NOMINATING PARTY: The United States of America

NAME USA CUN11 SOIL TOMATOES Open Field

BRIEF DESCRIPTIVE TITLE OF NOMINATION:
Methyl Bromide Critical Use Nomination for Pre-plant Soil Use for Tomato Grown in Open Fields (Submitted in 2009 for 2011 Use Season)

CROP NAME (OPEN FIELD OR PROTECTED): Tomatoes Open Field

QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION:

TABLE 1: QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION

YEAR	NOMINATION AMOUNT
2011	**336,191 kilograms**

NOMINATING PARTY CONTACT DETAILS:

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Following the requirements of Decision IX/6 paragraph (a)(1) The United States of America has determined that the specific use detailed in this Critical Use Nomination is critical because the lack of availability of methyl bromide for this use would result in a significant market disruption. . ■ Yes ☐ No

____________________ ____________________ ____________

Signature Name Date

Title: ____

(Details on this page are requested under Decision Ex. I/4(7), for posting on the Ozone Secretariat website under Decision Ex. I/4(8).)

This form is to be used by holders of single-year exemptions to reapply for a subsequent year's exemption (for example, a Party holding a single-year exemption for 2005 and/or 2006 seeking further exemptions for 2007). It does not replace the format for requesting a critical-use exemption for the first time.

In assessing nominations submitted in this format, TEAP and MBTOC will also refer to the original nomination on which the Party's first-year exemption was approved, as well as any supplementary information provided by the Party in relation to that original nomination. As this earlier information is retained by MBTOC, a Party need not re-submit that earlier information.

CONTACT OR EXPERT(S) FOR FURTHER TECHNICAL DETAILS:

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LIST OF DOCUMENTS SENT TO THE OZONE SECRETARIAT IN OFFICIAL NOMINATION PACKAGE:

1. PAPER DOCUMENTS: **Title of paper documents and appendices**	**No. of pages**	**Date sent to Ozone Secretariat**
USA CUN11 SOIL TOMATOES Open Field		
2. ELECTRONIC COPIES OF ALL PAPER DOCUMENTS: ***Title of each electronic file (for naming convention see notes above)**	**No. of kilobytes**	**Date sent to Ozone Secretariat**
USA CUN11 SOIL TOMATOES Open Field		

* Identical to paper documents

METHYL BROMIDE CRITICAL USE RENOMINATION FOR PREPLANT SOIL USE (OPEN FIELD OR PROTECTED ENVIRONMENT)

TOMATOES

1. SUMMARY OF THE NEED FOR METHYL BROMIDE AS A CRITICAL USE

This nomination is for methyl bromide use in the production of tomatoes in Florida, Georgia, The Mid-Atlantic (Maryland, and Virginia), and the Southeast. U.S. tomato growers have been reducing methyl bromide use rates in all production areas.

The primary fumigant alternatives for methyl bromide that have shown promise against key tomato pests the spring application of the fumigant combination of 1,3 D + chloropicrin, followed by chloropicrin alone, followed by metam-sodium and the newly registered fumigant iodomethane.

Current research has demonstrated that in many cases iodomethane (MIDAS®) formulated with chloropicrin can be an efficacious methyl bromide alternative, however, transition time will be needed for many tomato producers to adapt production to using this material. Growers will need this time to adapt to the use of new application equipment appropriate to the lower flow rates typical with iodomethane, to retro-fit equipment in order to avoid corrosion by iodomethane, etc. Increased costs due to using iodomethane are described in the "economic assessment" section below. Given that 2009 will be the first cropping season under the new label for the use of this fumigant, farmer adoption will be slow. Application protocols have not been sufficiently established due to limited results of long term on-farm research. A major concern with the use of iodomethane is the potential increase of plant-back timing to avoid potential crop injury and loss.

In other recent work, some research results with dimethyl disulfide (DMDS) indicate that this fumigant is promising. However, preliminary research results from a single year of fumigation in pepper production demonstrate that, as a stand-alone product, the efficacy of DMDS is not comparable to methyl bromide and will require chloropicrin (MacRae and Culpepper, 2008). Treatments with DMDS plus chloropicrin and/or metam-sodium are not significantly different from methyl bromide + chloropicrin. In any case, this fumigant is not registered in the US and therefore cannot at this time be considered a practical methyl bromide alternative.

The application of a sequential 3 way fumigant combination, the “Georgia 3 Way” (consisting of 1,3-D + chloropicrin, followed by chloropicrin, followed by metam-sodium or metam-potassium), continues to be evaluated. It is considered to be useful as a spring applied fumigant mix in the state of Georgia. It should be noted that a major part of developing a commercially feasible protocol to use this system in all regions will require adjustment of rates and application timing for field and strip applications. Trials evaluating the “Georgia 3 Way” show that it can be as efficacious against key southern US tomato pests as methyl bromide and/or iodomethane + chloropicrin. An exception to this is a study by Chellemi (2008) where, in some trials, pepper plant height and yield was reduced due to crop injury. However, the injury was later correlated with high levels of soil potassium and probably not a direct result of the fumigation. Weed and nematode control for the “Georgia 3 Way” as compared to methyl bromide were not different.

Adding to the slow adoption of this system is the lack of established protocol that will be based on mitigating potential problems such as plant-back timing, soil moisture, and location/edaphic variability. The increased production costs, and cost of new or altered equipment needed for application will also be an impediment to adoption of the three fumigant mix.

Florida

Some production areas in Florida are located above karst topographic formations which places restrictions on the use of 1,3-D. Stinging nematode problems require either methyl bromide or 1,3-D. Some fields with key disease problems have achieved good control with chloropicrin, although there may be regulatory restrictions on its use at high rates. Where 1,3-D is allowed, the application of the three fumigant mix continues to be evaluated but is not considered a viable alternative.

Preliminary research has demonstrated that iodomethane can be an efficacious methyl bromide alternative, but protocols have not been sufficiently established. Given sufficient time to transition this fumigant can be worked into the production system.

Georgia

The three way fumigant combination continues to be evaluated, and has proven to be efficacious for spring application in Georgia. However, the lack of established protocol and the cost of new or altered equipment have been a limiting factor in the adoption of this fumigant combination.

Preliminary research has demonstrated that iodomethane can be an efficacious methyl bromide alternative, but protocols have not been sufficiently established. Given sufficient time to transition these fumigants can be worked into the production system.

Mid-Atlantic

Current research in this region has not been submitted and it is thus assumed that the use of iodomethane as a methyl bromide replacement, given time to transition, will be sufficient. However, just as in many areas of the country, the establishment of protocols will slow farmer adoption. Until results from on-farm research projects have established a protocol a period of transition will be needed.

Southeast

The "Georgia 3 Way" fumigant combination continues to be evaluated in the southeast. In a comment by Craig Anderson of the University of Arkansas, the cool temperatures and wet soils in early spring will extend the plant back timing due to the additional time needed for soil fumigant levels to dissipate to avoid crop injury and subsequent yield loss (Toth, 2008)

Preliminary research conducted in states other than those in the southeast have demonstrated that iodomethane can be an efficacious methyl bromide alternative, but protocols have not been sufficiently established. Concerns in the southeast about injury and delayed planting have lead some to question their usefulness in this region. Currently, there are several economic drawbacks that include the cost of iodomethane, the cost of using VIF or metalized mulches, and an initial cost of some minor equipment alteration.

2. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE

Our review of available research on other methyl bromide alternatives discussed by MBTOC for tomatoes suggests that, of the registered (i.e., legally available) chemistries, iodomethane, and combinations of metam sodium, 1,3-D, and/or chloropicrin have shown some potential as commercially viable replacement to methyl bromide. Non-chemical alternatives are either not viable for US tomatoes or require more research and commercial development before they can be technically and economically feasible. For some areas in the state of Gerogia, a 3 way fumigant combination of 1,3 D + chloropicrin, followed by chloropicrin alone, followed by metam-sodium, has shown promise against key tomato pests in spring season only fumigation. However, the aforementioned fumigant combination has not met with success in other areas of the southeast. The transition rate included in the BUNNIE incorporates an estimate of projected use of this strategy as well as the use of iodomethane.

Many of the alternatives require the evaluation of their relationship between fumigant alternatives, various mulches, and herbicide systems under different growing conditions. From this information on-farm protocols can be established.

Alternatives are considered not feasible where:
1) they have not been sufficiently tested or protocols have not been sufficiently developed for their use
2) costs are excessive
3) application difficulties exist due to such factors as equipment requirements
4) pest pressure is so high that alternatives are not effective
5) not registered for use in the US (such as DMDS).

The US nomination is only for those areas where the alternatives are still under extensive evaluation and pest pressure is high. In US tomato production there are several factors that make some of the assumed alternatives, other than iodomethane, unsuitable. These include:
1) Pest control efficacy of alternatives: the efficacy of alternatives may not be comparable to methyl bromide in some areas, making these alternatives technically and/or economically infeasible for use in tomato production.
2) Geographic distribution of key target pests: i.e., some alternatives may be comparable to methyl bromide as long as key pests occur at low pressure. The US is only nominating a CUE for tomato where the key pest pressure is moderate to high such as nutsedge in the Southeastern US.
3) Regulatory constraints: e.g., in Florida due to the presence of karst topographical features.
4) In Virginia and much of the mid-Atlantic, high water tables and the close proximity of production areas to environmentally sensitive estuaries makes the use of 1,3-D limited.

5) Delay in planting and harvesting: e.g., the plant-back interval for telone+chloropicrin is two weeks longer than methyl bromide+chloropicrin. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.
6) Alternatives that are nonselective are restrictive as a preplant burndown only.

3. IS THE USE COVERED BY A CERTIFICATION STANDARD?

Not used to meet a certification standard.

4. IF PART OF THE CROP AREA IS TREATED WITH METHYL BROMIDE, INDICATE THE REASON WHY METHYL BROMIDE IS NOT USED IN THE OTHER AREA, AND IDENTIFY WHAT ALTERNATIVE STRATEGIES ARE USED TO CONTROL THE TARGET PATHOGENS AND WEEDS WITHOUT METHYL BROMIDE THERE.

In the areas where methyl bromide is not currently used there is often low weed and/or pathogen pressure and/or no restrictions on 1,3-D use. In areas where 1,3-D can be used, there are a many growers have cooperated with universities and others on developing application protocols specific to their conditions for the 3 way fumigant combination (1,3 D + chloropicrin, followed by chloropicrin alone, followed by metam-sodium).

5. WOULD IT BE FEASIBLE TO EXPAND THE USE OF THESE METHODS TO COVER AT LEAST PART OF THE CROP THAT HAS REQUESTED USE OF METHYL BROMIDE? WHAT CHANGES WOULD BE NECESSARY TO ENABLE THIS?

No, areas that use methyl bromide do so because environmental sensitivity and/or heavy pest pressure preclude the use of fumigants that are employed when these conditions are not present.

Researchers are continuing to evaluate fumigant concentration and mulch interaction using the 3 way fumigation combination and iodomethane (Culpepper et al, 2007). However, there is still the need for more research to determine the fumigant rates and mulch combinations needed for pest control and crop safety where there is heavy pest pressure. In a study by Culpepper (Georgia CUE appendix 2011; see Appendix A for a reproduction of this submission), the 3 way fumigant combination resulted in tomato plant heights that were lower than the methyl bromide treated plots. When using the Blockade mulch (low permeability tarp) injury was severe with plant damage and tomato yields being reduced even when the soil was allowed to air, but they have seen good results in spring applications. This is similar to information provided by growers and university personnel in the southeast (Toth, 2008)

TABLE 2. TOMATO PLANT YIELDS AND HEIGHT IN RESPONSE TO TIME OF PLANTING AFTER FUMIGATING.

Fumigant	Mulch	Planting days after fumigation	Gas in bed at planting (ppm)	Yield (#/plot, highest value fruit only; no difference noted with total fruit)	Heights (cm) (3 wk after planting)
MB	LDPE	7	29	127 a	38 a
3-WAY	LDPE	7	77	127 a	32 cd
3-WAY	Blockade	7	368	55 c	14 f
MB	LDPE	7 + 1	2	117 a	37 ab
3-WAY	LDPE	7 + 1	13	132 a	33 cd
3-WAY	Blockade	7 + 1	31	99 b	27 e
MB	LDPE	14	2	142 a	37 ab
3-WAY	LDPE	14	4	132 a	34 bc
3-WAY	Blockade	14	38	114 a	30 de
MB	LDPE	14 + 1	0	133 a	35 abc
3-WAY	LDPE	14 + 1	3	127 a	33 cd
3-WAY	Blockade	14 + 1	27	119 a	30 de

Source: Georgia CUE Appendix; see Appendix A for a reproduction of this submission.

Developing a protocol for this system includes the titration of rates for field and strip applications (table 3). In preliminary data comparing the 3 fumigant combination, results have demonstrated that methyl bromide and iodomethane do not significantly differ in efficacy. However variability among results across locations demonstrates the need for further research (Toth, 2008). An exception to these findings was a study by Chellemi (2008) where pepper plant height and yield was reduced due to crop injury; however, the injury was later correlated with high levels of soil potassium and probably not a direct result of the fumigation. On the other hand, in three of the trials weed and nematode control for the three fumigant combination and methyl bromide were low; less than 0.01 weeds / foot of row and nematode concentration was less than 1.0 / 100 cc of soil.

TABLE 3. UGA Three FUMIGANT COMBINATION Adjusted Rates 11-2008.

Fumigant(s)	Rate (lb/acre)	Rate Adjusted for Strip Treatment (lb / acre)	Method
Methyl Bromide Chloropicrin	143 143	83 83	bedded, shank, standard tarp
Methyl Bromide Chloropicrin	143 143	83 83	bedded, shank, high barrier tarp
1,3-Dichloropropene Chloropicrin Metam Sodium	171 150 320	99 87 186	bedded, shank, standard tarp
1,3-Dichloropropene Chloropicrin Metam Sodium	171 150 320	99 87 186	bedded, shank, high barrier tarp

Source: Rates and application methods represent likely scenarios based on information from USDA NASS, EPA proprietary data, and/or stakeholder-submitted comments.
Table taken from Georgia CUE Appendix; see Appendix A for a reproduction of this submission.

Tomato growers in Maryland have again requested methyl bromide. These growers have historically used methyl bromide in their tomato production, purchasing it from the stockpile since the 2005 ban. Maryland growers, in common with other tomato growers in the mid-Atlantic region, have production areas with high water tables and in close proximity to environmentally sensitive estuaries; these factors make the use of 1,3-D limited, and thus the three fumigant combination cannot be considered as an alternative.

Techniques such as grafting, resistant rootstocks immune to target fungal pathogens, plant breeding, soil-less culture, organic production, substrates, plug, are not commercially feasible. Availability of such transplants is further hampered by the lack of infrastructure to make grafted tomato plants available on a large scale, concomitant with this is the high premium associated with these transplants at this time. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of fungal pathogens, nutsedges and nematodes. Grafting of solanaceous plants is relatively new to US growers, and has met with a great deal of concern regarding the potential for the establishment of off-type plants developing from the rootstock and/or fruit seeds. N. Burell et al. (2008) evaluated various grafted tomato cultivars in fields where iodomethane, DMDS, or methyl bromide were applied. The results of their research demonstrated that regardless of rootstock, yields of tomato plants responded equally without regard to fumigant type. In this case it would seem that the steady pace of on going transitioning to alternative herbicides such as iodomethane would be more advantageous to pursue.

6. SUMMARY OF RECENT RESEARCH

As mentioned earlier in this document, iodomethane formulated with chloropicrin has shown good efficacy against key tomato pests, including nutsedge, in a number of trials with tomato and related vegetables such as peppers (e.g., Louws et al. 2006, Culpepper 2006, 2007, 2008, Culpepper et al. 2008, Olsen 2008). Iodomethane had time limitations removed from its federal label in October, 2008, and has received state-level approval in 47 US states (California, Washington, and New York are the exceptions at this time). However, other important constraints must be considered when assessing the feasibility of iodomethane as a methyl bromide alternative. These include: (1) the cost of iodomethane formulations is higher than methyl bromide, and will probably remain so for the next several years, (2) growers and researchers will need time to evaluate iodomethane use in the various local production conditions covered by this nominations, and (3) growers and applicators will need to make some equipment modifications to adapt to the lower flow rates typical with less expensive iodomethane application rates and to avoid the corrosion of some metals that can occur with iodomethane (Sumner 2005, Noling et al. 2006). The economic impact of using iodomethane is further described in item 7 in this document (below). A consideration of these aspects has led the USG to conclude that while iodomethane appears to be technically feasible to manage key tomato pests in all parts of the US where it has been registered, time will be needed for growers and extension service experts to adapt its use successfully. Therefore, the amount of methyl bromide nominated for tomato has been adjusted downward while also considering the time needed to transition to iodomethane.

Performance data presented by B. Olsen at the November 2008 MBAO conference reported tomato yield data from 12 field sites where the average increase in yields from iodomethane treated plots over methyl bromide treated plots was 11 percent. Ten of the 12 study sites were in the southeast. It must be noted that there was no statistical analysis present with this data and as such there is no confirmation on whether this reported average increase in yields is significant. Despite these results, representatives of the southeast tomato growers' consortia are currently cautious about recommending iodomethane as a methyl bromide replacement (Toth, 2008).

Research conducted in Georgia demonstrated that, in small plots, purple nutsedge control for methyl bromide, iodomethane, and DMDS were not significantly different under LDPE, metalized, or VIF mulch (table 4). Yields of pepper and cucumber plants fumigated with iodomethane under VIF were not different from yields for untreated plots (Culpepper et al, 2007). The reader should keep in mind here that DMDS is not registered for use in the USA.

In a study by Chellemi (2008), pepper plant height and yield was reduced due to crop injury. However, the injury was later correlated with high levels of soil potassium and probably not a direct result of the fumigation. In this same study, three of the four trials reported weed and nematode control for the three fumigant combination and methyl bromide at less than 0.01 weeds / foot of row and nematode concentration at less than 1.0 / 100 cc of soil.

TABLE 4. PURPLE NUTSEDGE PLANTS IN SMALL PLOT PEPPER CROP (20 SQ FT)

*Fumigant(s)	Mulch		
	LDPE	Metalized	VIF
Methyl Bromide	0.5 a	0.0 a	0.3 a
Iodomethane	0.8 a	0.3 a	0.8 a
DMDS	2.5 a	0.5 a	0.0 a
Untreated	84 d	76 d	54 c

*All fumigation treatments contain chloropicrin.Table taken from Culpepper et al (2007)

Hausbeck and Cortright (2007) measured cucurbit plant vigor to determine fumigant/mulch interactions using either LPDE or VIF plastic mulch for the control of *Fusarium oxysporum*. Of the fumigants used in the study, the methyl bromide and iodomethane treatments resulted in cantaloupe plants with the highest vigor (Table 5). In general, treatments under LPDE had higher plant vigor when compared with plants grown under VIF. It is noteworthy that in this study VIF tarps were prone to wind removal, which reduced their reliability under some growing conditions.

TABLE 5: EVALUATION OF FUMIGANTS AND PLASTIC MULCHES FOR MANAGING *FUSARIUM* IN CUCURBIT CROPS 2007

Treatment (time after treatment to planting)	Rate of formulated product	Vigor*	
Untreated control under LDPE (5 days)		1.0-1.3	a**
Iodomethane+chloropicrin 50:50 under LDPE (10 days)	196 kg/ha	1.0	a
Iodomethane+chloropicrin 50:50 under VIF (10 days)	196 kg/ha	3.0	c
Methyl bromide+chloropicrin 67:33 under LDPE (10 days)	280 kg/ha	1.0	a
Methyl bromide+chloropicrin 67:33 under VIF (10 days)	280 kg/ha	2.7	bc
1,3 D + chloropicrin 65:35 under LDPE (21 days)	187 liters/ha	2.3	bc
1,3 D + chloropicrin 65:35 under VIF (21 days)	187 liters/ha	4.7	d
Chloropicrin under LDPE (14 days)	187 liters/ha	2.7	c
Chloropicrin under VIF (14 days)	187 liters/ha	3.3	cd

*Vigor rating of plant health; 1=healthy plants with no stunting, 5= moderated plant stunting with variable stand, 10=complete plant death.
**Column means with a letter in common are not significantly different (Fisher LSD Method; *P*=0.05).
From Hausbeck and Cortright 2007.

In addition to the limitations of VIF discussed above, the USG notes that the plant vigor in 1,3 D treatments in these new trials is lower than that seen in methyl bromide treatments. This is similar to what was seen in previous years' tests (Hausbeck and Cortright 2004; see also discussion in the cucurbit nominations).

As far as the USG has been able to determine, no other studies have been conducted since 2007 to evaluate the technical and commercial feasibility of fumigant alternatives to methyl bromide for controlling *F. oxysporum* subtypes under production conditions relevant to the Maryland/Delaware regions.

7. ECONOMIC FEASIBILITY OF ALTERNATIVES

The following economic analysis is organized by methyl bromide critical use application regions.

Readers should note that in this study net revenue is calculated as gross revenue minus operating costs. This is a good measure as to the direct losses of income that may be suffered by the users. It should be noted that net revenue does not represent net income to the users. Net income, which indicates profitability of an operation of an enterprise, is gross revenue minus the sum of operating and fixed costs. Net income should be smaller than the net revenue measured in this study. Fixed costs were not included because they are often difficult to measure and verify.

Summary of Economic Feasibility

The economic analysis of the tomato application compared data on yields, crop prices, revenues and costs using methyl bromide and using alternative pest control regimens in order to estimate the loss of methyl bromide availability. The alternatives identified as technically feasible - in cases of low pest infestation[1] – for different regions by the U.S. are: (a) iodomethane and (b) 1,3-dichloropropene and chloropicrin followed by chloropicrin, followed by metam-sodium/potassium (otherwise referred to as the Georgia 3-Way).

The economic factors that drive the feasibility analysis for fresh market tomato uses of methyl bromide alternatives are: (1) yield losses, referring to reductions in the quantity produced, (2) increased production costs, which may be due to the higher-cost of using an alternative, additional pest control requirements, and/or resulting shifts in other production or harvesting practices (3) quality losses, which generally affect the quantity and price received for the goods, and (4) missed market windows due to plant back time restrictions, which also affect the quantity and price received for the goods.

The economic reviewer then analyzed crop budgets for pre-plant sectors to determine the likely economic impact if methyl bromide were unavailable. Various measures were used to quantify the impacts, including the following:

(1) **Loss per Hectare.** For crops, this measure is closely tied to income. It is relatively easy to measure, but may be difficult to interpret in isolation.

(2) **Loss per Kilogram of Methyl Bromide**. This measure indicates the value of methyl bromide to crop production.

(3) **Loss as a Percentage of Gross Revenue.** This measure has the advantage that gross revenues are usually easy to measure, at least over some unit, *e.g.*, a hectare of land or a storage operation. However, high value commodities or crops may provide high revenues but may also entail high costs. Losses of even a small percentage of gross revenues could have important impacts on the profitability of the activity.

(4) **Loss as a Percentage of Net Operating Revenue**. We define net cash revenues as gross revenues minus operating costs. This is a very good indicator as to the direct losses of income that may be suffered by the owners or operators of an enterprise. However, operating costs can often be difficult to measure and verify.

(5) **Operating Profit Margin**. We define operating profit margin to be net operating revenue divided by gross revenue per hectare. This measure would provide the best indication of the total impact of the loss of methyl bromide to an enterprise. Again, operating costs may be difficult to measure and fixed costs even more difficult, therefore fixed costs were not included in the analysis.

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[1] It should be noted that the USG does not request methyl bromide for use in areas of low to moderate pest pressure. Only cases where key pests are present at moderate to high levels require methyl bromide for pest pressure.

These measures represent different ways to assess the economic feasibility of methyl bromide alternatives for methyl bromide users, who are tomato producers in this case. Because producers (suppliers) represent an integral part of any definition of a market, we interpret the threshold of significant market disruption to be met if there is a significant impact on commodity suppliers using methyl bromide. The economic measures provide the basis for making that determination.

Eastern US

We conclude that, at present, iodomethane would be the economically feasible alternative to methyl bromide for use in Eastern US tomato production in areas exhibiting karst topographical features. However, see the technical discussion above for a description of reasons why time will be needed for growers to transition to routine, commercially feasible iodomethane use. In areas where karst features are not present it appears that tomato growers can use a combination of three fumigants applied sequentially (1,3-D, chloropicrin, and metam-sodium/potassium) and achieve yields that are comparable to those produced by using methyl bromide for spring crops only. The USG factored this new technique into their request by adding a four year transition (assuming that all non-karst spring fumigations for tomatoes in the Southeast will transition away from methyl bromide over four years) for spring fumigations.

TABLE 6. VIRGINIA: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

VIRGINIA TOMATO GROWERS	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (CWT)	920	920	920
* PRICE PER UNIT (US$)	$ 33	$ 33	$ 33
= GROSS REVENUE PER HECTARE (US$)	$ 29,902	$ 29,902	$ 29,902
- OPERATING COSTS PER HECTARE (US$)*	$ 26,907	$ 28,354	$ 27,687
= NET REVENUE PER HECTARE (US$)	$ 2,995	$ 1,548	$ 2,215
1. LOSS PER HECTARE (US$)	$ -	$ 1,447	$ 780
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 17	$ 9
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	5%	3%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	48%	26%
5. OPERATING PROFIT MARGIN (%)	10%	5%	7%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

TABLE 7. MARYLAND: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

MARYLAND TOMATO GROWERS	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (BOX 25LBS)	4,953	4,953	4,953
* PRICE PER UNIT (US$)	$ 7	$ 7	$ 7
= GROSS REVENUE PER HECTARE (US$)	$ 35,287	$ 35,287	$ 35,287
- OPERATING COSTS PER HECTARE (US$)*	$ 30,269	$ 31,969	$ 31,888
= NET REVENUE PER HECTARE (US$)	$ 5,018	$ 3,319	$ 3,399
1. LOSS PER HECTARE (US$)	$ -	$ 1,699	$ 1,619
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 23	$ 22
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	5%	5%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	34%	32%
5. OPERATING PROFIT MARGIN (%)	14%	9%	10%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

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TABLE 8. SOUTHEASTERN US: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

SOUTHEASTERN TOMATO CONSORTIUM **	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (BOX 25LBS)	4,942	4,942	4,942
* PRICE PER UNIT (US$)	$ 7	$ 7	$ 7
= GROSS REVENUE PER HECTARE (US$)	$ 35,830	$ 35,830	$ 35,830
- OPERATING COSTS PER HECTARE (US$)*	$ 33,913	$ 35,428	$ 34,762
= NET REVENUE PER HECTARE (US$)	$ 1,918	$ 402	$ 1,069
1. LOSS PER HECTARE (US$)	$ -	$ 1,516	$ 849
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 20	$ 11
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	4%	2%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	79%	44%
5. OPERATING PROFIT MARGIN (%)	5%	1%	3%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

** Includes: South-Eastern United States (Alabama, Arkansas, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee).

TABLE 9. GEORGIA: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

GEORGIA FRUIT & VEGETABLE GROWERS ASSOCIATION	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (BOX 25LBS)	6,830	6,830	6,830
* PRICE PER UNIT (US$)	$ 9	$ 9	$ 9
= GROSS REVENUE PER HECTARE (US$)	$ 58,342	$ 58,342	$ 58,342
- OPERATING COSTS PER HECTARE (US$)*	$ 56,522	$ 57,763	$ 58,178
= NET REVENUE PER HECTARE (US$)	$ 1,820	$ 578	$ 164
1. LOSS PER HECTARE (US$)	$ -	$ 1,241	$ 1,656
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 8	$ 11
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	2%	3%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	68%	91%
5. OPERATING PROFIT MARGIN (%)	3%	1%	0%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

Florida

We conclude that, at present, iodomethane would be the economically feasible alternative to methyl bromide for use in Florida tomato production in areas of karst topography. Where karst features are not present the USG assumed that the sequential application of the three chemicals (discussed above) would have results that are similar to the performance of methyl bromide for spring plantings. Consequently, as described above, the transition was adjusted to account for the new combination

TABLE 10. FLORIDA NORTH: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

FLORIDA FRUIT & VEGETABLE ASSOCIATION – NORTH FLORIDA	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (BOX 25LBS)	3,548	3,548	3,548
* PRICE PER UNIT (US$)	$ 10	$ 10	$ 10
= GROSS REVENUE PER HECTARE (US$)	$ 34,874	$ 34,874	$ 34,874
- OPERATING COSTS PER HECTARE (US$)*	$ 30,804	$ 32,515	$ 31,848
= NET REVENUE PER HECTARE (US$)	$ 4,070	$ 2,359	$ 3,026
1. LOSS PER HECTARE (US$)	$ -	$ 1,711	$ 1,044
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 20	$ 12
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	5%	3%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	42%	26%
5. OPERATING PROFIT MARGIN (%)	12%	7%	9%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

TABLE 11. FLORIDA RUSKIN PALMETTO: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

FLORIDA FRUIT & VEGETABLE ASSOCIATION – RUSKIN PALMETTO	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (BOX 25LBS)	3,548	3,548	3,548
* PRICE PER UNIT (US$)	$ 10	$ 10	$ 10
= GROSS REVENUE PER HECTARE (US$)	$ 34,874	$ 34,874	$ 34,874
- OPERATING COSTS PER HECTARE (US$)*	$ 32,722	$ 33,452	$ 32,785
= NET REVENUE PER HECTARE (US$)	$ 2,152	$ 1,422	$ 2,089
1. LOSS PER HECTARE (US$)	$ -	$ 730	$ 63
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 7	$ 1
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	2%	0%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	34%	3%
5. OPERATING PROFIT MARGIN (%)	6%	4%	6%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

TABLE 12. FLORIDA PALM BEACH: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

FLORIDA FRUIT & VEGETABLE ASSOCIATION – PALM BEACH	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (BOX 25LBS)	4,666	4,666	4,666
* PRICE PER UNIT (US$)	$ 11	$ 11	$ 11
= GROSS REVENUE PER HECTARE (US$)	$ 50,152	$ 50,152	$ 50,152
- OPERATING COSTS PER HECTARE (US$)*	$ 48,230	$ 49,197	$ 48,530
= NET REVENUE PER HECTARE (US$)	$ 1,922	$ 955	$ 1,622
1. LOSS PER HECTARE (US$)	$ -	$ 967.11	$ 300.23
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 8.63	$ 2.68
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	2%	1%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	50%	16%
5. OPERATING PROFIT MARGIN (%)	4%	2%	3%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

TABLE 13. FLORIDA SOUTHWEST: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

FLORIDA FRUIT & VEGETABLE ASSOCIATION – SOUTHWEST	METHYL BROMIDE	Iodomethane	GA – 3 WAY METHOD
PRODUCTION LOSS (%)	0%	0%	0%
PRODUCTION PER HECTARE (BOX 25LBS)	4,666	4,666	4,666
* PRICE PER UNIT (US$)	$ 11	$ 11	$ 11
= GROSS REVENUE PER HECTARE (US$)	$ 50,152	$ 50,152	$ 50,152
- OPERATING COSTS PER HECTARE (US$)*	$ 48,230	$ 49,197	$ 48,530
= NET REVENUE PER HECTARE (US$)	$ 1,922	$ 955	$ 1,622
1. LOSS PER HECTARE (US$)	$ -	$ 967.11	$ 300.23
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 8.63	$ 2.68
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	2%	1%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	50%	16%
5. OPERATING PROFIT MARGIN (%)	4%	2%	3%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

TABLE 14. FLORIDA DADE: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

FLORIDA FRUIT & VEGETABLE ASSOCIATION – DADE	METHYL BROMIDE	Iodomethane	METAM PLUS CHLOROPICRIN
PRODUCTION LOSS (%)	0%	0%	15%
PRODUCTION PER HECTARE (BOX 25LBS)	3,548	3,548	3,016
* PRICE PER UNIT (US$)	$ 10	$ 10	$ 10
= GROSS REVENUE PER HECTARE (US$)	$ 34,874	$ 34,874	$ 29,643
- OPERATING COSTS PER HECTARE (US$)*	$ 34,172	$ 34,665	$ 34,202
= NET REVENUE PER HECTARE (US$)	$ 702	$ 209	$ (4,559)
1. LOSS PER HECTARE (US$)	$ -	$ 493	$ 5,261
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 3	$ 35
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	1%	15%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	70%	750%
5. OPERATING PROFIT MARGIN (%)	2%	1%	-15%

*Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

8. RESULTANT CHANGES TO REQUESTED EXEMPTION QUANTITIES

The USG has applied an aggressive transition rate which is reflected in the nomination amount and detailed in Table 15.

TABLE 15. NOMINATION AMOUNT: 2011 Methyl Bromide Usage Newer Numerical Index (BUNNI) – Transition Use Reduction Description Spreadsheet**.**

SECTOR		TOMATOES					
		Maryland Tomatoes	Virginia Tomato	Southeast Tomato Total	Georgia Tomato	Florida Tomato Total	Sector Total / Average
Quantity Requested for 2010:	Amount (kgs)	729	33,141	100,929	48,088	545,570	728,457
Quantity Recommended by MBTOC/TEAP for 2010 :	Amount (kgs)	729	33,141	100,929	48,088	545,570	728,457
Quantity Approved by Parties for 2010:	Amount (kgs)	729	33,141	100,929	48,088	545,570	728,457
	Area (ha)	5	203	619	296	3,356	4,479
	Rate	146	163	163	162	163	163
Transition from 2010 Baseline Adjusted Value	Percentage (%)	-70%	-82%	-83%	-81%	-81%	-81%
Quantity Required for 2011 Nomination:	Amount (kgs)	**365**	**14,145**	**44,781**	**21,578**	**255,322**	**336,191**
	Area (ha)	**2**	**87**	**275**	**132**	**1566**	**2062**
	Rate	**183**	**163**	**163**	**163**	**163**	**163**

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APPENDIX A

Reproduced from the 2011 Critical Use Exemption Application submitted by the Georgia Fruit & Vegetable Association

Summarized and Compiled by
A. Stanley Culpepper, University of Georgia, Tifton

1. Methyl Bromide Data Generated in Georgia

Continued efforts are underway in Georgia to implement effective and economical alternatives to methyl bromide. During the spring of 2008, at least 40% of the land fumigated for vegetable crops in the spring was treated with the 3-WAY which includes a systems approach of 1,3-dichloropropene, chloropicrin, and metam sodium. It is likely that 30 to 40% of Georgia's total crop will be treated with this alternative during 2008. Dimethyl disulfide (DMDS) plus chloropicrin also has proven to be effective in managing many pests and has the potential to be adopted once the price structure is known.

Although both the 3-WAY and DMDS appear promising, neither fumigant system will stand alone in managing pests. A herbicide program must be developed to compliment these fumigant systems. The 3-WAY does not provide adequate nutsedge control with summer/fall fumigations and the DMDS system does not adequately control grasses or *Amaranthus* species. Until program using fumigants and herbicides can be developed, having methyl bromide available is essential.

The two aforementioned fumigant systems also pose significant challenges when determining the time interval needed between fumigating and planting. Initial research results suggest the plant back interval for the 3-WAY will be at least 3 times longer than that noted with methyl bromide (Item 3 below). For DMDS, the research is currently in progress with results available by September of 2008. Early indications suggest that the plant back for DMDS plus chloropicrin applied under a high barrier mulch will be similar to that noted with the 3-WAY system.

Future research will focus on developing and implementing a herbicide program to compliment both the 3-WAY and DMDS fumigant systems as well as determining the amount of time that must pass between fumigating with these alternatives and planting.

2. A herbicide system must be developed for the UGA 3-WAY during summer/fall fumigation

Introduction

Georgia growers are adopting an effective alternative to methyl bromide during the spring fumigation cycle. However, research is needed to determine if this alternative is effective during the summer/fall fumigation period. Fumigants may be less effective in the summer/fall when compared to the spring because of warmer soils causing increased gas dissipation.

Materials and Methods

An experiment was conducted in TyTy Georgia at the University of Georiga's Ponder Farm. The trial was conducted on a Tifton sandy loam soil with 92% sand, 2% silt, and 6% clay with a pH of 6.4 and 1% organic matter. Land was prepared by disking the trial area multiple times and then roto-tilling a 6 foot wide bed by 60 feet in length for each plot immediately prior to fumigating and installing mulch.

The study was fumigated during the fall of 2007 on July 17. Soil temperature was 84 degrees at 8 inches. The experiment consisted of 4 treatments (Table 1) that were replicated three times. The UGA 3-WAY consisted of a system of Telone II (12 gal/A) followed by chloropicrin (150 lb/A) followed by Vapam (75 gal/A). The Telone II was placed 12 inches deep using a Yetter system having 3 injection knives on a 32 inch bed top, methyl bromide and chloropicrin were injected 8 inches deep with a super bedder using 3 injection knives on a 32 inch bed top, and Vapam was injected 4 inches deep and 4 inches apart using disc blades in the final bed just prior to covering with mulch. Methyl bromide was applied at 240 lb/A. All fumigant rates are provided as broadcast rates but were actually only applied in the bed. Mulch used included low density polyethylene or Blockade high barrier mulch.

Visual crop injury, visual weed control, and the number of nutsedge shoots penetrating the mulch were measured throughout the season. No visual injury was noted. Percent control and nutsedge penetrating the crop provided similar results thus only percent control is reported. Jumbo pepper was harvested four times, once a week for four weeks.

Table 1. Comparing methyl bromide and the 3-Way for the control of nutsedge and tomato yield.

Fumigant	Mulch		Late-season purple nutsdege control		Harvests 1-2 (Jumbo pepper)			Harvests 1-4 (Jumbo pepper)	
			%		# fruit/plot	lbs/plot		# fruit/plot	lbs/plot
3-WAY	LDPE		48 d		34 c	16 c		44 c	19 c
3-WAY	Blockade		60 c		50 b	24 b		71b	32 b
MB	Blockade		85 b		106 a	48 a		136 a	61 a
None	LDPE		0 f		13 d	6 d		19 d	8 d

Results and Discussion

Poor nutsedge control was noted with the UGA 3-WAY system when applied under LDPE or Blockade mulch. Fumigant gas emissions occurred so rapidly that nutsedge tubers were likely not under a high enough concentration of gases long enough to provide adequate control as is the case in the spring. Methyl bromide was far more effective with nearly twice the level of control noted with the 3-WAY even under blockade mulch. As expected, yields followed trends in nutsedge control since it was the only pest impacting the crop. Yields from plots treated with methyl bromide were more than double that of the UGA 3-WAY applied under LDPE mulch. Although yield was improved with the 3-WAY applied under blockade mulch compared to LDPE mulch, this higher yield was only approximately half of that noted with the methyl bromide system.

Conclusions

The UGA 3-WAY is not a stand alone replacement to methyl bromide during a summer/fall fumigation in Georgia. Either an effective and economical herbicide system must be developed to compliment this alternative program or another more effective fumigant system must be developed.

3. Determining plant back intervals when fumigating with the UGA 3-WAY

Introduction

The UGA 3-WAY system is replacing methyl bromide rapidly in Georgia. Although this system has been effective during the spring, the program has the potential to delay planting after fumigation. Research is needed to determine the time interval needed between fumigation and planting vegetable crops.

Materials and Methods

An experiment was conducted in Tifton Georgia at the University of Georgia's Tifton Vegetable Park. The trial was conducted on a Tifton sandy loam soil with 94% sand, 2% silt, and 4% clay with a pH of 6.2 and 1% organic matter. Land was prepared by disking the trial area multiple times and then roto-tilling a 6 foot wide bed by 20 feet in length for each plot immediately prior to fumigating and installing mulch.

The study was fumigated during the spring of 2007 on February 27. Soil temperature was 59 degrees at 8 inches. The experiment consisted of 12 treatments (Table 1) that were replicated three times. The UGA 3-WAY consisted of a system of Telone II (12 gal/A) followed by chloropicrin (150 lb/A) followed by Vapam (75 gal/A). The Telone II was placed 12 inches deep using a Yetter system having 3 injection knives on a 32 inch bed top, chloropicrin was placed 8 inches deep with a super bedder using 3 injection knives on a 32 inch bed top, and Vapam was injected 4 inches deep and 4 inches apart using disc blades in the final bed just prior to covering with mulch. Methyl bromide (MB) was included for comparison and was applied at 350 lb/A. All fumigant rates are provided as broadcast rates but were actually only applied in the bed. Mulch used included low density polyethylene or Blockade high barrier. Crops were planted 7 or 14 days after fumigating while poking the plant hole through the mulch. Crops were also planted on days 8 or 15 which was 1 day after poking the hole on days 7 and 14 in an attempt to air the bed. Crops planted included tomato, pepper and cucumber.

Visual crop injury and crop heights (7 tomato, 20 pepper, 7 cucumber plants per plot) were measured throughout the season. Tomato, pepper and cucumber were harvested five, four, and nine times, respectively.

Table 1. Plant heights in response to time of planting after fumigating.

Fumigant	Mulch	Planting days after fumigation	Gas in bed at planting		Heights (cm) (3 wk after planting)		
			ppm		Tomato	Pepper	Cucumber
MB	LDPE	7	29		38 a	21 ab	30 ab
3-WAY	LDPE	7	77		32 cd	17 d	24 d
3-WAY	Blockade	7	368		14 f	4 f	12 f
MB	LDPE	7 + 1	2		37 ab	20 abc	32 a
3-WAY	LDPE	7 + 1	13		33 cd	18 cd	26 cd
3-WAY	Blockade	7 + 1	31		27 e	11 e	20 e
MB	LDPE	14	2		37 ab	22 a	32 a
3-WAY	LDPE	14	4		34 bc	20 abc	31 ab
3-WAY	Blockade	14	38		30 de	18 cd	28 bc

MB	LDPE	14 + 1	0		35 abc	22 a	31 ab
3-WAY	LDPE	14 + 1	3		33 cd	21 ab	31 ab
3-WAY	Blockade	14 + 1	27		30 de	19 bcd	28 bc

Table 2 . Plant yields in response to time of planting after fumigating.

Fumigant	Mulch	Planting days after fumigation	Gas in bed at planting		Yield (#/plot, highest value fruit only; no difference noted with total fruit)		
			ppm		Tomato	Pepper	Cucumber
MB	LDPE	7	29		127 a	227 a	45 de
3-WAY	LDPE	7	77		127 a	195 ab	60 a
3-WAY	Blockade	7	368		55 c	114 c	40 e
MB	LDPE	7 + 1	2		117 a	212 a	47 cde
3-WAY	LDPE	7 + 1	13		132 a	193 ab	57 ab
3-WAY	Blockade	7 + 1	31		99 b	159 bc	47 cde
MB	LDPE	14	2		142 a	220 a	49 bcde
3-WAY	LDPE	14	4		132 a	190 ab	55 abc
3-WAY	Blockade	14	38		114 a	188 ab	49 bcde
MB	LDPE	14 + 1	0		133 a	204 ab	49 bcde
3-WAY	LDPE	14 + 1	3		127 a	202 ab	50 bcd
3-WAY	Blockade	14 + 1	27		119 a	190 ab	42 de

Results and Discussion

No visual stunting from methyl bromide was noted with any treatment at 3 wk after transplanting (data not shown). When planting 7 days after fumigating with the 3-WAY under LDPE mulch, crop heights were reduced at least 20% when compared to the methyl bromide control (Table 1). Growth reduction from the 3-WAY under Blockade mulch was far greater and ranged from 60 to 80%. Airing the bed for one day did not alleviate stunting. Waiting 14 days after fumigating before planting did alleviate fumigant stunting when crops were planted on the LDPE mulch. However, significant reduction in plant growth was still noted when planting into the blockade mulch. Airing the bed for 1 d did not eliminate crop stunting when planting on the blockade mulch.

Tomato and cucumber were resilient in overcoming early season reduction in plant growth with only minor trends for reduced yields when planted on LDPE mulch, when compared to the methyl bromide control. Yield reductions were noted with tomato when planted on Blockade mulch at 7 or 8 d after fumigating. Pepper tended to be more sensitive than other crops with lower yields or a trend for lower yields when planting on both mulches at each planting date except for the 15 day plant date on LDPE mulch.

Results and Discussion

This research is the first step in determining the time interval needed between fumigating and planting. The most effective tactic will likely not be days after fumigating but ppm of fumigant in the bed at planting as the environment plays such a role in the dissipation of gas from the soil. This research suggests that for the UGA 3-WAY, less than 5 ppm should be in the bed at time of planting.