

EVALUATING GAS FUMIGANTS RELEASED THROUGH VARIOUS MULCHES 2006

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Introduction

Methyl bromide has been used as a soil fumigant since the 1930's. Since its discovery and implementation, methyl bromide has been consistently effective for control of nematodes, fungi, soil insects, and weeds. Methyl bromide's high vapor pressure allows rapid and thorough distribution throughout the soil profile. This vapor pressure facilitates a relatively short plant-back interval.

In addition to the horticultural advantages, plastic mulches also serve to delay the volatilization of fumigant gases like methyl bromide from soil, and reduce emissions into the atmosphere. In practical reality however, the LDPE mulches in common use today actually provide little direct physical barrier to the diffusion of methyl bromide through the mulch. Beds which are moist and tightly compressed are much more resistant to methyl bromide diffusion than beds which are dry and only loosely compacted or pressed (Noling, 2002).

Emissions of Methyl Bromide from Agricultural Fields

In recent years many different experiments have been conducted to obtain information on methyl bromide emissions from bare and mulched soil following field application. Much of this research appears to show that as much as 20 to 90% of the methyl bromide applied to a given field can ultimately out-gas through the LDPE plastic mulch cover and into the air after soil

fumigation. Many different chemical, soil, and environmental factors interact to cause the wide variation of reported emission losses from soil with methyl bromide. In general, the rates in which methyl bromide volatilizes from soil under typical conditions are initially high following application and then decrease with time, such that after 5 to 7 days post application, little remains in soil (Figure.1). Data is plotted only to show general decline in emissions with time, and highest daily rates of emission occurring midday and lowest emissions at night. Besides temperature, other soil and environmental conditions can modify methyl bromide emissions from soil greatly.

Mulch Permeability

The permeability (the ability to pass through) of a plastic mulch to a gas fumigant is based on the thickness, density, and chemical composition of the plastic mulch. Regardless of composition, thicker mulches are generally less permeable to methyl bromide than are thin mulches (Figure 2). In most cases, practical and cost efficiency considerations prevent the use of thicker LPDE mulches for enhanced containment of methyl bromide in soil. Some plastic mulches provide better diffusion barrier to certain fumigants than others. For example, permeability to methyl bromide decreases as the density of a mulch increases. High density polyethylene (HDPE) mulches are less permeable to methyl bromide than LDPE mulches.

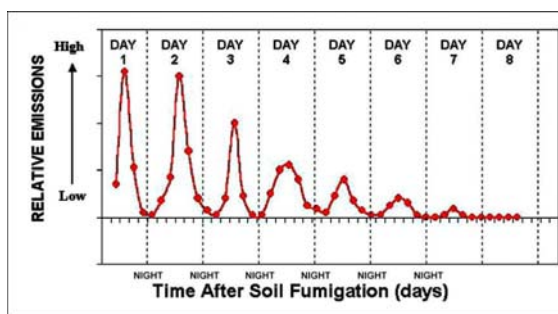


Figure 1. Generalized representation of the relative emissions of methyl bromide volatilizing through a plastic mulch cover with time after initial soil fumigation. (Noling 2002)

Objectives

- Measure the amount of gas movement of methyl bromide, methyl iodide and chloropicrin through various mulches.

Methods and Materials

TVP Test - Plot land was prepared at the University of Georgia Tifton Vegetable Park for commercial pepper production on February 23, 2006. Soil type is Tifton sandy loam. Two mulch films were obtained. They were LDPE (black on black) and metalized (silver on black with a black strip 12 inches wide down the center). Methyl bromide, methyl iodide and three way combination (1,3-Dichloropropene (Telone II), Chloropicrin and metam sodium (VAPAM)) were the fumigants used in the test.

Ponder Spring Test - Plot land was prepared at the University of Georgia Ponder Farm for commercial pepper production on February 22, 2006. Soil type is Tifton sandy loam. Four mulch films were evaluated. They were LDPE (embossed), LDPE Smooth (non-embossed), VIF Domestic (Cadillac) and metalized smooth (silver on black). Methyl bromide, methyl iodide and three

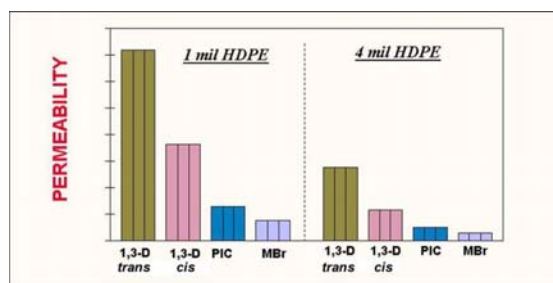


Figure 2. Permeability of methyl bromide (Mbr), Chloropicrin (Pic), and two isomers of 1,3-Dichloropropene (Telone) through high density polyethylene (HDPE) plastic mulch of two thicknesses. (Noling 2002)

way combination (1,3-Dichloropropene (Telone II), Chloropicrin and metam sodium (VAPAM)) were the fumigants used in the test.

Ponder Fall Test – An additional area of plot land was prepared at the University of Georgia Ponder Farm for commercial pepper production on July 19, 2006. Soil type is Tifton sandy loam. Three mulch films were evaluated. They were LDPE (embossed), VIF Domestic (Cadillac) and metalized smooth (silver on black). Methyl bromide, methyl iodide and three way combination (1,3-Dichloropropene (Telone II), Chloropicrin and metam sodium (VAPAM)) were the fumigants used in the test.

Telone II was applied at 12 gallons/acre and metam sodium was applied at 75 gallons/acre for all trials. Table 1 is the rates used for the three tests. Table gives the temperature and rainfall fro the days gas fumigant data was measured.

At the time the beds were formed at all locations soil moisture was ideal for soil fumigation and bed formation. Each fumigant gas was measured with a gas detector pump (GASTEC GV100S) with detector tubes for each. Plastic

funnels measuring 6.5 inches were glued to mulch beds to be used to collect gases as they pass through the mulch (Figure 3). Gas detector tubes were used to measure the fumigant gasses in ppm.

The range used were methyl bromide (0.9 – 500ppm), methyl iodide (5 - 40ppm), and chloropicrin (0.05 – 16ppm).



Figure 3. Plastic funnels installed to collect gas fumigants released through various mulches.

Table 1. Application rate of gas fumigants used in all trails.

	Methyl Bromide (67:33)	Methyl Iodide(50:50)	Three Way Combination – Chloropicrin
Application Rate (Gallons/Acre)			
TVP* - LDPE	400	400	150
TVP – Metalized Stripe	400	400	150
PS** – LDPE	350	350	150
PS – LDPE Smooth	350	350	150
PS – Metalized	350	350	150
PS – VIF	350	350	150
PF*** – LDPE	350	350	150
PF – Metalized	175	175	75
PF - VIF	175	175	75

* Tifton Vegetable Park, ** Ponder Farm Spring, *** Ponder Farm Fall

Results and Discussion

Fumigants were applied in 6 feet by 25 feet plots with 32 inch bed tops. Methyl bromide, methyl iodide and chloropicrin were applied with a supper bedder layer injecting fumigant 8 inches with injection knives 11 inches apart. Telone II was applied with coulter injection knife at 12 inches depth 12 inches apart in the pre-bed. Vapam was

applied 4inches deep with coulter knives 4 inches apart on the bed top.

Funnels were glued to the films immediately after fumigation. Samples of the air in the funnels were taken 1, 24, 48 hours after application of the fumigants. Fumigant gas was measured every day in the funnels until no gases were detected. Plots of the measured methyl bromide gas through different

Table 2. Temperature and rainfall data for the days

Date	Max. Temp. (°F)	Min. Temp. (°F)	Rain (in)	Date	Max. Temp. (°F)	Min. Temp. (°F)	Rain (in)
Feb 22, 2006	73.4	55.6	0.00	Jul 19, 2006	93.6	74.8	0.00
Feb 23, 2006	65.7	49.1	0.02	Jul 20, 2006	93.6	71.4	0.00
Feb 24, 2006	65.5	48.0	0.00	Jul 21, 2006	94.3	72.9	0.00
Feb 25, 2006	57.7	51.4	1.48	Jul 22, 2006	94.8	74.3	0.00

mulches for the three trials are shown in figures 4-6. Figures 7-9 illustrates the measured amount of methyl iodide gas through various mulches in the three trials. The three way combination only chloropicrin could be measured with the detector tubes. The graphics showing the measured fumigant gas moving through different mulches are figures 10-12.

These figures show that the permeability of metalized and VIF mulches to fumigant gas had significant reduction to LDPE plastic mulch. This reduction is illustrated in figures 13-15. Fumigants passing through mulches were reduced by 20 to 90 percent. VIF mulch had the highest reduction.

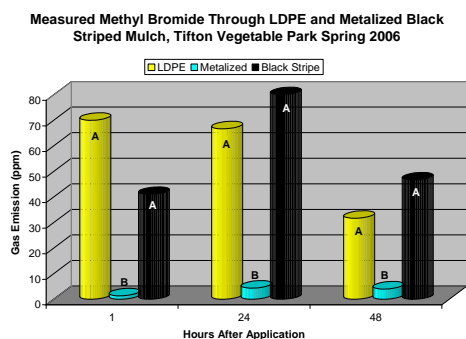


Figure 4. Measured methyl bromide fumigant gas (400 lb/acre) through LDPE and metalized black stripe mulch, Tifton Vegetable Park Spring 2006. Values followed by the same letter do not significantly differ (P=0.05, LSD).

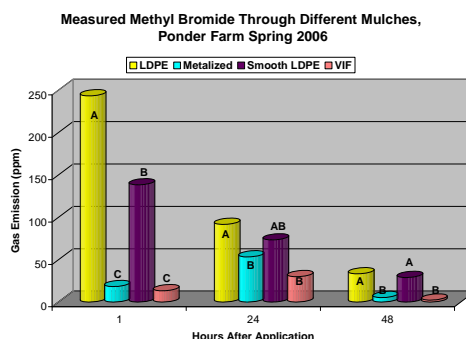


Figure 5. Measured methyl bromide fumigant gas (350 lb/acre) through LDPE, metalized, Smooth LDPE and VIF mulch, Ponder Farm Spring 2006. Values followed by the same letter do not significantly differ (P=0.05, LSD).

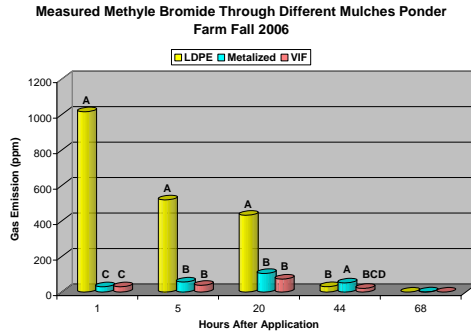


Figure 6. Measured methyl bromide fumigant gas through LDPE (350 lb/acre), metalized (175 lb/acre), and VIF (175 lb/acre) mulch, Ponder Farm Fall 2006.

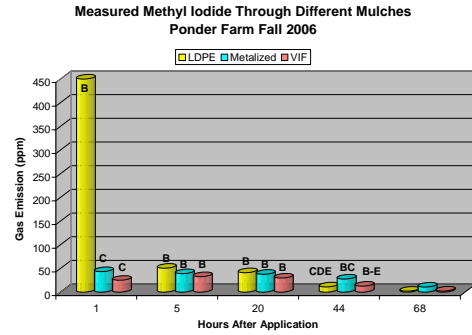


Figure 9. Measured methyl iodide fumigant gas through LDPE (350 lb/acre), metalized (175 lb/acre), and VIF (175 lb/acre) mulch, Ponder Farm Fall 2006.

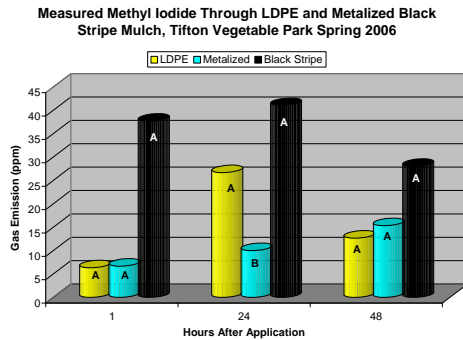


Figure 7. Measured methyl iodide fumigant gas (400 lb/acre) through metalized and black stripe mulch, Tifton Vegetable Park Spring 2006. Values followed by the same letter do not significantly differ ($P=0.05$, LSD).

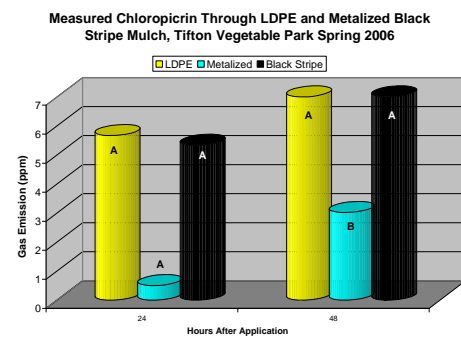


Figure 10. Measured chloropicrin fumigant gas (150 lb/acre) through metalized and black stripe mulch, Tifton Vegetable Park Spring 2006. Values followed by the same letter do not significantly differ ($P=0.05$, LSD).

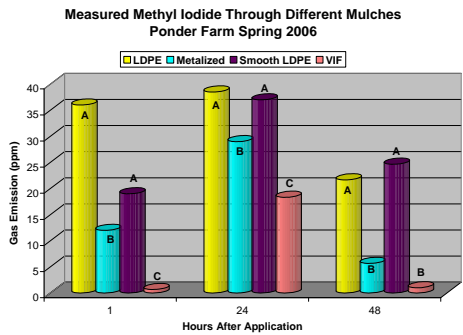


Figure 8. Measured methyl iodide fumigant gas (350 lb/acre) through LDPE, metalized, Smooth LDPE and VIF mulch, Ponder Farm Spring 2006. Values followed by the same letter do not significantly differ ($P=0.05$, LSD).

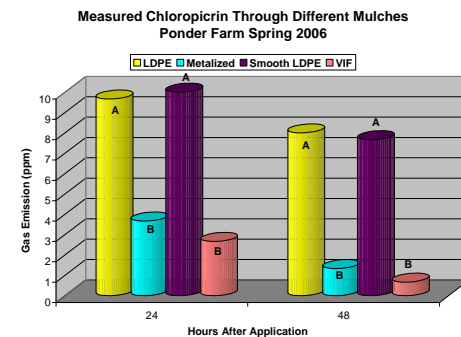


Figure 11. Measured chloropicrin fumigant gas (150 lb/acre) through LDPE, metalized, Smooth LDPE and VIF mulch, Ponder Farm Spring 2006. Values followed by the same letter do not significantly differ ($P=0.05$, LSD).

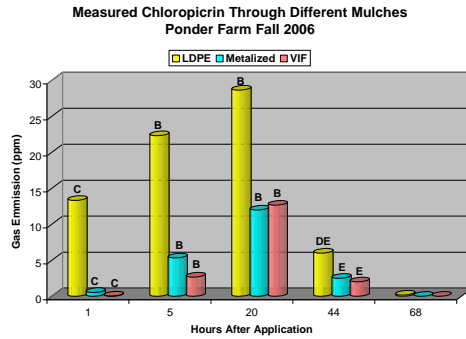


Figure 12. Measured chloropicrin fumigant gas through LDPE (150 lb/acre), metalized (75 lb/acre), and VIF (75 lb/acre) mulch, Ponder Farm Fall 2006.

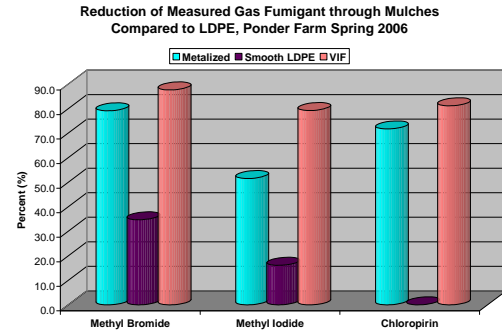


Figure 14. Reduction of fumigant due to using alternative mulches to LDPE, Ponder Farm Spring 2006.

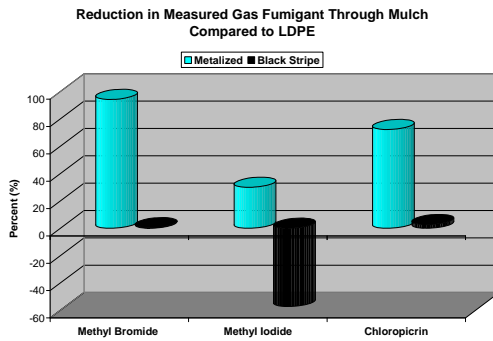


Figure 13. Reduction of fumigant due to using alternate mulch to LDPE, Tifton Vegetable Park Spring 2006.

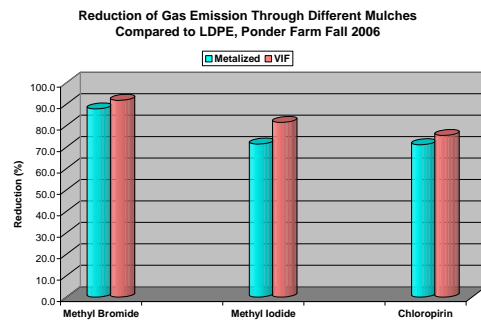


Figure 15. Reduction of fumigant due to using alternative mulches to LDPE, Ponder Farm Fall 2006.

Pepper was transplanted the week of March 14-17, 2006 for the spring tests. Before transplanting holes were punch in the mulch film 3 days prior to transplanting at the Ponder farm. The mulch film was punch and transplanted immediately at the TVP. Figure 16 shows transplant growth 3 weeks after transplanting grown in metalized black stripe mulch. The

transplants grown on the LDPE did not have as much stunting as metalized black stripe. The methyl iodide and three way fumigation showed the most stunting. Figures 18-20 illustrate the percent stunting measured at the three different tests. Pepper yield (figures 21-23) was measured on all three tests. Yields reflect the amount of stunting measured for each test.



Figure 16. Stunting of pepper 3 weeks after transplanting using metalized black strip mulch.



Figure 17. Comparison of stunting 3 weeks after transplanting on LDPE versus metalized black stripe at TVP. April 7, 2006.

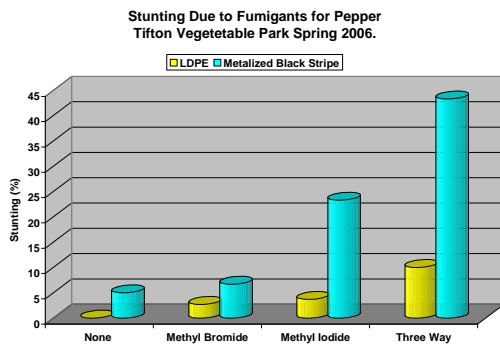


Figure 18. Comparison of plant stunting for various fumigants and mulches. Tifton Vegetable Park Spring 2006, April 17, 2006.

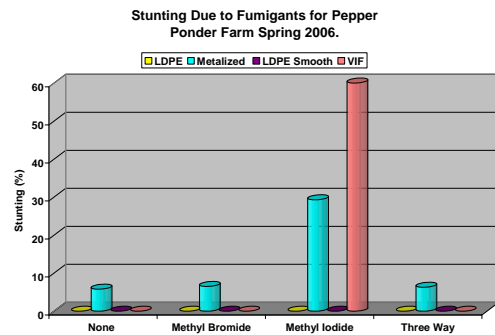


Figure 19. Comparison of plant stunting for various fumigants and mulches. Ponder Farm Spring 2006, April 21, 2006.

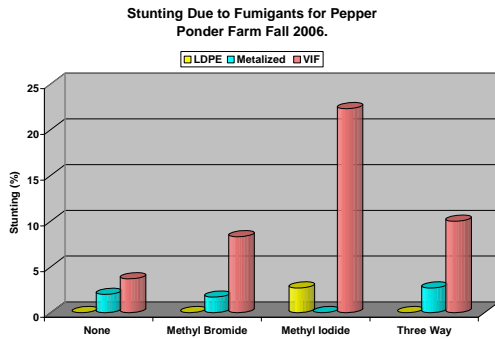


Figure 20. Comparison of plant stunting for various fumigants and mulches. Ponder Farm Fall 2006, August 15, 2006.

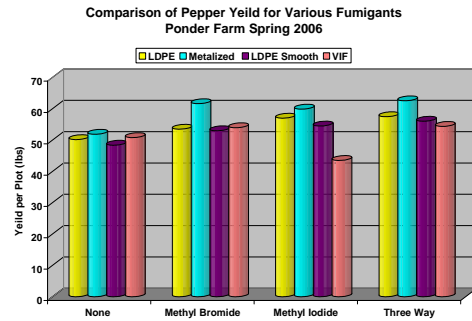


Figure 22. Comparison of pepper yields for various fumigants and mulches. Ponder Farm Spring 2006.

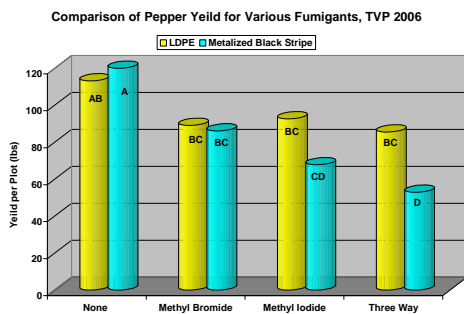


Figure 21. Comparison of pepper yields for various fumigants and mulches. Tifton Vegetable Park Spring 2006.

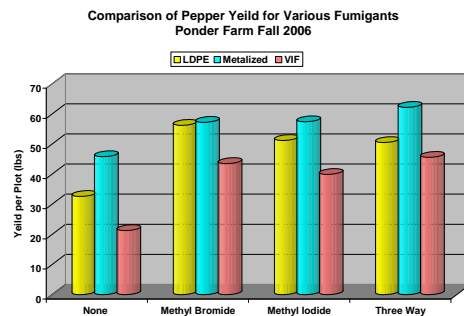


Figure 23. Comparison of pepper yields for various fumigants and mulches. Ponder Farm Fall 2006.

Conclusions

The use of higher permeability mulch plastics can reduce the amount of gas fumigants released to the atmosphere and increase the amount of contact time with the soil. Growers need to be cautious of transplant stunting when using the mulches with higher permeability.

References

Noling, J.W. 2002. Reducing Methyl Bromide Application Rates with Plastic Mulch Technology. Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. ENY-046.