MBAO Presentation in Orlando, FL
Nov. 6-8, 2012

A two-year tomato study in Florida sandy soil using carbonated Telone C35 and impermeable films

J. E. Thomas*[1], L.H. Allen, Jr. [2], J.W. Noling[3] and D.W. Dickson[3]
[1]Soil and Water Science Department, University of Florida, Gainesville, FL 32611, USA
[2]USDA-ARS and Agronomy Department, University of Florida, Gainesville, FL 32611, USA
[3]Entomology and Nematology Department, University of Florida, Citrus Research Center, Lake Alfred, FL, 33850, USA
[4]Entomology and Nematology Department, University of Florida, Gainesville, Florida 32611, USA

Methyl bromide (MeBr) was suspended in 2005 for agricultural use in the U.S. with the exception of yearly critical exemptions. Although the 2012 critical use nomination would allow 54,423 kg of MeBr to be used in the U.S. (Tomato CUN, 2012), the need for an efficient, low-cost alternative still exists. The main aim of this study was to compare the efficacy of reduced rates of carbonated fumigant, Telone C35, versus non-carbonated fumigant under virtually impermeable film (VIF) or totally impermeable film (TIF). It is recognized that TIF is a better barrier than VIF film for reducing volatilization of Telone C35, an alternative fumigant to MeBr, into the atmosphere. Maintaining appropriate concentration of the three biologically active compounds in the root zone for an adequate period of time after fumigation is essential for effective pest-pathogen management. It was demonstrated that carbonating Telone C35 provided better distribution; hence, it should enable a lower application rate to be more effective than an application by N_2 at the same rate. Our results also indicated that carbonated Telone C35 penetrated deeper than non-carbonated Telone C35 at the lowest application rate. Although this was beneficial by inhibiting re-infestation by deep dwelling nematodes, it may be problematic for areas with shallow water tables. The final results indicate that although the carbonated Telone C35 gave a better marketable crop yield than non-carbonated fumigant at the lowest application rate under TIF, and both had better marketable crop yield than the full rate methyl bromide treatment under VIF, although there was no statistical difference in the marketable crop yield for the three treatments.

METHODS

Field site, fumigant, and plastic mulches. The field site was located at the Plant Science Research and Education Unit of the University of Florida in Citra about 35 km south of Gainesville, Florida. Soil at the site was classified as Arredondo fine sand. Analytical grade (Z) -and (E)-1,3-dichloropropene (1,3-D) and chloropicrin (CP) with greater than 99% purity plus Telone C35 [about 65% 1,3-D and 35% CP] were provided by Dow AgroSciences (Indianapolis, IN). Methyl Bromide (53%) mixed with chloropicrin (47%) was obtained from Great Lakes Chemical Corp. (West Lafayette, IN). Two types of black plastic film were tested. The first one, commonly referred to as a virtually impermeable film (VIF), was supplied by Berry Plastic Inc. (formerly Pliant Plastics Inc.) under the tradename “Blockade” (0.03175 mm thick). The second black film labeled as “Vapor Safe” (0.04572 mm thick) by Raven Plastic Industries was touted as a totally impermeable film (TIF).

Plots and fumigant treatment. Prior to fumigation, raised beds (0.90 m wide and 11 m long) were formed. These beds were injected with Telone C35 by three conventional sweptback chisels at 30 cm apart to 20 cm depth. All bed treatments were constructed in four replicates in random double block design. The positive control was MBr:Pic (448 kg/ha) with VIF and the negative controls received no fumigant, but were covered with either TIF or VIF. The non-carbonated Telone C35 was dispersed using N_2 at fumigant rates of 150, 226, and 439 kg/ha. The carbonated Telone C35 was dispensed by CO_2 at rates of 150 and 226 kg/ha. The lowest fumigant rates were covered by VIF and TIF in separate beds, while the higher rate treatments only used VIF.

Soil-pore air sampling. After fumigation, a set of seven different lengths of stainless steel soil gas probes (1, 5, 10, 20, 30, 40 and 60 cm) were installed in the center trace of each TIF beds with the lowest application rate of Telone C35. Thirty-five milliliters of soil-pore air were withdrawn daily from the probes. Plastic syringes were used to withdraw soil-pore air from the probes through a XAD-4 resin sampling tube, which absorbed (Z)- and (E)-1,3-D and CP (Ou *et al.*, 2005).

Surface air sampling. Emission samples were collected from the lowest application rate rows (both VIF and TIF covered) as well as the highest rate Telone C35 row covered by VIF. These samples were collected at 3, 24, 48, 120, and 144 hours after injection. A stainless steel collection pan (4.7 L volume and 471 cm^2 cover area) was placed daily on the surface of each film bed over the center track of the chisel injection. A second collection pan was placed on the bare soil next to the edge of film beds that had been treated with lowest rate Telone C35 and covered with TIF. A volume of 50 mL air was withdrawn from the collection pans at 15 minute intervals for 60 minutes using a plastic syringe to trap (Z)- and (E)-1,3-D and CP on XAD-4 resin. (Thomas *et al.*, 2004).

Analysis. After XAD-4 resin samples were extracted with n-hexane, a 1-mL aliquot was transferred to an amber GC vial for analysis of (Z)- and (E)-1,3-D and CP on a Perkin-Elmer Autosystem gas chromatograph (GC) equipped with an electron-capture detector (Thomas *et al.*, 2004).

RESULTS

Subsurface distribution of (Z)- and (E)-1,3-D and CP. Three hours after Telone C35 was chisel injected, the (Z)- and (E)-1,3-D and CP had diffused downward from 30 cm depth to 60 cm depth for CO_2 application, but not for N_2 application at full or one-third rate. Average concentrations of the three compounds were fairly variable. Since (Z)-1,3-D is more volatile than (E)-1,3-D and CP (Hornsby *et al.*, 1995), greater concentrations of (Z)-1,3-D were found at all depths for all application methods. Twenty-four hours after injection, concentrations of the three compounds at all depths for the one-third rate carbonated treatment under TIF became less variable than all non-carbonated treatments under TIF or VIF (Figure 1). Peak concentration likely occurred shortly before 24 hours from the time of injection, although the 24 hour samples exhibited the maximum measured concentration.

Volatilization of (Z)- and (E)-1,3-D and CP. After monitoring the surface emissions from the center of the bed and the furrow next to the bed, it was concluded that the quicker emission of the Telone C35 components from the bare soil next to the carbonated fumigant plots compared to the non-carbonated beds implied that not only was the vertical subsurface dispersion influenced, but that the horizontal dispersion was also affected by the use of CO_2 versus N_2. It was found that that the use of TIF reduced emissions by ~70% for both carbonated and non-carbonated fumigants when used at one-third the label rate. However, when VIF covered the bed, the emissions were cut by 31% for one-third rate non-carbonated Telone C35 while the emissions from the one-third rate carbonated fumigant rows were lowered by 63% from bed and furrow.

KEY CONCLUSIONS

1) Carbonated Telone C35 dispersed faster, deeper, and wider than non-carbonated Telone C35.
2) The use of totally impermeable plastic film ("VaporSafe by Raven Plastic Industries) allowed the application rate of Telone C35 to be reduced by two-thirds of the label rate and still achieve the statistically equivalent marketable yield experienced when methyl bromide is used at its label rate under VIF.

ACKNOWLEDGEMENT

This research was funded by the USDA NIFA award #2010-51102-21657.

LITERATURE CITED

Hornsby, A.G., R.D. Wauchope, and A.E. Herner. 1995. Pesticide properties in the environment. Springer-Verlag, New York.

Ou, L.-T., J.E. Thomas, L.H. Allen, Jr., L.A. McCormack, J.C. Vu, and D.W. Dickson. 2005. Effects of application methods and plastic covers on distribution of cis- and trans-1,3-dichloropropene and chloropicrin in root zone. J. Nematol., 37:483-488.

Thomas, J.E., L.-T. Ou, L.H. Allen, Jr., L.A. McCormack, J.C. Vu, and D.W. Dickson. 2004. Persistence, distribution, and emission of Telone C35 injected into a Florida sandy soil affected by moisture, organic matter, and plastic film cover. J. Environ. Sci. Health, B39:505-516.

Tomatoes CUN, 2012. Methyl Bromide critical use nomination for pre-plant soil use for tomato grown in open fields. Available at: Orchard CUN, 2011. USA CUN11 Orchard replant Open Field. Available at: http://www.epa.gov/ozone/mbr/CUN2012/2012_USTomatoes.pdf (Verified 9/4/2012)

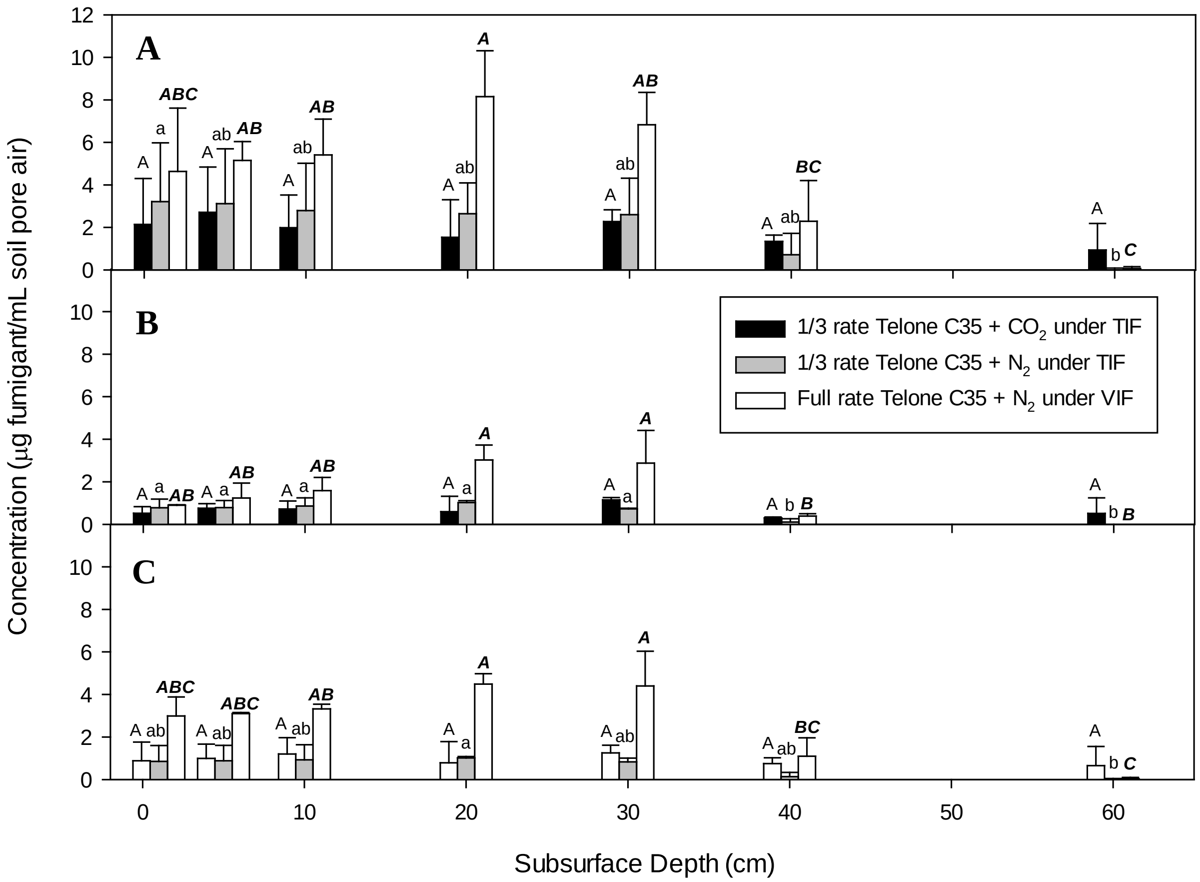

Figure 1. Subsurface distribution under TIF or VIF of Telone C35 active ingredients twenty-four hours after injection using CO_2 or N_2 as the propellant/dispersant. Graph "A" shows (Z)-1,3-dichloropropene, "B" depicts (E)-1,3-dichloropropene and "C" is for chloropicrin. Each treatment was statistically analyzed separate from all other treatments using Waller-Duncan K-ratio t-test with k=100. Similar letters represent statistical equivalence among various depths for that treatment.