scale field demonstration trials and small plot herbicide tolerance and efficacy studies also have demonstrated that crop growth can be severely restricted, and yield significantly reduced in response to some preplant, preemergence, or post emergence applied herbicides. Differences in timing, rates, and methods of herbicide application and incorporation can all be important factors contributing to phytotoxic crop response and weed control efficacy.

**NONCHEMICAL ALTERNATIVES:** Soil solarization has been evaluated as a nonchemical alternative to methyl bromide in many large scale and small plot studies. As a soil treatment it has reduced nutsedge densities compared to the nontreated control, but not to a commercially acceptable level and provided only marginal control of root-knot nematode. In long term studies, soil solarization reduced the incidence of Fusarium wilt of tomato compared with an untreated control but only to an intermediate, commercially unacceptable level compared to

either methyl bromide or Telone C-17. Overall, tomato production was comparable with methyl bromide and Telone C-17 + Tillam, but solarization reduced yields on average to a level intermediate between that of the fumigants and the nontreated control. Summer cover cropping studies have been conducted in various years and statewide locations to evaluate their utility for weed and soilborne pest control. Overall, these studies have collectively demonstrated that the selection of cover crop can be very important in terms of promoting or reducing pest population densities of nematodes and of weeds in the field. Flooding was shown to provide only a small numerical reduction in root-knot nematode soil population level, final harvest root gall severity, and yellow and purple nutsedge densities, and these differences were never significantly reduced below the level of the non-flooded control. In a number of studies, **use of host plant resistance was also evaluated as part of an integrated, nonchemical, pest management approach to replace or minimize dependence on methyl bromide. These studies demonstrated that use of resistant varieties do confer a higher degree of plant tolerance to nematode parasitism, but they are also not immune from crop damage.** Overall, the nonchemical studies confirm that the use of cover crops, resistant varieties, soil solarization, and flooding should not be construed as stand alone pest control alternatives to methyl bromide, but as components of an IPM programs, and that in some cases only marginal benefits maybe be accrued with their use.

#### **OVERVIEW and FUTURE CONSIDERATIONS**

A substantial part of the research conducted appears to support the general conclusion that acceptable pest control and crop yield response can be obtained with in-row applications of Telone C-17 or Telone C-35. This collaborative work has shown that use of Telone products formulated with chloropicrin can significantly reduce the incidence and severity of soilborne diseases; however, to obtain consistent soilborne disease control, equivalent or nearly so to that of methyl bromide, an additional application of chloropicrin at the time of bed formation may be required. In general, Telone C-35, applied alone or in combination with another fumigant, consistently has produced tomato, strawberry, and pepper yields which were near equivalent to that of methyl bromide. Small plot trials also have demonstrated that fumigant treatment combinations which included Telone C-35 can be equally as effective as methyl bromide for pest control efficacy and crop yield response. The biggest challenge facing the scientific community in Florida is developing better alternatives which further enhance performance consistency and minimize the 5-10% impacts on yield for each of the methyl bromide dependent crops. It is also imperative that regulatory changes occur to declare the new system which includes Telone products a viable alternative to methyl bromide.