

**METHYL BROMIDE CRITICAL USE NOMINATION FOR PREPLANT SOIL USE FOR EGGPLANT
GROWN IN OPEN FIELDS**

FOR ADMINISTRATIVE PURPOSES ONLY: DATE RECEIVED BY OZONE SECRETARIAT: YEAR: CUN:

NOMINATING PARTY:	The United States of America
BRIEF DESCRIPTIVE TITLE OF NOMINATION:	Methyl Bromide Critical Use Nomination for Preplant Soil Use for Eggplant Grown in Open Fields (Submitted in 2006 for 2008 Use Season)

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<p>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.</p> <p style="text-align: center;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>

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

List all paper and electronic documents submitted by the Nominating Party to the Ozone Secretariat

1. PAPER DOCUMENTS: Title of Paper Documents and Appendices	Number of Pages	Date Sent to Ozone Secretariat

2. ELECTRONIC COPIES OF ALL PAPER DOCUMENTS: Title of Electronic Files	Size of File (kb)	Date Sent to Ozone Secretariat

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PART A: SUMMARY

1. NOMINATING PARTY:

The United States of America (U.S.)

2. DESCRIPTIVE TITLE OF NOMINATION:

Methyl Bromide Critical Use Nomination for Preplant Soil Use for Eggplant Grown in Open Fields (Submitted in 2006 for 2008 Use Season)

3. CROP AND SUMMARY OF CROP SYSTEM:

This is a request for eggplant grown in the States of Florida, Georgia, and Michigan. In Florida, eggplant can be grown year-round, and are often double cropped with pepper or cucumber following eggplant harvest. The vegetable crop that follows eggplant in a double cropping production system depends upon prevailing environmental and economic factors. Growers in Florida often put eggplant in as an extra crop, and grow okra, squash, or cucumbers after the eggplant has been harvested. A spring crop of eggplant may follow as a second crop after a fall crop of pepper or tomato. Eggplant does best on well-drained, fertile, sandy-loam soils at a pH of 6.0-6.5. Poorly drained soils may result in slow plant growth, reduced root systems, and low yields. Eggplant requires a long, warm, frost-free growing season, usually of 14-16 weeks. Cold temperatures below 5°C injure this crop. The best temperatures are 27-32°C during the day and 21-32°C during the night. Plant growth is curtailed at temperatures below 16°C. Additionally, soil temperature below 16°C restricts germination. However, most eggplant is started in the field from transplants. Methyl bromide (MB) is always used in the full-bed mulch process. Until 1999, the chemical formulation primarily used was 98 percent methyl bromide and two percent chloropicrin. Since then, growers have shifted to formulations with lower concentrations of methyl bromide and higher amounts of chloropicrin due to the phase-out schedule of methyl bromide (USDA, 2002).

4. METHYL BROMIDE NOMINATED

TABLE 4.1: METHYL BROMIDE NOMINATED

YEAR	NOMINATION AMOUNT (KG)	NOMINATION AREA (HA)
2008	79,546	611

*This amount includes 433 kg for research.

5. BRIEF SUMMARY OF THE NEED FOR METHYL BROMIDE AS A CRITICAL USE:

The US nomination is only for those areas where the alternatives are not suitable. In US eggplant production there are several factors that make the potential alternatives to methyl bromide unsuitable. These include:

- 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 eggplant production.

- 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, and in such cases the US is only nominating a CUE for eggplants where the key pest pressure is moderate to high such as nutsedge in the Southeastern US.
- regulatory constraints: e.g., telone use is limited in Florida and Georgia due to the presence of karst geology.
- delay in planting and harvesting: e.g., the plant-back interval for telone+chloropicrin is two weeks longer than methyl bromide+chloropicrin, and in Michigan an additional delay would occur because soil temperature must be higher to fumigate with alternatives. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.

Methyl bromide is the only fumigant that consistently provides reliable control of target weeds, nematodes, and pathogens. There are no technically or economically feasible alternatives. The best alternatives (e.g. 1,3-D + chloropicrin, metam sodium) are not as effective in controlling nutsedge and have a long waiting period for planting that would disrupt planting schedules and cause growers to miss key market windows. Furthermore, regulatory restrictions due to concerns over human exposure and ground water contamination, along with technical limitations, result in potential economic infeasibility of 1,3-D alone or in combination as a practical MB alternative. Key among these factors are a 28 day planting delay due both to label restrictions, low soil temperatures, and a mandatory 30.4 m buffer for treated fields near inhabited structures.

5.1 Michigan

In Michigan eggplant the key target pest is *Phytophthora capsici*. These soil fungi can easily destroy the entire harvest from affected areas if left uncontrolled. In small plot trials with peppers and cucurbits in Michigan (Hausbeck and Cortright 2004), the level of control provided by 1, 3 D + chloropicrin or metam-potassium was comparable to that afforded by MB. No trials were done with eggplants specifically, but since peppers are also a solanaceous crop, these results are promising. However, it is noteworthy that *P. capsici* has recently been shown to occur in irrigation water in Michigan (Gevens and Hausbeck 2003). This will increase the likelihood of repeated re-infestation of this pathogen. It is also not yet clear whether these small-scale results accurately reflect efficacy of MB alternatives in commercial fresh vegetable (peppers, eggplant, and cucurbit) production. These trials were done at a single location that only had cucurbit crops grown on it in the past, and other studies of these MB alternatives (described in the regional discussions later in this document) have not shown such promising results, suggesting that the pathogen in this Michigan study may not have adapted to solanaceous crops. Perhaps more importantly, this study used fumigants applied in June when soil temperatures are much warmer than in April, which is typically when fumigation must be done by eggplant growers who need to plant according to premium market price windows. Given the lower dissipation of these MB alternatives at temperatures around 4 °C, it is unlikely that the good efficacy seen in this trial would be consistently repeated if fumigations were timed more typically. Furthermore, regulatory restrictions (e.g., mandatory 30 m buffer zone for treated fields near inhabited structures) due to concerns over human exposure and ground water contamination, along with technical and economic limitations, result in potential infeasibility of this formulation as a practical MB alternative. Also, variations in soil temperatures or rainfall could easily cause delays in fumigation events, since the most likely MB substitutes (1,3 D + chloropicrin and metam-sodium/potassium) currently available have label restrictions or efficacy limitations permitting use only above certain temperatures or when rain is not imminent. Label restrictions on these aMB alternatives also mandate planting delays based on rates used; at higher rates these delays can be as much as 2 weeks longer than those for MB itself. There could thus be unpredictable but potentially significant economic effects created by the planting delays (described above), which will disrupt the schedule of delivery of fresh eggplant harvest to wholesale buyers.

Florida and Georgia

Nutsedges, when present at moderate to severe infestations, are key pests which require MB for control in the Southeastern U.S., including Florida and Georgia. Other pest problems in this region that are managed with MB include southern blight, damping-off, and wilt. Of MB alternatives, only 1,3-D + chloropicrin has some efficacy against *Phytophthora*. However, 1,3-D cannot be applied in areas overlying karst geology which is common throughout the Southeast.

Growers in this region also face root-knot nematodes and the fungal pathogens described above as key pests. Left uncontrolled, any of these pests could completely destroy the harvests from affected areas. Halosulfuron, which is effective against nutsedges, can be applied only in row middles, but cannot be applied in raised beds, where nutsedge competition is critical (Florida CUE #03-0054).

Metam-sodium offers erratic, inconsistent control of nutsedges and nematodes, while 1,3-D + chloropicrin provides adequate control of nematodes and diseases (Eger 2000, Noling et al. 2000). However, metam-sodium has yield losses of up to 44 percent compared to MB where weed infestations are moderate to severe (Locascio et al. 1997). Metam-sodium also creates a planting delay as long as 30 days to avoid risk of phytotoxic injury to crops compared to a 14-day delay for MB. Further, due to regulatory restrictions resulting from groundwater contamination concerns, 1,3-D + chloropicrin cannot be used in large portions of the southeastern U.S. due to the presence of karst geology. There is up to a 28-day planting delay (vs. 14 days for MB) due to regulatory restrictions for 1,3-D + chloropicrin also. Any apparent technical feasibility of metam-sodium and 1,3-D + chloropicrin (and various combinations thereof) are based on small plot research trials that done on crops other than eggplant. For fungi and nutsedge pests at least, no on-farm, large scale trials have yet been done. In a recent small-plot field study conducted in Tifton, Georgia by Culpepper and Langston (2004) on peppers, 1,3-D + chloropicrin, followed by more chloropicrin, was more effective than MB against yellow nutsedge, but less effective against purple nutsedge. Although this treatment performed as well as MB in terms of spring pepper yield, its fall yield performance was inferior to that of MB.

In a second treatment, 1,3-D by itself, followed by chloropicrin, was significantly less effective than methyl bromide for the control of both purple and yellow nutsedge, but as effective as MB for the control soil nematodes. In terms of spring and fall pepper yield, however, this treatment performed as well as MB. In a third treatment, 1,3-D + chloropicrin, followed by metam sodium, was as effective as MB against yellow nutsedge, 36% less effective than MB against purple nutsedge, and as effective as MB for the control of soil nematodes. This treatment also performed as well as MB in terms of both spring and fall pepper yield. It must be noted that nutsedge pressure in this study was relatively low and populations were composed primarily of yellow nutsedge, as opposed to the hardier purple nutsedge. Also, even this promising study did not use eggplants as a test crop system.

Thus, although these MB alternatives show some promise, they will require further testing and larger-scale validation.

Some researchers have also reported that these MB alternatives are degraded more rapidly in areas where they are applied repeatedly due to enhanced metabolism by soil microorganisms. This phenomenon may compromise long-term efficacy of these compounds and appears to need further scientific scrutiny.

In sum, neither of these MB alternatives is presently adequate for control of key pests, and MB remains a critical use for eggplant in the Southeastern United States.

Implications of MB loss for individual growers

If MB were to be removed as a pest control option for U.S. eggplant, the particular growers in each region cited in this nomination would have to stop crop production or suffer substantial losses. These growers would either leave agriculture entirely or switch to other crops that do not rely on pre-plant fumigation for soil pest control. The extent of this impact on the affected growers is debatable, but given the current embryonic state of commercial deployment of MB alternatives, it is possible that growers who currently treat their land routinely with MB would face this outcome.

TABLE A.1: EXECUTIVE SUMMARY FOR EGGPLANT*

Region		Florida	Georgia	Michigan
AMOUNT OF APPLICANT REQUEST				
2008	Kilograms	108,862	48,868	3,799
AMOUNT OF NOMINATION				
2008	Kilograms	53,307	22,017	3,788

* See Appendix A for a complete description of how the nominated amount was calculated.

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

In Florida and Georgia, where weeds, especially nutsedge, are the main methyl bromide target pests neither 1,3-D nor metam sodium, alone or in combination with chloropicrin, adequately control moderate to high nutsedge populations. In Florida and, to a lesser extent in Georgia, the use of 1,3-D is prohibited in areas overlying karst geology because of groundwater contamination concerns. It is estimated that 40% of the Florida's production area overlies karst geology. The 1,3-D label prohibits its use in Dade County, Florida. Moreover, for Florida and Georgia farmers, using products containing 1,3-D and metam sodium in the fall may be impractical because of the required longer waiting periods for planting following application, 28 days for 1,3-D and 21 days for metam sodium, compared to 14 days for methyl bromide. Such delays could cause Florida and Georgia growers to miss part of the key market windows.

In Michigan, where soil-borne pathogens are the key methyl bromide target pests, neither 1,3-D nor metam sodium is effective against soil-borne fungi. Furthermore, the 28 and 21 day planting delays for 1,3-D and metam sodium, respectively, might disrupt this state's carefully-timed planting and harvesting schedules, causing growers to miss part of the market windows. The 1,3-D + chloropicrin combination may be as effective as methyl bromide against soil-borne pathogens. However, the 21-day planting delay would hinder grower adoption of this alternative.

7. (i) PROPORTION OF CROPS GROWN USING METHYL BROMIDE

TABLE 7.1: PROPORTION OF CROPS GROWN USING METHYL BROMIDE*

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TOTAL CROP AREA 2001-2002 AVERAGE (HA)	PROPORTION OF TOTAL CROP AREA TREATED WITH METHYL BROMIDE (%)
Florida	647	100
Georgia	539	60%
Michigan	Not available	Not available
NATIONAL TOTAL*	2197	51

* Includes States not requesting MB

7. (ii) IF ONLY 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 Georgia, areas are not treated with MB only when they do not have nutsedges or nematodes naturally present in eggplant fields. Simple absence of all pests is the only reason these areas are not presently treated with MB. In Michigan, areas not treated apparently do not have any infestation (i.e., zero oospores or chlamydo spores per unit soil) of the key fungal pests. The applicant states that soil infestation is spreading in the region annually.

7. (iii) 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?

Growers have the option to use halosulfuron only in row middles.

8. AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

FLORIDA - TABLE 8.1: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION	FLORIDA	GEORGIA	MICHIGAN
YEAR OF EXEMPTION REQUEST	2008	2008	2008
KILOGRAMS OF METHYL BROMIDE	108,862	48,868	3,799
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	Strip Bed	Predominantly Strip Bed	Predominantly Strip Bed
FORMULATION TO BE USED FOR THE CUE	67:33	67:33	67:33 or 50:50
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION (<i>m² or ha</i>)	647	325	32
DOSAGE RATE* (<i>g/m²</i>) OF ACTIVE INGREDIENT USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	16.8	15.0	12.0

*Predominately strip/bed treatment

9. SUMMARIZE ASSUMPTIONS USED TO CALCULATE METHYL BROMIDE QUANTITY NOMINATED FOR EACH REGION:

The amount of methyl bromide nominated by the U.S. was calculated as follows:

- The percent of regional hectares in the applicant’s request was divided by the total area planted in that crop in the region covered by the request. Values greater than 100 percent are due to the inclusion of additional varieties in the applicant’s request that were not included in the USDA National Agricultural Statistics Service surveys of the crop.
- Hectares counted in more than one application or rotated within one year of an application to a crop that also uses methyl bromide were subtracted. There was no double counting in this sector.

- Growth or increasing production (the amount of area requested by the applicant that is greater than that historically treated) was subtracted. The applicant that included growth in their request had the growth amount removed.
- Quarantine and pre-shipment (QPS) hectares is the area in the applicant's request subject to QPS treatments. Not applicable in this sector.
- Only the acreage experiencing one or more of the following impacts were included in the nominated amount: moderate to heavy key pest pressure, regulatory impacts, karst geology, buffer zones, unsuitable terrain, and cold soil temperatures.

FLORIDA- PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

FLORIDA - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

FLORIDA - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TARGET PESTS (WEEDS, PLANT-PARASITIC NEMATODES) AND PATHOGENS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
Florida	Purple and yellow nutsedge (<i>Cyperus rotundus</i> & <i>C. esculentus</i>), root-knot nematodes (<i>Meloidogyne</i> spp.), nightshade (<i>Solanum</i> spp.), southern blight (<i>Sclerotium rolfsii</i>), white clover (<i>Trifolium repens</i>)	Methyl bromide is the only fumigant that consistently controls key target weeds affecting eggplant in Florida. Neither 1,3-D nor metam sodium is effective under high nutsedge population pressures. 1,3-D cannot be applied in areas overlying karst geology (about 40% of the production area in Florida).

FLORIDA - 11. (i) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

FLORIDA - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	FLORIDA
CROP TYPE:	Vegetable crop for fresh market
ANNUAL OR PERENNIAL CROP:	Annual
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	Peppers, cucurbits
SOIL TYPES:	Sandy and sandy-loam soils
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Annually
OTHER RELEVANT FACTORS:	Double-cropped with cucurbit; may be preceded by pepper.

FLORIDA - TABLE 11.2: CHARACTERISTICS OF CLIMATE AND EGGPLANT CROP SCHEDULE: NOT DOUBLE-CROPPED

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	Zones: 9a, 10a, 10b - In 1997, 80% of the state's eggplant production was in the southeast; remainder of about 20% distributed in the rest of the state, mostly in the central and northern regions.											
RAINFALL (mm)	65.5	50.0	72.5	134.1	175.8	193.3	152.7	65.0	42.7	158.8	62.0	66.8
OUTSIDE TEMP. (°C)	19.4	22.1	25.3	27.6	28.2	28.2	27.3	24.1	19.2	17.3	16.0	16.9
FUMIGATION SCHEDULE ^A				X	X	X	X	X	X	X	X	
PLANTING SCHEDULE ^B					E	E	E	E	E	E	E	E
KEY HARVEST WINDOW ^C	E	E	E	E	E				E	E	E	E

^ANon-double cropped, earliest start date: June 15.

^B For Non-Double cropped eggplant production, planting eggplants is usually initiated around July 1; shaded cells represent variation in transplanting dates

^CFor Non-Double Cropped Eggplants; Harvest Period usually begins as early as Nov. 1, may continue until July 31, depending on when planted and weather conditions.

FLORIDA - TABLE 11.3: CHARACTERISTICS OF CLIMATE AND EGGPLANT CROP SCHEDULE; DOUBLE-CROPPED

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	Zones 9a, 10a, 10b - In 1997, 80% of the state's eggplant production was in the southeast; remainder of about 20% distributed in the rest of the state, mostly in the central and northern regions.											
RAINFALL (mm)	65.5	50.0	72.5	134.1	175.8	193.3	152.7	65.0	42.7	158.8	62.0	66.8
OUTSIDE TEMP. (°C)	19.4	22.1	25.3	27.6	28.2	28.2	27.3	24.1	19.2	17.3	16.0	16.9
FUMIGATION SCHEDULE ^A				X	X	X	X					
PLANTING SCHEDULE ^B					E	E	E	E				2C
KEY HARVEST WINDOW ^F	E	E	2C	2C	2C				E	E	E	E

^A Double-cropped; assumed to be with cucurbits; earliest start date is June 15.

^B For Double-Cropped eggplant production, planting (E) is typically initiated on July 1; variance can be until October 1. The second crop of cucurbits transplants would typically be initiated around Feb 1, and may vary until end of Feb, or 1st part of March.

^C For Double Cropped Eggplants, Harvest Period usually begins as early as Nov. 15 (E), may continue until April 15, depending on when planted and weather conditions; Harvesting of second crop (2C) may start around May 1 and continue until mid-July

FLORIDA – 11. (ii) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (i) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?
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The karst geology prevalent in Florida and, to a lesser extent, Georgia severely limits the use of 1,3-D in those States. There are no atypical characteristics identified in the nomination which might prevent the utility of Devrinol™ (napromide) and trifluralin for nutsedge control and for control of broad-leaved weed species, such as morningglory. Halosulfuron, however has several label limitations (e.g., reduced effectiveness if rain events follow within 4 hours of application), and plant-back restrictions (0 to 36 months) (U.S. EPA, CUN 2003/050).

**FLORIDA - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE, AND/OR MIXTURES
CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED**

FLORIDA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004
AREA TREATED (<i>hectares</i>)	809	728	728	728	647	647
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED (<i>total kilograms</i>)	127,384	114,646	114,623	114,623	101,888	100,284
FORMULATIONS OF METHYL BROMIDE <i>MB /chloropicrin</i>)	67:33 or 98:2	67:33 or 98:2	67:33 or 98:2	67:33 or 98:2	67:33 or 98:2	67:33 or 98:2
METHOD BY WHICH METHYL BROMIDE APPLIED	Mostly injected 25-30 cm depth	Mostly injected 25-30 cm depth	Mostly injected 25-30 cm depth	Mostly injected 25-30 cm depth	Mostly injected 25-30 cm depth	Mostly injected 25-30 cm depth
ACTUAL DOSAGE RATE FOR THE ACTIVE INGREDIENT (<i>g/m²</i>)*	15.7	15.7	15.7	15.7	15.7	15.5

FLORIDA - PART C: TECHNICAL VALIDATION

FLORIDA - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

FLORIDA – TABLE 13.1: REASON FOR ALTERNATIVES NOT BEING FEASIBLE

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
CHEMICAL ALTERNATIVES		
1,3 -D (Telone™)	Limestone solution channels potentially leading to groundwater (karst geology) underlies a portion of FL production areas. Label restriction states that these products cannot be used where karst geology exists, estimated to be about 40% in 2002 for eggplant area; Telone is not labeled for use in Dade County.	No
Halosulfuron	Registered for use on eggplant (Dec. 2002, US EPA, Aug. 2003); use restricted to the row middle only; potential crop injury; severe plant back restrictions from 3 to 36 months for most vegetables; severe restrictions when used in pest management strategy that includes soil-applied organophosphates.	No
Metam-sodium (Vapam™)	Does not work under high pest pressure. Limited niche as a complementary treatment with other fumigants and herbicides, never stand alone (Noling, 2003). Considered as best available alternative for Dade County only (Aerts, 2003).	No
Napromide (Devrinol™)	Weak in terms of nutsedge efficacy; does not control established weeds (CUE 03-0017); waste of money (Noling, 2003).	No
Trifluralin	Aids in control of annual grasses; does not manage broadleaf weeds. May cause excessive crop stress leading to reductions in stands and yields.	No
NON CHEMICAL ALTERNATIVES		
Solarization	Weed density (yellow and purple nutsedge) was greater in the solarized treatments compared to the methyl bromide treatment. Worked for the 1 st year in FL peppers; if pest threshold is low (Chellemi, et al., 1997)	No
<i>Myrothecium verrucaria</i> (Ditera™)	Biological nematicide; registered on broad range of crops, field efficacy is untested	No
COMBINATIONS OF ALTERNATIVES		
1,3-D + chloropicrin (Telone II or Telone C-35) + Devrinol + trifluralin	Strategy involves applying 1,3-D Flat Fumigation, followed by chloropicrin 3-4 wks post fumigation + both herbicides before laying plastic. Chloropicrin may not be efficacious in managing white mold (<i>Sclerotium rolfsii</i>). Producers in Dade County are prohibited from using Telone products.	Yes, except for areas with underlying karst geology.
Solarization + 1,3-D	May work in areas with low weed, pest or disease pressure. Eliminated root galling and high density of root-knot nematodes. (Chellemi, D.O., et al. 1997. Application of soil solarization to Fall Production of cucurbits and pepper. Proc. Fla. State Hort. 110:333-336.)	No
Solarization + biocontrol fungus, <i>Gliocladium virens</i>	Ristaino, J.B., Perry, K.B. and R. D. Lumsden. 1996. Soil solarization and <i>Gliocladium virens</i> reduce the incidence of southern blight (<i>Sclerotium rolfsii</i>) in bell pepper in the field. Biocon.Sci. and Tech. 6:583-593.	No

* Regulatory reasons include local restrictions (e.g. occupational health and safety, local environmental regulations) and lack of registration.

FLORIDA - 14. LIST AND DISCUSS WHY REGISTERED (and Potential) PESTICIDES AND HERBICIDES ARE CONSIDERED NOT EFFECTIVE AS TECHNICAL ALTERNATIVES TO METHYL BROMIDE:

FLORIDA – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
None	Other than options discussed elsewhere, no alternatives exist for the control of the key pests when they are present in the soil and/ or afflict the below ground portions of eggplants.

FLORIDA - 15. LIST PRESENT (and Possible Future) REGISTRATION STATUS OF ANY CURRENT AND POTENTIAL ALTERNATIVES:

FLORIDA – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Iodomethane	Pre-plant soil fumigant. Not registered yet.	Yes	Unknown
Trifloxysulfuron sodium	Herbicide. Registration pending ONLY in tomato, FL only. Crop Injury issues exist.	Yes	Unknown
Fosthiazate	OP nematicide. Not registered.	Yes	Unknown
Furfural (Multigard™)	Not registered.	Yes	Unknown
Sodium azide	Not registered. Registration application not yet submitted.	No	Unknown
Propargyl bromide	Not registered. Registration application not yet submitted.	No	Unknown
<i>Paecilomyces lilacinus</i>	Biological nematicide. Registration pending.	Yes	Unknown
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

FLORIDA - 16. STATE RELATIVE EFFECTIVENESS OF RELEVANT ALTERNATIVES COMPARED TO METHYL BROMIDE FOR THE SPECIFIC KEY TARGET PESTS AND WEEDS FOR WHICH IT IS BEING REQUESTED:

FLORIDA – TABLE C.1: ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3 D + chloropicrin	Nutsedges, fungal pathogens	0-40 % (0 % would be possible only in lightly infested areas; these areas are not included in this request for MB)	29 % (Locascio et al., 1997)
Metam-sodium (with or without chloropicrin)	Nutsedges, fungal pathogens	0-66 % (0 % would be possible only in lightly infested areas; these areas are not included in this request for MB)	44 % (Locascio et al., 1997)
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			29 % where 1,3 D can be used; 44 % where only metam sodium can be used

Data (narrative only) and information are bridged for eggplants from the best available information (Locascio et al. 1997).

Locascio et al. (1997) studied MB alternatives on tomatoes grown in small plots at two Florida locations. Various treatments were tested on plots that had multiple pests. At the Bradenton site there was moderate to heavy *Fusarium* infestation; heavy purple nutsedge infestation and light root-knot nematode pressure. At Gainesville there was heavy infestation of yellow and purple nutsedge and moderate infestation of root-knot nematode. The treatments at both locations included MB (67%) + chloropicrin (33%) chisel-injected at 390 kg/ha; metam-sodium (chisel-injected) at 300L/ha; metam-sodium drip-irrigated at 300L/ha; and 1,3-D + 17% chloropicrin chisel-injected at 327L/ha. In pairwise statistical comparisons, the yield was significantly lower in metam-sodium treatments compared to MB at both sites. At Bradenton, the average yield from both metam-sodium treatments was 33% of the MB yields, suggesting a 67% yield loss from not using MB. At Gainesville, the average yield of the two metam-sodium treatments was 56% of the MB yield, suggesting a 44% yield loss from not using MB. The yield of the 1,3-D treatment at Gainesville was 71% of the MB standard suggesting a 29% loss by not using MB (yield data for 1,3-D were not reported for Bradenton). In considering 1,3 D results, one must keep in mind that this MB alternative cannot be used in areas where karst geology exists.

An additional study on some alternative fumigants was performed in 2004 by Culpepper and Langston in Tifton, Georgia. A summary is presented both in the sections discussing Georgia and in the “Summary of technical feasibility” section for Florida (below). While the results were promising, this trial was not used as the basis for yield loss estimates primarily because nutsedge pressure was relatively low and weed populations did not contain many purple nutsedge plants. Reliable control of these weeds (which are arguably harder than yellow nutsedge) would have to be demonstrated before such a study could be used to revise yield losses.

TABLE 16.1. FUMIGANT ALTERNATIVES TO METHYL BROMIDE FOR POLYETHYLENE-MULCHED TOMATO (LOCASCIO ET AL. 1997)

Chemicals	Rate (/ha)	Average Nutsedge Density (#/m ²)	Average Marketable Yield (ton/ha)	% Yield Loss (compared to MB)
Untreated (control)	-	300 ^{ab}	20.1 ^a	59.1

MB + Pic (67-33), chisel-injected	390 kg	90 ^c	49.1 ^b	---
1,3 D + Pic (83-17), chisel-injected	327 l	340 ^a	34.6 ^c	29.5
Metam Na, Flat Fumigation	300 l	320 ^a	22.6 ^a	54.0
Metam Na, drip irrigated	300 l	220 ^b	32.3 ^c	34.2

Notes: (1) Numbers followed by the same letter (within a column) are not significantly different at the 0.05 level of probability, using Duncan's multiple range test.

(2) Data shown are from the Gainesville/Horticultural Unit site, 1994 season (this was one of three sites included in this study). This site had relatively high nutsedge pressure, and data for both pest pressure and marketable yields for all treatments shown.

Yield loss estimates could likely be lower for growers who can legally use 1,3-D products. For example, evidence from one tomato and bell pepper grower using Telone II on 30 percent of his total area suggests that average yields declined 6.16 % across all fields, while average yield declines were 15.77 % in side-by-side plantings (FFVA, 2002). The standard deviation on these yields did not change, which resulted in an increase in the coefficient of variation from 32.7 percent on fields planted to methyl bromide to 38.3 percent on fields planted to Telone II. These results suggest that alternatives to methyl bromide reduce yields by as much as 15.7 % and that risk associated with yield variability would likewise increase.

FLORIDA - 17. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE?:

Iodomethane is under consideration for potential methyl bromide replacement. Although it is currently being considered for registration by regulatory authorities, it is unknown when it will be registered. Please refer to Table 15.1.

FLORIDA - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE?:

The U. S. Government is presently unaware of large scale, commercial greenhouse operations for eggplants. It might be expected, however that there are local (or small community) operations of organic eggplant production that target fresh market and/or temporal (seasonal) sectors.

FLORIDA - SUMMARY OF TECHNICAL FEASIBILITY

In Florida neither 1,3-D nor metam sodium, alone or in combination with chloropicrin, adequately control moderate to high nutsedge populations. In addition, 1,3-D cannot be applied in areas overlying karst geology, estimated to be 40% of the production area in the State. Furthermore, using products containing 1,3-D and metam sodium in the fall would mean longer waiting periods for planting following application, 28 days for 1,3-D and 21 days for metam sodium, compared to 14 days for methyl bromide. Such delays may cause Florida growers to miss part of the key market windows.

The top priority of control associated with each major segment of pest management across Florida eggplant production regions remained weeds, especially the nutsedges, because of the lack of registered herbicides that do not cause crop injury, or have severe plant-back restrictions. When nutsedge pressure is moderate to severe, the 1,3-D + chloropicrin combination is not technically feasible because it needs to be coupled with an effective herbicide to provide control for the entire growing season (U.S. EPA, 2002).

There are no herbicides which control nutsedge in the crop row. Paraquat and glyphosate will suppress emerged nutsedge, but cannot be used in the crop row because of potential crop injury (SE Pepper Consortium CUE 02-0041).

In the study reported in Item 16 (Table 16.1), 1,3-D + chloropicrin treatments did not adequately control moderate to high nutsedge populations, and yield losses occurred when compared to MB plus chloropicrin treatments. Additional research on this alternative to improve efficacy against nutsedge is needed in areas with moderate to high nutsedge pressure. Lack of an effective, registered herbicide impairs adoption in crops such as eggplant (Banks, 2002).

Culpepper and Langston (2004) recently compared the effectiveness of several soil fumigants in managing soil pests affecting peppers in Tifton, Georgia. Eggplants were not used as a test crop, so here, again, data from peppers are used to “bridge” a discussion. Results show that 1,3-D followed by chloropicrin was significantly less effective than methyl bromide for the control of both purple and yellow nutsedge, but as effective as MB for the control soil nematodes. In terms of spring and fall crop yield, this treatment performed as well as MB. 1,3-D + chloropicrin, followed by more chloropicrin was more effective than MB for the control of yellow nutsedge, but less effective against purple nutsedge. This treatment performed as well as MB in terms of spring crop yield, but poorly in terms of fall yield. 1,3-D + chloropicrin, followed by metam sodium was 36% less effective than methyl bromide for the control of purple nutsedge, but as effective as MB for the control of yellow nutsedge. This combination was as effective as MB against soil nematodes. In terms of spring and fall crop yield, this treatment performed as well as MB. This suggests that these treatments are showing promise and will require further testing and validation in commercial fields. However, it should also be noted that nutsedge populations were relatively low and predominantly composed of yellow nutsedge, which may be easier to control than purple nutsedge.

Diseases caused by soil-borne plant pathogenic fungi, (e.g., *Sclerotinia*, *Phytophthora* spp., *Verticillium* spp., *Pythium* spp. and *Rhizoctonia solani*) may be curtailed if weather conditions are detrimental for disease development. These pathogens commonly reside in many production areas, since many eggplant production areas are old tomato production fields. Fungicides such as chlorothalonil, and azoxystrobin are considered to be only prophylactic, and may not offer sufficient pest management. Resistance of *Phytophthora* spp. to metalaxyl and mefenoxam (Ridomil and Ridomil Gold, respectively) has been reported in tomato crop areas, and most recently pepper (Lamour and Hausbeck, 2003).

Nematode pests, such as the root knot nematode species of *Meloidogyne*, were third to weed pests in terms of priority of pest management strategies in Florida eggplant production. Pre-plant control of nematodes is critical since nematode root feeding and damage may predispose plant tissues to invasion by fungal pathogens, potentially leading to wilt, loss of plant vigor, and significant yield losses. Fumigant alternatives such as metam-sodium have proven inconsistent (Noling, 2003; FFVA, 2002).

Approximately 40 percent of the eggplant production area in Florida has karst geology. Because it is illegal for producers to use 1,3-D products (Telone II, Telone C-35) on these soils, growers would likely use a combination of metam-sodium + a herbicide, such as halosulfuron or napropamide.

GEORGIA - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

GEORGIA - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

GEORGIA - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TARGET PESTS (WEEDS, PLANT-PARASITIC NEMATODES) AND PATHOGENS	SPECIFIC REASONS WHY METHYL BROMIDE NEEDED
Georgia	1. Yellow and Purple Nutsedge (<i>Cyperus esculentus</i> , <i>C. rotundus</i>) [100%] 2. Crown and Root rot (<i>Phytophthora capsici</i>) [40%] 3. Plant-parasitic nematodes (<i>Meloidogyne incognita</i> ; <i>Pratylenchus sp</i>) [70%] 4. Southern Blight (<i>Sclerotium rolfsii</i>) [70%] 5. Pythium root and collar rots (<i>P. irregulare</i> , <i>P. myriotylum</i> , <i>P. ultimum</i> , <i>P. aphanidermatum</i>) [100%]	Registered alternatives are not as effective as methyl bromide. Methyl bromide is needed for timely management of targeted pests and pathogens. Using products containing 1,3-D and metam sodium in the fall is impractical because of the long waiting periods for planting following application under plastic mulch. For 1,3-D there is a 28 day waiting period; for metam sodium, there is a 21-day waiting period. Such delays could cause growers to miss part of the higher market windows.

GEORGIA - 11. (i) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

GEORGIA - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	GEORGIA
CROP TYPE:	Vegetable crop for the fresh market
ANNUAL OR PERENNIAL CROP:	Annual; generally 1 year
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	Eggplants, followed by a cucurbit crop (cucumbers, or squash) or pepper.
SOIL TYPES:	Sandy loam; clay loam
FREQUENCY OF METHYL BROMIDE FUMIGATION:	1 time per year; (either in spring or fall)
OTHER RELEVANT FACTORS:	The grower may complete two, three or even four crops in one fumigation cycle.

GEORGIA - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE "PLANT HARDINESS ZONE"	Climate zones 7a, 7b, 8a, and 8b noted in the application. Zone 7a: -15.0 to -17.7 °C (0 to 5 °F); Oklahoma City, OK; South Boston, VA Zone 7b: -12.3 to 14.9 °C (5 to 10 °F); Griffin, GA Zone 8a: -9.5 to -12.2 °C (10 to 15 °F); Tifton, GA Zone 8b: -6.7 to -9.4 °C (15 to 20 °F); Austin, TX; Gainesville, FL Portions of GA fall into all four of these zones.											
SOIL TEMP. (°C)	17.8	22.5	27.1	29.9	31.0	30.4	27.9	23.3	12.2	12.2	10.6	13.1
RAINFALL (mm)	127	97	89	114	142	122	86	58	58	114	114	107
AMBIENT TEMP. (°C)	21.0	25.4	29.3	31.9	32.6	32.5	30.7	26.3	21.0	17.3	16.4	17.8
FUMIGATION SCHEDULE^A					▶ ◀							
PLANTING SCHEDULE^{A,B}	↗ ↘				▶ ◀							
KEY HARVEST (MARKET) WINDOW^{A,B}			↗		↘			▶	◀			

Shaded areas represent typical duration of activity. Darker shaded areas represent duration of activities for the second crop.

^A Methyl bromide applied either in the spring or fall allows the grower to economically produce at least two crops (sometimes 3 or 4), the second crop usually cucumbers, from one fumigation event.

^B Two crops are represented from one fumigation event.

▶ = initiation of fumigation or planting and/or harvest of first crop; ◀ = termination of fumigation or planting and/or harvest of first crop. ↗ = initiation of planting and/or harvest of second crop; ↘ = termination of planting and/or harvest of second crop.

GEORGIA – 11. (ii) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (i) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?
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Nearly all of the vegetable production occurs on Coastal Plain Soils, which are subject to high temperatures and excess heat. In addition to weed pests, soil-borne fungal pathogens and plant-parasitic nematodes are endemic to the region and nearly all production areas have severe infestations, thereby necessitating annual treatment with a soil fumigant.

GEORGIA - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE ON EGGPLANTS, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

GEORGIA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE ON EGGPLANTS

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004
AREA TREATED (<i>hectares</i>)	251	333	315	321	346	291
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED (<i>total kilograms</i>)	47,723	50,023	47,288	48,139	51,968	43,763
FORMULATIONS OF METHYL BROMIDE	98:2 (15% of area) 67:33 (85% of area)	67:33	67:33	67:33	67:33	67:33
METHODS BY WHICH METHYL BROMIDE APPLIED	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp
ACTUAL DOSAGE RATE FOR THE ACTIVE INGREDIENT (<i>g/m²</i>)*	19.1	15.0	15.0	15.0	15.0	15.0

GEORGIA - PART C: TECHNICAL VALIDATION

GEORGIA - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

GEORGIA – TABLE 13.1: REASON FOR ALTERNATIVES NOT BEING FEASIBLE

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE + CITATIONS**	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
CHEMICAL ALTERNATIVES		
1,3-D products (includes Telone II, Telone EC, & Telone C-35)	Products will not adequately control nutsedge. Label restriction states that these products cannot be used where karst geology exists (~8% of the production area). Up to 2 applications of Telone II, in-line, or EC formulations may be needed to manage moderate to severe pest population levels. Also, there is a 28-day waiting period at the time of application until planting, which could cause loss of over half of the harvest season and the higher-end market windows to be missed. These are plantings made in July and harvested in the fall (Georgia CUE # 03-0049; Kelley, 2003). This only applies to light to moderate infestations and only with Telone C-35.	No
Metam-sodium	Product does not adequately control nutsedge. Also, there is a 21-day waiting period at the time of application until planting (40% of harvest season missed), which may cause part of the higher-end market windows to be missed. These are plantings made in July and harvested in the fall. Beginning the application cycle earlier is not an option, since crops from the previous fumigation cycle must be terminated and cleaned up prior to metam application (Georgia CUE # 03-0049; Kelley, 2003). Repeated applications of MITC (the breakdown product of metam sodium) are known to enhance its biodegradation as a result of adapted microorganisms (Duncan and Yates, 2003).	No
Halosulfuron	Registered for specific uses in eggplant (Dec. 2002, US EPA, Aug. 2003); application for eggplant is for ROW MIDDLE application and would not provide control of nutsedge in the eggplant bed; potential crop injury; severe plant back restrictions from 3 to 36 months for most vegetables.	No
COMBINATIONS OF ALTERNATIVES ---		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE + CITATIONS**	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
<p>1. 1,3-D products and a herbicide, e.g. napropamide</p> <p>2. Metam-sodium and a herbicide, e.g. napropamide</p> <p>3. Iodomethane and a herbicide, e.g. napropamide</p> <p>4. Glyphosate treatment of plots between the first and second crops (Webster, et al. 2001)</p> <p>5. Pest-resistant cultivars combined with alternative fumigant strategies 1, 2, and 3</p>	<p>Currently, there are no data to substantiate transition toward a suitable alternative to annual methyl bromide fumigation. Alternative chemicals and cultural practices that are under consideration include various combinations of currently registered and unregistered fumigants and/or herbicides.</p> <p>Iodomethane is not registered in the U.S. Please refer to Table 15.</p>	<p>No</p>
<p>1,3 dichloropropene followed by chloropicrin</p>	<p>Culpepper and Langston (2004) have tested the effectiveness of several soil fumigant combinations for the management of nutsedges and nematodes affecting peppers in Tifton, Georgia. Results show that 1,3-D followed by chloropicrin was significantly less effective than MB for the control of both purple and yellow nutsedge, but as effective as MB for the control soil nematodes. In terms of spring and fall crop yield, however, this combination performed as well as MB. This treatment is promising and will require further testing and validation in commercial fields.</p>	<p>Yes, except for areas with underlying karst geology</p>
<p>1,3 dichloropropene + chloropicrin (Telone C35) followed by chloropicrin</p>	<p>Culpepper and Langston (2004) have tested the effectiveness of several soil fumigant combinations for the management of nutsedges and nematodes affecting peppers in Tifton, Georgia. In this study, 1,3-D + chloropicrin, followed by more chloropicrin was more effective than MB for the control of yellow nutsedge, but less effective against purple nutsedge. This treatment performed as well as MB in terms of spring crop yield, but poorly in terms of fall yield. This combination does not appear to show promise as a MB alternative.</p>	<p>No</p>
<p>1,3 dichloropropene + chloropicrin (Telone C35) followed by metam sodium</p>	<p>Culpepper and Langston (2004) have tested the effectiveness of several soil fumigant combinations for the management of nutsedges and nematodes affecting peppers in Tifton, Georgia. In this study, 1,3-D + chloropicrin, followed by metam sodium was 36% less effective than MB for the control of purple nutsedge, but as effective as MB for the control of yellow nutsedge and soil nematodes. In terms of spring and fall crop yield, this treatment performed as well as MB. This combination is promising and will require further testing and validation in commercial fields.</p>	<p>No, but shows promise</p>

* Regulatory reasons include local restrictions (e.g. occupational health and safety, local environmental regulations) and lack of registration.

GEORGIA - 14. LIST AND DISCUSS WHY REGISTERED (and Potential) PESTICIDES AND HERBICIDES ARE CONSIDERED NOT EFFECTIVE AS TECHNICAL ALTERNATIVES TO METHYL BROMIDE:

GEORGIA – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
None	Other than options discussed elsewhere, no alternatives exist for the control of the key pests when they are present in the soil and/ or afflict the below ground portions of eggplants.

The U.S. EPA only considered those technically feasible registered alternatives which are relevant for managing severe pathogen and pest pressures.

Paraquat and glyphosate will suppress emerged nutsedge, but cannot be used in the crop row because of potential crop injury (SE Pepper Consortium CUE for 2004).

Fumigation of products containing 1,3-D and metam sodium (Vapam and/or K-pam) in the summer or fall is practically impossible because of the waiting periods for planting following application under plastic mulch. For 1,3-D there is a 28-day waiting period; for metam sodium, there is a 21-day waiting period. Such delays may cause reduction in yields and market windows missed. Thus, since the fall crop is dependent upon timely planting, a long waiting period (e.g., 28 days) would cost growers at least half of the harvest season, thereby missing the higher market windows (Kelley, 2003).

GEORGIA - 15. LIST PRESENT (and Possible Future) REGISTRATION STATUS OF ANY CURRENT AND POTENTIAL ALTERNATIVES:

GEORGIA – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Iodomethane	Not registered	Yes	Unknown
Fosthiazate	Not registered.	Yes	Unknown
Furfural (Multigard™)	Not registered	Yes	Unknown
Sodium azide	Not registered. Registration application not yet submitted.	No	Unknown
Propargyl bromide	Not registered. Registration application not yet submitted.	No	Unknown
<i>Paecilomyces lilacinus</i>	Not registered. Registration pending.	Yes	Unknown
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

GEORGIA - 16. STATE RELATIVE EFFECTIVENESS OF RELEVANT ALTERNATIVES COMPARED TO METHYL BROMIDE FOR THE SPECIFIC KEY TARGET PESTS AND WEEDS FOR WHICH IT IS BEING REQUESTED

GEORGIA – TABLE C.1: ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3 D + chloropicrin	Nutsedges	0-40 % (0 % would be possible only in lightly infested areas; these areas are not included in this request for MB)	29 % (Locascio et al., 1997)
Metam-sodium (with or without chloropicrin)	Nutsedges	0-66 % (0 % would be possible only in lightly infested areas; these areas are not included in this request for MB)	44 % (Locascio et al., 1997)
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			29 % where 1,3 D can be used; 44 % where only metam sodium can be used

Data (narrative only) and information are bridged for eggplants from the best available information.

Locascio et al. (1997) studied MB alternatives on tomatoes grown in small plots at two Florida locations. Various treatments were tested on plots that had multiple pests (Table 16.1). At the Bradenton site there was moderate to heavy *Fusarium* infestation; heavy purple nutsedge infestation and light root-knot nematode pressure. At Gainesville there was heavy infestation of yellow and purple nutsedge and moderate infestation of root-knot nematode. The treatments at both locations included MB (67%) + chloropicrin (33%) chisel-injected at 390 kg/ha; metam-sodium (chisel-injected) at 300L/ha; metam-sodium drip-irrigated at 300L/ha; and 1,3-D + 17% chloropicrin chisel-injected at 327L/ha. In pairwise statistical comparisons, the yield was significantly lower in metam-sodium treatments compared to MB at both sites. At Bradenton, the average yield from both metam-sodium treatments was 33% of the MB yields, suggesting a 67% yield loss from not using MB. At Gainesville, the average yield of the two metam-sodium treatments was 56% of the MB yield, suggesting a 44% yield loss from not using MB. The yield of the 1,3-D treatment at Gainesville was 71% of the MB standard suggesting a 29% loss by not using MB (yield data for 1,3-D were not reported for Bradenton). In considering 1,3 D results, one must keep in mind that this MB alternative cannot be used in areas where karst geology exists.

An additional study on some alternative fumigants was performed in 2004 by Culpepper and Langston in Tifton, Georgia. A summary is presented in the “Summary of Technical Feasibility” section for Georgia (below). While the results were promising, this trial was not used as the basis for yield loss estimates primarily because nutsedge pressure was relatively low and weed populations did not contain many purple nutsedge plants. Reliable control of these weeds (which are arguably hardier than yellow nutsedge) would have to be demonstrated before such a study could be used to revise yield losses.

TABLE 16.1. FUMIGANT ALTERNATIVES TO METHYL BROMIDE FOR POLYETHYLENE-MULCHED TOMATO (LOCASCIO ET AL. 1997)

Chemicals	Rate (/ha)	Average Nutsedge Density (#/m ²)	Average Marketable Yield (ton/ha)	% Yield Loss (compared to MB)
Untreated (control)	-	300 ^{ab}	20.1 ^a	59.1
MB + Pic (67-33), chisel-injected	390 kg	90 ^c	49.1 ^b	---
1,3 D + Pic (83-17), chisel-injected	327 l	340 ^a	34.6 ^c	29.5
Metam Na, Flat Fumigation	300 l	320 ^a	22.6 ^a	54.0
Metam Na, drip irrigated	300 l	220 ^b	32.3 ^c	34.2

Notes: (1) Numbers followed by the same letter (within a column) are not significantly different at the 0.05 level of probability, using Duncan's multiple range test.

(2) Data shown are from the Gainesville/Horticultural Unit site, 1994 season (this was one of three sites included in this study). This site had relatively high nutsedge pressure, and data for both pest pressure and marketable yields for all treatments shown.

GEORGIA - 17. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE?

Iodomethane is under consideration for potential methyl bromide replacement. Although it is currently being considered for registration by regulatory authorities, it is currently unknown when it will be registered. Please refer to Table 15.1.

In addition, the following new long-term studies have been initiated at the Coastal Plain Experiment Station in Tifton, Georgia, with funding provided by USDA-CSREES, Methyl Bromide Transitions Grant:

- Evaluation of the effects of soil conditions, particularly soil temperature and moisture, on nutsedge species efficacy from several fumigants.
- Investigation of the impact of multiple-season adoption of methyl bromide alternatives in terms of pest species composition, including weeds, diseases, and nematodes.
- Integration of multiple tactics as alternatives to methyl bromide for management of weeds, diseases, and nematodes in pepper and eggplant.
- Evaluation of vegetable crop response to herbicides applied under plastic prior to crop transplants and characterize herbicide fate when applied in a plasticulture system between summer and fall crops.

GEORGIA - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE?

No. Any organic production of eggplants is presumed insignificant and probably not cost-effective because of the intensive management of pests (for organic production) and the long growing season.

GEORGIA - SUMMARY OF TECHNICAL FEASIBILITY

Neither 1,3-D nor metam sodium, alone or in combination with chloropicrin, adequately control moderate to high nutsedge populations in Georgia. In addition, 1,3-D cannot be applied in areas overlying karst geology (~ 8 % of the eggplant area; CUE #03-0050). Furthermore, using products containing 1,3-D and metam sodium in the fall is impractical because of the required long waiting periods for planting following application, 28 days for 1,3-D and 21 days for metam sodium. Such delays would cost Georgia farmers at least half of the harvest season, thereby missing key market windows.

In studies on peppers (Csinos et al. 1999, Noling et al. 2000), 1,3-D + chloropicrin treatments did not adequately control moderate to high nutsedge populations, and yield losses occurred when compared to MB plus chloropicrin treatments. Additional research on this alternative to demonstrate efficacy against nutsedge is needed in areas with moderate to high nutsedge pressure, considered to be approximately 58% of the current eggplant production area (Culpepper, 2004). Lack of an effective, registered herbicide impairs adoption in crops such as pepper (Banks, 2002), and probably other high value vegetable crops for the fresh market (Monks, Southeast Peppers Consortium, CUE 03-0041).

Culpepper and Langston (2004) recently compared the effectiveness of several soil fumigants in managing soil pests affecting peppers in Tifton, Georgia. Eggplants were not used as a test crop, so here, again, data from peppers are used to “bridge” a discussion. Results show that 1,3-D followed by chloropicrin was significantly less effective than methyl bromide for the control of both purple and yellow nutsedge, but as effective as MB for the control soil nematodes. In terms of spring and fall crop yield, this treatment performed as well as MB. 1,3-D + chloropicrin, followed by more chloropicrin was more effective than MB for the control of yellow nutsedge, but less effective against purple nutsedge. This treatment performed as well as MB in terms of spring crop yield, but poorly in terms of fall yield. 1,3-D + chloropicrin, followed by metam sodium was 36% less effective than methyl bromide for the control of purple nutsedge, but as effective as MB for the control of yellow nutsedge. This combination was as effective as MB against soil nematodes. In terms of spring and fall crop yield, this treatment performed as well as MB. This suggests that these treatments are showing promise and will require further testing and validation in commercial fields. However, it should also be noted that nutsedge populations were relatively low and predominantly composed of yellow nutsedge, which may be easier to control than purple nutsedge.

Nematode pests, such as the root knot nematode species of *Meloidogyne*, were third to nutsedge and fungal pathogens in terms of priority of pest management strategies in Georgia eggplant production. Pre-plant control of nematodes is critical since nematode root feeding and damage may predispose plant tissues to invasion by fungal pathogens, potentially leading to wilt, loss of plant vigor, and significant yield losses. Fumigant alternatives such as metam-sodium have proven inconsistent (Noling, 2003; FFVA, 2002).

Diseases caused by soil-borne plant pathogenic fungi, (e.g., *Phytophthora* spp., *Pythium* spp. and *Sclerotium rolfsii*) may be curtailed if weather conditions are detrimental for disease development. These pathogens are endemic in many vegetable production areas in Georgia. Fungicides such as chlorothalonil, and azoxystrobin are considered to be only prophylactic, and may not offer sufficient pest management. Resistance of *Phytophthora* spp to metalaxyl and mefenoxam (Ridomil and Ridomil Gold, respectively) has been reported in tomato crop areas, and most recently pepper (Lamour and Hausbeck, 2003)

The use of products containing 1,3-D and metam sodium in the fall is impractical because of the long waiting periods for planting following application under plastic mulch. For 1,3-D there is a 28 day waiting period; for metam sodium, there is a 21-day waiting period. Such delays would cost growers at

least half of the harvest season, thereby missing the higher market windows. Thus, since the fall crop is dependent upon timely planting, the required waiting period would cost growers at least half of the harvest season, thereby missing the higher market windows (Kelley, 2003).

MICHIGAN - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

MICHIGAN - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

MICHIGAN - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TARGET PESTS (WEEDS, PLANT-PARASITIC NEMATODES) AND PATHOGENS	SPECIFIC REASONS WHY METHYL BROMIDE NEEDED
Michigan	Crown and root rots caused by Soil-borne Fungus - <i>Phytophthora capsici</i> .	Methyl bromide alone allows growers to fumigate and plant early in order to capture the key market window (July - September) and have their product available for premium prices, as well as ensuring demand for their crop during the entire growing season, especially during the mid and late season. The fumigation and planting schedule allow growers to maintain market diversity, as well.

MICHIGAN - 11. (i) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

MICHIGAN - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	MICHIGAN
CROP TYPE:	Vegetable crop for the fresh market
ANNUAL OR PERENNIAL CROP:	Annual -- generally 1 year
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	Rotation sequence commonly followed by a pepper or cucurbit crop
SOIL TYPES:	Sandy loam, clayish loam
FREQUENCY OF METHYL BROMIDE FUMIGATION:	1 time every 2 years
OTHER RELEVANT FACTORS:	Michigan's diversified vegetable crop production is designed to meet key late spring and summer market demands in Midwestern states.

MICHIGAN - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE FOR EGGPLANTS

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE “PLANT HARDINESS ZONE” (e.g. temperate, tropical)	Generally characterized as 5b according to the USDA Hardiness Zone Map, with annual minimum temperature ranges (average) as -23.4 to -26.1 °C (-15 to -10 °F). Example cities: Columbia, Missouri and Mansfield, Pennsylvania.											
SOIL TEMP. (°C)	<10	10 - 15	15-20	20- 25	20- 25	20- 25	20	10- 15	<10	<10	<10	<10
RAINFALL (mm)	40	72	101	48	47	32	17	31	36	20	6	8
OUTSIDE TEMP. (°C)	0.2	7.4	12.1	17.5	20.6	20.9	18.1	8	2.4	-2.9	-8	-7
FUMIGATION SCHEDULE		▶ ◀										
PLANTING SCHEDULE			▶ ◀									
KEY HARVEST (MARKET) WINDOW					▶			◀				

Shaded areas represent typical duration of activity; ▶ = typical initiation of activity, ◀ = typical termination of activity

MICHIGAN – 11. (ii) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (i) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Michigan experiences heavy rainfall events across the entire state at any given moment of the growing season. Heavy rain events (over 25 mm) can trigger rapid root and crown rot development, and promote dissemination of *Phytophthora capsici* via irrigation sources. Generally, there is no difference in the amount of infection depending on soil type or production area. The pathogen is widespread and indigenous on almost all soil types in Michigan (Cortwright, 2003; Gevens and Hausbeck, 2003).

All fumigation practices need to be completed by the first week of May to allow growers to plant early and capture the early market (July-September).

Significant rainfall events (>25.4 mm) or cold soil temperatures (<4.4 °C) could delay fumigation and planting. Such cold soil temperatures often occur in early spring (March – April) in this region (Schaetzl and Tomczak 2001).

Lighter soil types may make drip application difficult (Cortright, 2003).

MICHIGAN - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

Michigan's use of methyl bromide for vegetable production has declined steadily since the mid-1990s, when growers switched to different application methods (i.e. from Flat Fumigation to tarped beds) and formulations, from 98:2 to 67:33 (methyl bromide:chloropicrin). Since 1997, all methyl bromide is applied to tarped beds, with 100% of low density polyethylene sheeting and 95% of the area was treated with the 67:33 formulation. Since 2000, about 5% of the area used the 50:50 methyl bromide:chloropicrin formulation. Growers are using anti-drip valves to eliminate loss of MB at the end of rows when the machinery is removed from the ground.

Please see Table 12.1 for further information.

MICHIGAN - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004
AREA TREATED (<i>hectares</i>)	24	29	32	34	32	35
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED (<i>total kg</i>)	2,937	3,500	3,905	4,057	3,848	4,179
FORMULATIONS OF METHYL BROMIDE (<i>methyl bromide/ Chloropicrin</i>)	67:33	67:33 or 50:50	67:33 or 50:50	67:33 or 50:50	67:33 or 50:50	67:33 or 50:50
METHOD BY WHICH METHYL BROMIDE APPLIED	Injected 20-25 cm strip treatment	Injected 20-25 cm strip treatment	Injected 20-25 cm strip treatment	Injected 20-25 cm strip treatment	Injected 20-25 cm strip treatment	Injected 20-25 cm strip treatment
ACTUAL DOSAGE RATE FOR THE ACTIVE INGREDIENT (<i>g/m²</i>)*	12.1	12.0 or 9.0	12.1 or 9.0	12.1 or 9.0	12.0 or 9.0	12.0 or 9.0

MICHIGAN - PART C: TECHNICAL VALIDATION

MICHIGAN - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

MICHIGAN – TABLE 13.1: REASON FOR ALTERNATIVES NOT BEING FEASIBLE

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE + CITATIONS**	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
CHEMICAL ALTERNATIVES		
1,3-Dichloropropene (1,3-D)	Inconsistently effective against soil-borne fungi. In a recent study conducted in Oceana County, Michigan by Hausbeck and Cortright (2004), yields from pepper plots treated with 1,3-D+chloropicrin were comparable to yields from control plots and plots treated with MB + chloropicrin. These results, while promising, were from fumigation conducted under the optimally warm conditions of June, and require further validation in cooler conditions and at larger scales. However, there is also a Federal label restriction of a 30.4 m buffer zone between treated fields and inhabited structures, which will reduce overall pest control in a field. 28-day waiting period for planting may be disruptive to timely eggplant production and marketing.	No
Chloropicrin	Does not distribute evenly throughout the soil profile when used by itself, resulting in poor efficacy. Does not control <i>Phytophthora capsici</i> when used at maximum label rates. (California Pepper Commission, CUE 02-0017; CUE03-0017)	No
Metam Sodium (or metam potassium)	Poor fumigant with erratic results and inconsistent distribution in soil profiles; does not control <i>Phytophthora</i> (California Pepper Commission, CUE 02-0017; CUE03-0017). Repeated applications of MITC (the breakdown product of metam sodium) are known to enhance its biodegradation as a result of adapted microorganisms (Duncan and Yates, 2003). Phytotoxicity has been reported with this fumigant. 21-day day waiting period for planting may be disruptive to timely eggplant production and marketing. In a recent study conducted in Oceana County, Michigan by Hausbeck and Cortright (2004), yields from pepper plots treated with metam potassium (K-Pam) were comparable to yields from control plots and plots treated with MB + chloropicrin. These results, while promising, were from fumigation conducted under the optimally warm conditions of June, and require further validation in cooler conditions and at larger scales.	No
COMBINATIONS OF ALTERNATIVES		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE + CITATIONS**	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
1,3-D + chloropicrin (Telone C-35)	The 28-day waiting period for planting could disrupt the eggplant production and marketing timing. Regulatory restrictions due to concerns over human exposure and ground water contamination, along with technical limitations, result in potential economic infeasibility of this formulation as a practical MB alternative. In a recent study conducted in Oceana County, Michigan by Hausbeck and Cortright (2004), yields from pepper plots treated with 1,3-D+chloropicrin were comparable to yields from control plots and plots treated with MB + chloropicrin. These results, while promising, were from fumigation conducted under the optimally warm conditions of June, and require further validation in cooler conditions and at larger scales.	No
Metam Sodium/Crop Rotation	The limitations of metam-sodium/potassium have been discussed previously (above). As regards rotation, A 4-5 year rotation cycle is necessary to reduce inoculum levels. The economic threshold of <i>Phytophthora capsici</i> is presumed to be 1 oospore/ft ² (Michigan CUE 03-0061). Because of high land costs, very few crops are of high enough economic value to be rotated with eggplants. Also, 21-day day waiting period for planting after metam sodium fumigation may be disruptive to timely eggplant production and marketing.	No
Metam Sodium/Furfural (Multigard™)	Results of a 2003 small plot field study demonstrated practically equivalent soil pest control of targeted pests (plot vigor) and slightly lesser yields than methyl bromide. (Hausbeck and Cortright, 2004). However, furfural is not yet registered by the U.S.EPA, though it is under consideration by federal authorities.	Insufficient data and trials to estimate cost-effectiveness at this time.

* Regulatory reasons include local restrictions (e.g. occupational health and safety, local environmental regulations) and lack of registration.

MICHIGAN - 14. LIST AND DISCUSS WHY REGISTERED (and Potential) PESTICIDES AND HERBICIDES ARE CONSIDERED NOT EFFECTIVE AS TECHNICAL ALTERNATIVES TO METHYL BROMIDE:

A number of effective fungicides are available for treatment of these fungi when they infect aerial portions of crops. However, these infections are not the focus of MB use, which is meant to keep newly planted transplants free of these fungi. Potential yield losses to *Phytophthora capsici* affect up to 10% of the production area, especially if the plants are infected early in the growing season. The pest situation is exacerbated by the widespread occurrence of indigenous populations of *P. capsici*, (Michigan CUE #03-0061; Gevens and Hausbeck, 2003), significant rainfall events (greater than 254 mm) which trigger rapid disease development (Cortright, personal communication, 2003), metalaxyl and mefenoxam-insensitivity reported among *Phytophthora* spp. populations in several vegetable production areas (Lamour and Hausbeck, 2003; Parra and Ristaino, 1998), and planting restrictions for registered alternative fumigants (e.g. 1,3-D + chloropicrin and metam-sodium).

Label-mandated planted delays of up to 30 days for the alternative fumigants 1,3 D or metam-sodium/potassium + chloropicrin imply that, if growers who must plant eggplant early in the season are forced to use only these options, they would face losses of their target markets even if pests were adequately controlled. For these growers, fumigation needs to be completed by the first week of May to

allow them to plant early and capture the early market (July - September) in order to have their product available for premium prices, as well as to ensure demand for their crop during the entire growing season (especially during the mid and late season). According to the applicant, Michigan's diversified vegetable crop industry is designed to meet market demands in the late spring and through the summer for Midwestern market and therefore requires carefully-timed planting and harvesting schedules. The fumigation with methyl bromide and planting schedule allow growers to maintain market diversity, as well.

MICHIGAN - 15. LIST PRESENT (and Possible Future) REGISTRATION STATUS OF ANY CURRENT AND POTENTIAL ALTERNATIVES:

MICHIGAN – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Iodomethane	Not registered.	Yes	unknown
Fosthiazate	OP nematicide. Under review.	Yes	Unknown
Furfural (Multigard™)	Not registered.	Yes	Unknown
Sodium azide	Not registered.	Yes	Unknown
Diallyl sulfide	Registered to control <i>Sclerotinia</i> spp. (plant-pathogenic fungi). Very limited and narrow spectrum of uses.	Uses may be expanded	Unknown
Metam sodium	Registered	Yes	Reregistration scheduled for 2005-06
Propargyl bromide	Not registered.	Yes	Unknown
<i>Paecilomyces lilacinus</i>	Not registered. Registration pending.	Yes	Unknown
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

**MICHIGAN - 16. STATE RELATIVE EFFECTIVENESS OF RELEVANT ALTERNATIVES
COMPARED TO METHYL BROMIDE FOR THE SPECIFIC KEY TARGET PESTS AND WEEDS FOR
WHICH IT IS BEING REQUESTED**

A field trial was conducted in small plots in 2004 in Michigan by Hausbeck and Cortright (2004) of Michigan State University. This study examined a number of vegetable crops including eggplant. Results, submitted with their 2004 CUE request, indicated that 1,3 D + 35 % chloropicrin treatments (shank-injected at 56.7 liters/ha) showed an average of 44% yield loss compared to MB (due to both *Phytophthora* and *Fusarium* combined). Chloropicrin alone (shank-injected at 233.6 l/ha) showed an average 15.5% loss compared to MB. Metam-potassium + chloropicrin showed yields similar to those seen with MB. Metam-sodium was not tested, but can reasonably be assumed to be equivalent to metam-potassium (since the active ingredient is identical). Methyl iodide (currently unregistered for eggplant) with 33% chloropicrin (shank-injected, at 36.8 kg/ha, respectively), also showed yields similar to that of MB. It should be noted that even large differences in average yields across various treatments were often not statistically significant, suggesting that there was high variability in the data. Thus far, no new data have been generated to complement this work, though further research is planned (see Section 17 below).

In studies with other vegetable crops, 1, 3 D + chloropicrin has generally shown better control of fungi than metam-sodium formulations (though still not as good as control with MB). For example, in a study using a bell pepper/squash rotation in small plots, Webster et al. (2001) found significantly lower fungal populations with 1,3 D + 35 % chloropicrin (drip applied, 146 kg/ha of 1,3 D), as compared to the untreated control. However, MB (440 kg/ha, shank-injected) reduced fungal populations even more. It should be noted that *P. capsici* was not present in test plots, though *Fusarium* spp. were. Methyl iodide had no significant suppressive effect, as compared to the untreated control. However, neither of these MB alternatives increased squash fruit weight significantly over the untreated control. Indeed, as compared to the MB standard treatment plots, squash fruit weight was 63 % lower in the 1,3 D plots, and 41 % lower in the methyl iodide plots. The proportion of marketable squash fruit (defined only as those fruit so bad as to have to be discarded) in the 1,3 D plots was 30 % lower than that in the MB plots, although in the methyl iodide plots it was equivalent to MB. In another study, conducted on tomatoes, Gilreath et al. (1994) found that metam-sodium treatments did not match MB in terms of plant vigor at the end of the season; again, *Fusarium* (but not *P. capsici*) was one of several pests present.

Taken together, these studies indicate that, while the recent trials in Michigan are promising for the use of metam-sodium/potassium + chloropicrin, there is still great inconsistency in efficacy and protection from yield losses. However, the Michigan trials were conducted in the warm conditions of June, so growers cannot be confident that similar results would be seen if fumigation were done in the cooler conditions of springtime in this region. Further, no large scale field trials have yet been performed to demonstrate reliable, consistent pest control similar to that of MB in the cucurbit growing regions of Michigan. Given the highly variable results with this MB alternative, EPA decided that the best case yield loss scenario would be a level similar to what was assessed in the 2003 Critical Use Nomination. Hence Table C.1 and the associated economic loss analyses (Part E) are based on the level used in that Nomination.

MICHIGAN – TABLE C.1: ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
Metam-sodium/potassium + chloropicrin	Soil borne fungal diseases	Under cold soil conditions (below 10° C) this alternative cannot be used due to label restrictions. However, under warmer soil temperatures (typical of June or later) we anticipate no yield losses (based on results from Hausbeck and Cortright 2004), but there is potentially a 2 week planting delay as per label restrictions.	For plantings done in cold conditions, losses are incurred due to regulatory constraints.
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			Regulatory constraints

MICHIGAN - 17. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE? (If so, please specify.)

The critical use exemption applicant states that 1,3 D + chloropicrin, metam-sodium, furfural, propylene oxide, and sodium azide will continue to be the subjects of field studies of utilization and efficacy enhancement where *Phytophthora* is the target pest. It should be kept in mind that furfural, propylene oxide, and sodium azide are currently unregistered for use on eggplants, and there are presently no commercial entities pursuing registration in the U.S. The regulatory restrictions on 1,3 D discussed elsewhere will also remain as negative influences on the economics of this MB alternative. The timeline for developing the above-mentioned MB alternatives in Michigan (by Michigan State University) is as follows:

- 2003 – 2005: Test for efficacy (particularly against the more prevalent *Phytophthora* fungi)
- 2005 – 2007: Establish on-farm demonstration plots for effective MB alternatives
- 2008 – 2010: Work with growers to implement widespread commercial use of effective alternatives.

Research is also under way to optimize the use of a 50 % MB: 50 % chloropicrin formulation to replace the currently used 67:33 formulation. In addition, field research is being conducted to optimize a combination of crop rotation, raised crop beds, black plastic, and foliar fungicides. Use of virtually impermeable film (VIF) will also be investigated as a replacement for the currently used low density polyethylene (LDPE). All research is to be conducted by Michigan State University staff in collaboration with commercial eggplant growers.

MICHIGAN - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE?

The Agency is presently unaware of large scale, commercial greenhouse operations for eggplants. It might be expected, however that there are local (or small community) operations of both organic and hothouse eggplant production that target fresh market, and/or temporal (seasonal) sectors, e.g., farmers' markets. Large-scale production is probably not cost-effective, because of the intensive management of pests and the long growing season for eggplants.

MICHIGAN - SUMMARY OF TECHNICAL FEASIBILITY

The U.S. EPA has determined that only metam-potassium (or metam-sodium) with chloropicrin has some technical feasibility against the key pest of eggplants in this region. 1,3 D + chloropicrin, which has shown promise against these pests in trials in other regions and crops, did not provide control comparable to MB in new tests conducted in Michigan in 2003. Metam sodium/potassium has also been inconsistent across different studies, and no large-plot studies have been performed to show commercial feasibility in eggplants (e.g., Martin 2003, Hausbeck and Cortright, 2004; Csinos et al., 1999). Important technical and regulatory constraints on both 1,3 D and metam-sodium/potassium formulations must also be considered: a 21 – 30 day planting delay, mandatory 100 foot buffers (for 1,3 D) near inhabited structures – both of which will cause negative economic impacts, and potentially lower dissipation (and thus efficacy) in the cool soils of this region.

Currently unregistered alternatives, such as furfural and sodium azide, have shown good efficacy against the key pests involved in small plot tests. However, even if registration is pursued soon (and the U.S. EPA has no indications of any commercial venture planning to do so), these options will need more research on how to adapt them to commercial eggplant production in Michigan.

There are currently no non-chemical alternatives that are currently viable for MB replacement for commercial eggplant growers. In sum, while the potential exists for a combination of chemical and non-chemical alternatives to replace MB use in Michigan eggplants, analysis of ongoing research will help determine the timeline of transition from MB to alternatives.

PART D: EMISSION CONTROL

19. TECHNIQUES THAT HAVE AND WILL BE USED TO MINIMIZE METHYL BROMIDE USE AND EMISSIONS IN THE PARTICULAR USE:

TABLE 19.1: TECHNIQUES TO MINIMIZE METHYL BROMIDE USE AND EMISSIONS

TECHNIQUE OR STEP TAKEN	VIF OR HIGH BARRIER FILMS	METHYL BROMIDE DOSAGE REDUCTION	INCREASED % CHLOROPICRIN IN METHYL BROMIDE FORMULATION	LESS FREQUENT APPLICATION
WHAT USE/EMISSION REDUCTION METHODS ARE PRESENTLY ADOPTED?	Currently some growers use HDPE tarps.	Growers have switched from a 98% MB formulation to a 67 % formulation. Between 1997 and 2001, the US has achieved a 36 % reduction in use rates.	From 2 % to 33 %	No
WHAT FURTHER USE/EMISSION REDUCTION STEPS WILL BE TAKEN FOR THE METHYL BROMIDE USED FOR CRITICAL USES?	Research is underway to develop use in commercial production systems	Research is underway to develop use of a 50 % MB formulation in Michigan commercial production systems. Not known if other regions are planning similar work.	Research is underway to develop use of a 50 % MB formulation in Michigan commercial production systems. Not known if other regions are planning similar work.	The US anticipates that the decreasing supply of methyl bromide will motivate growers to try less frequent applications.
OTHER MEASURES	Examination of promising but presently unregistered alternative fumigants and herbicides, alone or in combination with non-chemical methods, is planned in all regions (Please see Section 17 for each region for details)	Measures adopted in Michigan will likely be used in the other regions when fungi are the only key pests involved	Measures adopted in Michigan will likely be used in the other regions when fungi are the only key pests involved	Unknown

20. IF METHYL BROMIDE EMISSION REDUCTION TECHNIQUES ARE NOT BEING USED, OR ARE NOT PLANNED FOR THE CIRCUMSTANCES OF THE NOMINATION, STATE REASONS

In accordance with the criteria of the critical use exemption, each party is required to describe ways in which it strives to minimize use and emissions of MB. The use of MB in the growing of eggplant in the U.S. is minimized in several ways. First, because of its toxicity, methyl bromide has, for the last 40

years, been regulated as a restricted use pesticide in the U.S. As a consequence, methyl bromide can only be used by certified applicators who are trained at handling these hazardous pesticides. In practice, this means that methyl bromide is applied by a limited number of very experienced applicators with the knowledge and expertise to minimize dosage to the lowest level possible to achieve the needed results. In keeping with both local requirements to avoid “drift” of methyl bromide into inhabited areas, as well as to preserve methyl bromide and keep related emissions to the lowest level possible, methyl bromide application for eggplant is most often machine injected into soil to specific depths.

As MB has become scarcer, users in the U.S. have, where possible, experimented with different mixes of methyl bromide and chloropicrin. Specifically, in the early 1990s, MB was typically sold and used in mixtures made up of 98% MB and 2% chloropicrin, with the chloropicrin being included solely to give the chemical a smell enabling those in the area to be alerted if there was a risk. However, with the outset of very significant controls on methyl bromide, users have been experimenting with significant increases in the level of chloropicrin and reductions in the level of MB. While these new mixtures have generally been effective at controlling target pests, at low to moderate levels of infestation, it must be stressed that the long term efficacy of these mixtures is unknown.

Tarpaulin (high density polyethylene) is also used to minimize use and emissions of MB. In addition, cultural practices are utilized by eggplant growers.

Reduced MB concentrations in mixtures, cultural practices, and the extensive use of tarpaulins to cover land treated with methyl bromide has resulted in reduced emissions and an application rate that we believe is among the lowest in the world for the uses described in this nomination.

PART E: ECONOMIC ASSESSMENT

Economic data from the 2005 submission for all applicants were not substantially different from those in 2004 (greater or less than a 10% change in costs and revenue). Given these insignificant differences, the economic analyses were not updated for any applicants other than Michigan, which was updated to reflect a change in the requested pounds of MeBr.

The economic assessment is organized by MeBr critical use application. Cost of MeBr and alternatives are given first in table 21.1. This is followed in table 22.1 by a listing of net and gross revenues by applicant. Expected losses when using MeBr alternatives are then further decomposed in tables E1 through E3.

Reader please 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. We did not include fixed costs because it is often difficult to measure and verify.

21. OPERATING COSTS OF ALTERNATIVES COMPARED TO METHYL BROMIDE OVER 3-YEAR PERIOD:

TABLE 21.1: EGGPLANT – OPERATING COSTS OF ALTERNATIVES COMPARED TO METHYL BROMIDE OVER 3-YEAR PERIOD

ALTERNATIVE	YIELD*	COST IN YEAR 1 (US\$/ha)	COST IN YEAR 2 (US\$/ha)	COST IN YEAR 3 (US\$/ha)
Florida				
Methyl Bromide	100%	\$15,322	\$15,322	\$15,322
1,3-D + Chloropicrin	71%	\$14,272	\$14,272	\$14,272
Metam-Sodium	56%	\$13,557	\$13,557	\$13,557
Georgia				
Methyl Bromide	100%	\$32,365	\$32,365	\$32,365
1,3-D + Chloropicrin	71%	\$27,530	\$27,530	\$27,530
Metam-Sodium	56%	\$24,493	\$24,493	\$24,493
Michigan				
Methyl Bromide	100%	\$23,598	\$23,598	\$23,598
1,3-D + Chloropicrin	94%	\$23,185	\$23,185	\$23,185

* As percentage of typical or 3-year average yield, compared to methyl bromide e.g. 10% more yield, write 110.

22. GROSS AND NET REVENUE:

TABLE 22.1: EGGPLANT – YEAR 1, 2, AND 3 GROSS AND NET REVENUES

ALTERNATIVES <i>(as shown in question 21)</i>	YEAR 1, 2, AND 3	
	GROSS REVENUE FOR LAST REPORTED YEAR <i>(US\$/ha)</i>	NET REVENUE FOR LAST REPORTED YEAR <i>(US\$/ha)</i>
Florida		
Methyl Bromide	\$21,730	\$6,408
1,3-D + Chloropicrin	\$15,428	\$1,156
Metam-Sodium	\$12,169	\$(1,388)
Georgia		
Methyl Bromide	\$42,857	\$10,491
1,3-D + Chloropicrin	\$30,428	\$2,899
Metam-Sodium	\$24,000	\$(493)
Michigan		
Methyl Bromide	\$34,074	\$10,476
1,3-D + Chloropicrin	\$29,627	\$6,442

NOTE: Year 1 equals year 2 and 3.

MEASURES OF ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

FLORIDA EGGPLANT - TABLE E.1: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

FLORIDA EGGPLANT	METHYL BROMIDE	1,3-D + CHLOROPICRIN	METAM-SODIUM
YIELD LOSS (%)	0%	29%	44%
YIELD PER HECTARE	1,893	1,344	1,060
* PRICE PER UNIT (US\$)	\$11	\$11	\$11
= GROSS REVENUE PER HECTARE (US\$)	\$21,730	\$15,428	\$12,169
- OPERATING COSTS PER HECTARE (US\$)	\$15,322	\$14,272	\$13,557
= NET REVENUE PER HECTARE (US\$)	\$6,408	\$1,156	\$(1,388)
FIVE LOSS MEASURES *			
1. LOSS PER HECTARE (US\$)	\$0	\$5,252	\$7,796
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US\$)	\$0	\$35	\$52
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	24%	36%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	82%	122%
5. PROFIT MARGIN (%)	29%	7%	-11%

GEORGIA EGGPLANT - TABLE E.2: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

GEORGIA EGGPLANT	METHYL BROMIDE	1,3-D + CHLOROPICRIN	METAM-SODIUM
YIELD LOSS (%)	0%	29%	44%
YIELD PER HECTARE	6,326	4,491	3,542
* PRICE PER UNIT (US\$)	\$7	\$7	\$7
= GROSS REVENUE PER HECTARE (US\$)	\$42,857	\$30,428	\$24,000
- OPERATING COSTS PER HECTARE (US\$)	\$32,365	\$27,530	\$24,493
= NET REVENUE PER HECTARE (US\$)	\$10,491	\$2,899	\$(493)
FIVE LOSS MEASURES *			
1. LOSS PER HECTARE (US\$)	\$0	\$7,593	\$10,985
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US\$)	\$0	\$51	\$73
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	18%	26%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	72%	105%
5. PROFIT MARGIN (%)	24%	10%	-2%

MICHIGAN EGGPLANT- TABLE E.3: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

MICHIGAN EGGPLANT	METHYL BROMIDE	1,3-D + CHLOROPICRIN
YIELD LOSS (%)	0%	6%
YIELD PER HECTARE	3,665	3,445
* PRICE PER UNIT (US\$)	\$9	\$8.60
= GROSS REVENUE PER HECTARE (US\$)	\$34,074	\$29,627
- OPERATING COSTS PER HECTARE (US\$)	\$23,598	\$23,185
= NET REVENUE PER HECTARE (US\$)	\$10,476	\$6,442
1. LOSS PER HECTARE (US\$)	\$0	\$4,034
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US\$)	\$0	\$34
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	12%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	39%
5. PROFIT MARGIN (%)	31%	22%

SUMMARY OF ECONOMIC FEASIBILITY

There are currently few alternatives to methyl bromide for use in eggplant. Furthermore, there are factors that limit existing alternatives’ usability and efficacy from place to place. These include pest complex, climate, and regulatory restrictions. As described above, the two most promising alternatives to methyl bromide in Florida and Georgia for control of nut-sedge in eggplant (1,3-D + chloropicrin and metam-sodium) are considered not technically feasible. This derives from regulatory restrictions and the magnitude of expected yield losses when they are used. Economic data representing the Florida and Georgia eggplant growing conditions are included in this section as a supplement to the biological review to illustrate the impacts of using MeBr alternatives, not to gauge them with respect to economic feasibility. However, in Michigan 1,3-D + chloropicrin is considered technically feasible.

Michigan

The US concludes that, at present, no economically feasible alternatives to MeBr exist for use in Michigan eggplant production. Yield losses and missed market windows are the factors that have proven most important in this conclusion, which are discussed individually below.

1. Yield Loss

The US anticipates yield losses of 6% throughout Michigan eggplant production.

2. Missed Market Windows

The US agrees with Michigan's assertion that growers will likely receive significantly lower prices for their produce if they switch to 1,3-D + chloropicrin. This is due to changes in the harvest schedule caused by the above described soil temperature complications and extended plant back intervals when using 1,3-D + chloropicrin.

The analysis of this effect is based on the fact that prices farmers receive for their eggplants vary widely over the course of the growing season. Driving these fluctuations are the forces of supply and demand. Early in the growing season, when relatively few eggplants are harvested, the supply is at its lowest and the market price is at its highest. As harvested quantities increase, the price declines. In order to maximize their revenues, eggplant growers manage their production systems with the goal of harvesting the largest possible quantity of eggplants when the prices are at their highs. The ability to sell produce at these higher prices makes a significant contribution toward the profitability of eggplant operations.

Specific data representing these market fluctuations are not available for Michigan eggplant. However, because of the similar production system and growing conditions, Michigan pepper price data was used to represent price fluctuations in Michigan eggplant and their impact on growers' gross revenues. Though data availability is limiting, it was assumed that if eggplant growers adjust the timing of their production system, as required when using 1,3-D + chloropicrin, that they will, over the course of the growing season, receive gross revenues reduced by approximately 7.5%. The season average price was reduced by 7.5% in analysis of the alternatives to reflect this. Based on currently available information, the US believes this reduction in gross revenues serves as a reasonable indicator of the typical effect of planting delays resulting when MeBr alternatives are used in Michigan eggplant production.

Florida

No technically (and thus economically) feasible alternatives to MeBr are presently available to the effected eggplant growers. As such, the US concludes that use of MeBr is critical in Florida eggplant production.

Florida's application for MeBr critical use indicated that more than one crop is typically grown per growing season but did not provide specific production and sales data for this crop. As a result of this gap in data, economic assessment of Florida eggplant production was based on a single crop production system. This characterization of growing conditions could result in the critical need for MeBr appearing smaller than it actually is, because the value the second crop derives from methyl bromide is not included in the analysis.

Other potentially significant economic factors, such as price reductions due to missed market windows, were not analyzed for this region, as the case for critical use of MeBr is sufficiently strong based solely on yield loss.

Georgia

No technically (and thus economically) feasible alternatives to MeBr are presently available to the effected eggplant growers. As such, the US concludes that use of MeBr is critical in Georgia eggplant production.

Other potentially significant economic factors, such as price reductions due to missed market windows, were not analyzed for this region, as the case for critical use of MeBr is sufficiently strong based solely on yield loss.

PART F. FUTURE PLANS

23. WHAT ACTIONS WILL BE TAKEN TO RAPIDLY DEVELOP AND DEPLOY ALTERNATIVES FOR THIS CROP?

Since 1997, the U.S. EPA has made the registration of alternatives to methyl bromide a high registration priority. Because the EPA currently has more applications pending in its registration review queue than the resources to evaluate them, EPA prioritizes the applications. By virtue of being a top registration priority, methyl bromide alternatives enter the science review process as soon as U.S. EPA receives the application and supporting data rather than waiting in turn for the EPA to initiate its review.

As one incentive for the pesticide industry to develop alternatives to methyl bromide, the Agency has worked to reduce the burdens on data generation, to the extent feasible while still ensuring that the Agency's registration decisions meet the Federal statutory safety standards. Where appropriate from a scientific standpoint, the Agency has refined the data requirements for a given pesticide application, allowing a shortening of the research and development process for the methyl bromide alternative. Furthermore, Agency scientists routinely meet with prospective methyl bromide alternative applicants, counseling them through the preregistration process to increase the probability that the data is done right the first time and rework delays are minimized.

The U.S. EPA has also co-chaired the USDA/EPA Methyl Bromide Alternatives Work Group since 1993 to help coordinate research, development and the registration of viable alternatives. This coordination has resulted in key registration issues (such as worker and bystander exposure through volatilization, township caps and drinking water concerns) being directly addressed through USDA's Agricultural Research Service's U.S.\$15 million per year research program conducted at more than 20 field evaluation facilities across the country. Also EPA's participation in the evaluation of research grant proposals each year for USDA's U.S.\$2.5 million per year methyl bromide alternatives research has further ensured close coordination between the U.S. government and the research community.

The amount of methyl bromide requested for research purposes is considered critical for the development of effective alternatives. Without methyl bromide for use as a standard treatment, the research studies can never address the comparative performance of alternatives. This would be a serious impediment to the development of alternative strategies. The U.S. government

estimates that eggplant research will require 433 kg per year of methyl bromide for 2005 and 2006. This amount of methyl bromide is necessary to conduct research on alternatives and is in addition to the amounts requested in the submitted CUE applications. One example of the research is a field study testing the comparative performance of methyl bromide, host resistance, cultural practices, pest management approaches for control of root-knot nematodes. Another example is a five year field study comparing methyl bromide to 1,3-D combined with biologically based materials including transplant treatments for control of weeds, root-knot nematodes and soil borne fungal pathogens.

24. HOW DO YOU PLAN TO MINIMIZE THE USE OF METHYL BROMIDE FOR THE CRITICAL USE IN THE FUTURE?
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For further details regarding the transition plans for this sector please consult the national management strategy.

25. ADDITIONAL COMMENTS ON THE NOMINATION?

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APPENDIX A. 2008 Methyl Bromide Usage Newer Numerical Index (BUNNI).

2008 Methyl Bromide Usage Newer Numerical Index - BUNNI					Eggplant	
January 24, 2006	Region	Michigan Eggplant	Florida Eggplant	Georgia Eggplant	Sector Total or Average	
Dichotomous Variables	Strip or Bed Treatment?	Strip	Strip	Strip		
	Currently Use Alternatives?	Yes	Yes	Yes		
	Tarps / Deep Injection Used?	Tarp	Tarp	Tarp		
Most Likely Combined Impacts (%)	Karst -1,3-D Limitation (%)	0%	40%	8%		
	100 ft Buffer Zones (%)	0%	1%	0%		
	Key Pest Distribution (%)	75%	52%	52%		
	Regulatory Issues (%)	0%	0%	0%		
	Unsuitable Terrain (%)	0%	0%	0%		
	Cold Soil Temperature (%)	100%	0%	0%		
	Total Combined Impacts (%)	100%	71%	55%		
Most Likely Baseline Transition	(%) Able to Transition	0%	26%	26%		
	Minimum # of Years Required	0	7	7		
	(%) Able to Transition / Year	0%	4%	4%		
EPA Adjusted Use Rate (kg/ha)		120	130	130		
EPA Adjusted Strip Dosage Rate (g/m2)		19	20	20		
2008 Applicant Requested Usage	Amount - Pounds	8,375	240,000	107,736	356,111	
	Area - Acres	78	1,600	804	2,482	
	Rate (lb/A)	107.37	150.00	134.00	143	
	Amount - Kilograms	3,799	108,862	48,868	161,529	
	Treated Area - Hectares	32	647	325	1,004	
Rate (kg/ha)	120	168	150	161		
EPA Preliminary Value kgs		3,799	108,862	48,868	161,529	
EPA Baseline Adjusted Value has been adjusted for:		MBOC Adjustments, Double Counting, Growth, Use Rate/Strip Treatment, LPF Transition, and Combined Impacts				
EPA Baseline Adjusted Value		kgs	3,788	55,331	22,829	81,948
EPA Transition Amount		kgs	-	(2,024)	(812)	(2,836)
Most Likely Impact Value (kgs)	kgs	3,788	53,307	22,017	79,113	
	ha	31	410	169	611	
	Rate	120	130	130	130	
Sector Research Amount (kgs)		433	2008 Total US Sector Nomination		79,546	

1 Pound = 0.453592 kgs 1 Acre = 0.404686 ha

* ALL OF THE APPLICANTS HAVE BEEN ADJUSTED FOR STRIP TREATMENTS EXCEPT MICHIGAN WHO ADJUSTED ON THEIR OWN

Footnotes for Appendix A:

Values may not sum exactly due to rounding.

- Dichotomous Variables** – dichotomous variables are those which take one of two values, for example, 0 or 1, yes or no. These variables were used to categorize the uses during the preparation of the nomination.
- Strip Bed Treatment** – Strip bed treatment is ‘yes’ if the applicant uses such treatment, no otherwise.
- Currently Use Alternatives** – Currently use alternatives is ‘yes’ if the applicant uses alternatives for some portion of pesticide use on the crop for which an application to use methyl bromide is made.
- Tarps/ Deep Injection Used** – Because all pre-plant methyl bromide use in the US is either with tarps or by deep injection, this variable takes on the value ‘tarp’ when tarps are used and ‘deep’ when deep injection is used.
- Pest-free cert. Required** - This variable is a ‘yes’ when the product must be certified as ‘pest-free’ in order to be sold
- Other Issues** - Other issues is a short reminder of other elements of an application that were checked
- Frequency of Treatment** – This indicates how often methyl bromide is applied in the sector. Frequency varies from multiple times per year to once in several decades.

8. **Quarantine and Pre-Shipment Removed?** – This indicates whether the Quarantine and pre-shipment (QPS) hectares subject to QPS treatments were removed from the nomination.
9. **Most Likely Combined Impacts (%)** – Adjustments to requested amounts were factors that reduced to total amount of methyl bromide requested by factoring in the specific situations where the applicant could use alternatives to methyl bromide. These are calculated as proportions of the total request. We have tried to make the adjustment to the requested amounts in the most appropriate category when the adjustment could fall into more than one category.
10. **(%) Karst geology** – Percent karst geology is the proportion of the land area in a nomination that is characterized by karst formations. In these areas, the groundwater can easily become contaminated by pesticides or their residues. Regulations are often in place to control the use of pesticide of concern. Dade County, Florida, has a ban on the use of 1,3D due to its karst geology.
11. **(%) 100 ft Buffer Zones** – Percentage of the acreage of a field where certain alternatives to methyl bromide cannot be used due to the requirement that a 100 foot buffer be maintained between the application site and any inhabited structure.
12. **(%) Key Pest Impacts** - Percent (%) of the requested area with moderate to severe pest problems. Key pests are those that are not adequately controlled by MB alternatives. For example, the key pest in Michigan peppers, *Phytophthora* spp. infests approximately 30% of the vegetable growing area. In southern states the key pest in peppers is nutsedge.
13. **Regulatory Issues (%)** - Regulatory issues (%) is the percent (%) of the requested area where alternatives cannot be legally used (e.g., township caps) pursuant to state and local limits on their use.
14. **Unsuitable Terrain (%)** – Unsuitable terrain (%) is the percent (%) of the requested area where alternatives cannot be used due to soil type (e.g., heavy clay soils may not show adequate performance) or terrain configuration, such as hilly terrain. Where the use of alternatives poses application and coverage problems.
15. **Cold Soil Temperatures** – Cold soil temperatures is the proportion of the requested acreage where soil temperatures remain too low to enable the use of methyl bromide alternatives and still have sufficient time to produce the normal (one or two) number of crops per season or to allow harvest sufficiently early to obtain the high prices prevailing in the local market at the beginning of the season.
16. **Total Combined Impacts (%)** - Total combined impacts are the percent (%) of the requested area where alternatives cannot be used due to key pest, regulatory, soil impacts, temperature, etc. In each case the total area impacted is the conjoined area that is impacted by any individual impact. The effects were assumed to be independently distributed unless contrary evidence was available (e.g., affects are known to be mutually exclusive). For example, if 50% of the requested area had moderate to severe key pest pressure and 50% of the requested area had karst geology, then 75% of the area was assumed to require methyl bromide rather than the alternative. This was calculated as follows: 50% affected by key pests and an additional 25% (50% of 50%) affected by karst geology.
17. **Most Likely Baseline Transition** – Most Likely Baseline Transition amount was determined by the DELPHI process and was calculated by determining the maximum share of industry that can transition to existing alternatives.
18. **(%) Able to Transition** – Maximum share of industry that can transition
19. **Minimum # of Years Required** – The minimum number of years required to achieve maximum transition.
20. **(%) Able to Transition per Year** – The Percent Able to Transition per Year is the percent able to transition divided by the number of years to achieve maximum transition.
21. **EPA Adjusted Use Rate** - Use rate is the lower of requested use rate for 2008 or the historic average use rate or is determined by MBTOC recommended use rate reductions.
22. **EPA Adjusted Strip Dosage Rate** – The dosage rate is the use rate within the strips for strip / bed fumigation.
23. **2008 Amount of Request** – The 2008 amount of request is the actual amount requested by applicants given in total pounds active ingredient of methyl bromide, total acres of methyl bromide use, and application rate in pounds active ingredient of methyl bromide per acre. U.S. units of measure were used to describe the initial request and then were converted to metric units to calculate the amount of the US nomination.
24. **EPA Preliminary Value** – The EPA Preliminary Value is the lowest of the requested amount from 2005 through 2008 with MBTOC accepted adjustments (where necessary) included in the preliminary value.
25. **EPA Baseline Adjusted Value** – The EPA Baseline Adjusted Value has been adjusted for MBTOC adjustments, QPS, Double Counting, Growth, Use Rate/ Strip Treatment, Miscellaneous adjustments, MBTOC recommended Low Permeability Film Transition adjustment, and Combined Impacts.
26. **EPA Transition Amount** – The EPA Transition Amount is calculated by removing previous transition amounts since transition was introduced in 2007 and removing the amount of the percent (%) Able to Transition per Year multiplied by the EPA Baseline Adjusted Value.

27. **Most Likely Impact Value** – The qualified amount of the initial request after all adjustments have been made given in total kilograms of nomination, total hectares of nomination, and final use rate of nomination.
28. **Sector Research Amount** – The total U.S. amount of methyl bromide needed for research purposes in each sector.
29. **Total US Sector Nomination** - Total U.S. sector nomination is the most likely estimate of the amount needed in that sector.