METHYL BROMIDE CRITICAL USE NOMINATION FOR PREPLANT SOIL USE FOR FRUIT, NUT AND FLOWER NURSERIES

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 Fruit, Nut and Flower Nurseries (Submitted in 2006 for the 2008 Use Season)

NOMINATING PARTY CONTACT DETAILS

Contact Person:	John E. Thompson, Ph. D.
Title:	International Affairs Officer
Address:	Office of Environmental Policy U.S. Department of State 2201 C Street N.W. Room 4325 Washington, DC 20520 U.S.A.
Telephone:	(202) 647-9799
Fax:	(202) 647-5947
E-mail:	ThompsonJE2@state.gov

Following the requirements of Decision IX/6 paragraph (a)(1), the United States of America has determined that the specific use detailed in this Critical Use Nomination is critical because the lack of availability of methyl bromide for this use would result in a significant market disruption.

☐ Yes ☐ No

Signature	Name	Date

Title: _____

CONTACT OR EXPERT(S) FOR FURTHER TECHNICAL DETAILS

Contact/Expert Person:	Richard Keigwin
Title:	Acting Director
Address:	Biological and Economic Analysis Division Office of Pesticide Programs U.S. Environmental Protection Agency Mail Code 7503C Washington, DC 20460 U.S.A.
Telephone:	(703) 308-8200
Fax:	(703) 308-8090
E-mail:	Keigwin.Richard@epa.gov

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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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 Fruit, Nut and Flower Nurseries (Submitted in 2006 for the 2008 Use Season)

3. CROP AND SUMMARY OF CROP SYSTEM

This nomination is based on requests for critical use of methyl bromide (MB) by producers of nursery-grown raspberry, roses, and deciduous tree planting material. Nursery producers must provide stock plants that are pest-free to allow the establishment of plantings that are of the highest initial quality and optimize the longevity of orchards or other producing plots. Nurseries provide plants used by commercial growers of fresh and processed raspberries, rose bushes, and such diverse fruit crops as apricots, peaches, prunes, nectarines, cherries, plums, apples, pears, Asian pears (as well as ornamental pears), and nut crops such as almonds, walnuts, pistachios, pecans, and chestnuts. Approximately 95% of the trees are fruiting varieties sold to commercial producers (although residential consumers are also a market); the other 5% are ornamental types used for landscaping. Nurseries are concentrated in areas conducive to early plant growth—deciduous trees are primarily produced in California in the Sacramento and San Joaquin valleys in a Mediterranean climate, many large raspberry nurseries are located in eastern San Joaquin valley and western Washington where pest-free stock can be grown for markets in the cooler production areas of northern California and the Pacific Northwest.

Raspberry nurseries in the western U.S. provide raspberry stock to most of the growers in North America. Dry climates and soils make these areas ideal for production of high quality plant stock. Although there are relatively few raspberry nurseries, they provide all of the stock used by commercial growers, and therefore, have a large impact on raspberry production overall. MeBr is used on a total area of approximately 200 hectares of field beds. There is a large return in the benefits of certified pest-free stock to numerous commercial growers throughout the continent. The raspberry nursery industry uses flat fumigation techniques similar to that of the strawberry industry. Raspberry nursery stock is grown using a two-year production cycle beginning with tissue culture and moving to foundation planting the first year. Winter dormant plants are replanted in commercial nurseries and harvested after one year.

Deciduous tree nurseries range from 15 to over 600 hectares in field beds. A typical operation in California ranges between 80 and 120 hectares. The climate and soil make this region an ideal area for tree nurseries (as well as a major fruit and nut producing region). While some nurseries concentrate on specific tree crops, most nurseries grow and sell a variety of different trees. Nursery stock is grown on a cropping system that includes crop rotation or cover cropping between tree production cycles; therefore, not all of the nursery area is in tree production in a given year. The tree production cycle can be anywhere from a single year to several years

depending on the type of tree crop being produced. Nursery production of trees takes from one to four years in the ground depending on the type being produced. Almonds take one year and walnuts take at least two years. Also, target tree size determines how long plants are grown in the nursery. The most common cycle is for the tree crop to be in the ground for either one or two years. A typical nursery cycle starts by digging the current tree crop (to be sold) then planting a cover crop for one or two years, followed by replanting with a tree crop. In order to prepare the ground for planting, the fields are disked, deep ripped, leveled, and then fumigated to meet certification standards set by the California Department of Food and Agriculture (CDFA, 2001). MeBr is applied by shank and treated area is usually covered with a high barrier tarp. The fumigation is carried out around August and September, and planting begins in October, and may continue through January. The deciduous nurseries are subject to mandates set forth by the CDFA (2001) that trees must be pest free. The nomination is for the portion of tree nurseries in California that are in areas where alternatives are either unsuitable for meeting certification standards or subject to regulatory restrictions.

Nursery roses are grown in open field plots. A typical crop rotation for a two-year rose crop includes one year fallow, followed by one or two years of rotational crops, and then a two-year rose crop. The two-year rose crop cycle begins with land preparation (removing the cover crop, deep cultivation, and fumigation with methyl bromide), followed by planting the rootstock and T-bud grafting. In late winter of the first year, the rootstock tops are removed. The rose crop matures by the second autumn and is then harvested. This cycle varies depending on the type of rose crop being produced (e.g., two-year roses, one-year minis and patio trees, or 18-month mini bushes).

METHYL BROMIDE NOMINATED

TABLE 4.1: METHYL BROMIDE NOMINATED

YEAR	NOMINATION AMOUNT (KG)*	NOMINATION AREA (HA)
2008	**51,102**	**185**

** Includes research amount of 1,506 kgs, See Appendix A for complete description of how the nominated amount was calculated.*

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

TABLE A.1: EXECUTIVE SUMMARY*

Region		*Western Raspberry Nurseries*	*California Deciduous Fruit & Nut Tree Growers*	*California Nursery Roses*
AMOUNT OF APPLICANT REQUEST				
2008	**Kilograms**	37,229	11,289	1,998
AMOUNT OF NOMINATION				
2008	**Kilograms**	36,309	11,289	1,998

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

Nurseries must provide stock that is pest-free in order to meet state mandated certification requirements for plant material (CDFA, 2001). Use of products with 1,3-D can provide an effective alternative to MeBr for nematode control where allowed by township cap regulation and where soil type and moisture are acceptable, (e.g., Schneider et al., 2004). Moisture restrictions for 1,3-D may be more limiting than township caps. Nurseries with heavy soils or moisture greater than 12% (especially common in clay soils at depths of 1 to 1.5 meters) may not receive certification of nursery stock, because of failure to reduce populations of nematodes or pathogens. In these situations MeBr is critical.

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 (%)
Western Raspberry Nurseries	Not available	Not available
California Deciduous Fruit & Nut Tree Growers	Not available	Not available
California Nursery Roses	Not available	Not available
NATIONAL TOTAL:	Not available	Not available

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.

Nurseries must provide pathogen- and nematode-free stock. They rely on MeBr for certification when 1,3-D is not allowed because of soil or moisture conditions or township caps. Some areas with light, sandy soil-types, appropriate soil moisture, and no legal restrictions should be able to replace MeBr with 1,3-D alternatives.

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?

The critical need for MeBr exists for nurseries that are limited by state certification requirements or soil conditions where 1,3-D formulations are unacceptable.

8. Amount of Methyl Bromide Requested for Critical Use

Table 8.1. Amount of Methyl Bromide Requested for Critical Use

Region:	Western Raspberry Nurseries	California Deciduous Fruit & Nut Tree Growers	California Nursery Roses
Year of Exemption Request	**2008**	**2008**	**2008**
Kilograms of Methyl Bromide	37,229	11,289	1,998
Use: Flat Fumigation or Strip/Bed Treatment	Flat Fumigation	Flat Fumigation	Flat Fumigation
Formulation *(ratio of methyl bromide/chloropicrin mixture)* to be used for the CUE	67:33	75:25	98:2
Total Area to be treated with the methyl bromide or methyl bromide/Chloropicrin formulation *(ha)*	142	35	7
Application rate* *(kg/ha)* for the **Active Ingredient**	263	321	309
Dosage rate* *(g/m^2)* of **Active Ingredient** used to calculate requested kilograms of methyl bromide	26.3	32.1	30.9

9. Summarize Assumptions Used to Calculate Methyl Bromide Quantity Nominated for Each Region:

The amount of MeBr 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.
- Hectares counted in more than one application or rotated within one year of an application to a crop that also uses MeBr 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.
- Quarantine and pre-shipment (QPS) hectares is the area in the applicant's request subject to QPS treatments. QPS amount of MeBr is not included in the nomination.
- Only the hectares experiencing one or more of the following impacts were included in the nominated amount: moderate to heavy key pest pressure, regulatory impacts, and unsuitable terrain.

Western Raspberry Nurseries - Part B: Crop Characteristics and Methyl Bromide Use

Western Raspberry Nurseries 10. Key Diseases and Weeds for which Methyl Bromide Is Requested and Specific Reasons for this Request

WESTERN RASPBERRY NURSERIES. TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
Western Raspberry Nurseries	Primarily pathogens: *Phytophthora fragariae* var. *Rubi* (root rot), *Verticillium* spp. (wilt), others including *Pythium* spp., *Rhizoctonia* spp.	To meet certification requirements for sale of nursery stock.

WESTERN RASPBERRY NURSERIES 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

Raspberry nurseries in the western U.S. provide raspberry stock to most of the growers in North America. Raspberry nurseries have a large impact on raspberry production overall. USDA organic standards specifically allow the use of nursery stock propagated using MeBr for organic production in recognition of the vital role vigorous planting stock plays in organic and integrated pest management systems. This exemplifies that the use of MeBr in propagation nurseries reduces the need for MB, and other chemical inputs, in fruiting fields. MeBr use is concentrated within nurseries having a total area of approximately 200 hectares.

According to this consortium, "…fallow is part of the two-year cycle. The production of one acre of raspberry nursery is a 24-month process. It begins with land preparation in January of year 1. A cover crop is then grown during the winter, spring and early summer of year 1. In the summer the cover crop is incorporated into the soil and the land is prepared for fumigation. There is a brief fallow period in June of year 1 prior to fumigation. The field is fumigated in August of year 1. The planting beds are constructed in September of year 1. These beds lay "fallow" through the winter, until February of year 2. The planted crop will grow until harvest in November and December of year 2. Following the harvest we begin another cycle in January.

Although the nursery is a 24-month process, some land is fumigated each year to provide an annual supply of planting stock for our farmers. Therefore, the amount stated in the application refers to an annual usage."

WESTERN RASPBERRY NURSERIES. TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	WESTERN RASPBERRY NURSERIES
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Raspberry cane stock
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	2-3 years
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	1 year in foundation nursery, 1 year in commercial nursery. The raspberry nursery industry utilizes flat fumigation techniques similar to that of the strawberry industry. Raspberry nursery stock are grown using a two year production cycle beginning with tissue culture and moving to foundation nurseries the first year. Winter dormant plants are replanted in commercial nurseries and harvested after one year. Ten hectares of plants in a foundation nursery will serve to plant 100 hectares of a commercial nursery. A commercial nursery produces enough plants to provide 1200 hectares of commercial fields; therefore, pest infestation of nursery plants can impact significant areas of commercial fields.
SOIL TYPES: *(Sand, loam, clay, etc.)*	Typically light or medium
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Once in 2-3 years
OTHER RELEVANT FACTORS:	None identified

WESTERN RASPBERRY NURSERIES. TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 8a, 9a, 9b											
RAINFALL *(mm)*	16	72.1	17.3	0	trace	1.0	trace	0	44.7	56.9	9.9	30.5
OUTSIDE TEMP. *(°C)*	14.4	14.8	20.8	25.7	30.3	27.4	25.1	18.4	13.4	9.6	10.3	10.6
FUMIGATION SCHEDULE						X						
PLANTING SCHEDULE												X

*For Fresno, California.

WESTERN RASPBERRY NURSERIES 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Soil moisture is an important determinant of capacity of 1,3-D efficacy (McKenry, 1999). Moisture above 12% is common below 1 meter depth and reduction of 1,3-D nematicidal activity results at this moisture level; this is especially a problem with nurseries with heavier soils. It is critical that nurseries control pests in the top 1 meter of soil because the plant roots extend to this depth.

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

WESTERN RASPBERRY NURSERIES. 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 *(hectares)*	103	111	103	131	151	134
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	Flat Fumigation	Flat Fumigation	Flat Fumigation	Flat Fumigation	Flat Fumigation	Flat Fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	26,671	26,937	24,188	30,570	37,680	34,937
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*	67:33	67:33	67:33	67:33	67:33	67:33
METHOD BY WHICH METHYL BROMIDE APPLIED *)*	Shank injected, with tarp	Shank injected, with tarp	Shank injected, with tarp	Shank injected, with tarp	Shank injected, with tarp	Shank injected, with tarp
APPLICATION RATE [ACTIVE INGREDIENT] (kg/ha*)	258	242	235	234	249	260
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)***	25.7	25.8	24.2	23.5	23.4	25.2

WESTERN RASPBERRY NURSERIES. PART C: TECHNICAL VALIDATION

WESTERN RASPBERRY NURSERIES 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

WESTERN RASPBERRY NURSERIES. 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		
Chloropicrin	Not sufficiently effective to meet standards for pest-free nursery stock	No
1,3-dichloropropene (1,3-D)	In areas with moisture restrictions (e.g., >12% at 1-1.5 meters) (or under township caps) would not be able to meet standards for pest-free nursery stock; nurseries with no such restrictions should be able to use 1,3-D as an alternative	Possibly, where soil conditions and township caps allow use
Metam-sodium	Not sufficiently effective to meet standards for pest-free nursery stock	No
Dazomet	As with metam-sodium, would not meet standards for nursery. The use of dazomet in combination with 1,3-D was examined in a study submitted by the applicant. The study showed that although weed populations were suppressed, nematode populations were not controlled, causing stock to be commercially unacceptable. When dazomet was used in combination with 1,3-D, nematode populations were 15 times greater when compared to that of a dual application of 1,3-D.	No
NON CHEMICAL ALTERNATIVES		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Containerized production	A field is planted with tissue culture plugs. The wide, flat planting beds allow these plants to grow laterally in all directions and to produce long straight roots. The nursery is watered using overhead irrigation, this creates optimal growing conditions over the entire surface area of the beds. At the end of the growing season when plants are dormant they are mowed to about 20 cm long. The canes are chopped into small pieces and later they are incorporated into the soil to increase the organic matter. Then the beds are "lifted" and shaken, this removes soil from the plants and makes it easier to pick the plants up and place them in a box for transfer to the trimming operation. This system is efficient because the crews can move up each row with a mower, then the lifter followed by several workers who transfer the plants into the bin for movement to the trimming operation (Maybe add a sentence such as: Containerized production would change this efficient harvesting system and require different equipment.). Plants are produced with long straight roots, which are trimmed from the canes. The trimmed roots provide the root planting material used by the growers. Generally, container-grown plants produce shorter or curved roots. New canes are produced from adventitious root buds, it is likely that any reduction in surface area would reduce the number and/or quality (size, strength) of these new adventitious canes. Nursery managers have observed that when raspberries are grown in pots, the south, or hot, side of the pot has a reduced or absent root system, which reduces yield and increases water demands. Some of the largest nurseries are located in the eastern San Joaquin Valley of California where temperatures can reach over 40º C in the summer. Roots are not as large or healthy as what is produced in field systems.	No
Virtually Impermeable Film (VIF)	May have a role in reducing MeBr use rates while maintaining efficacy due to reduced emissions (Guillino et al., 2002; Martin, 2003). Ongoing studies may help assess value of VIF with MeBr and chemical alternatives (VIF use is restricted in California).	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Biofumigation, solarization, steam heat, biological control, cover crops/mulches, crop rotation, flooding and water management, grafting/resistant rootstocks, organic amendments, sanitation, and resistant cultivars	Some of these alternatives are important components of an IPM system and are currently employed by the industry. These practices include field sanitation to reduce inoculum, crop rotation to reduce hosts, and attempts to breed resistance to pathogens. However, these alternatives will not meet requirements of CDFA for nursery stock certification either individually or in combinations. Use of flooding is not practical because of the topographic features of many production areas and requirements for excessive water use. The use of steam also requires large quantities of water and is slow and expensive to perform, which would impact planting and production intervals for this industry. Use of solarization is not practical due to the depth of heating required to eliminate propagules; environmental constraints at high altitude nurseries, including high winds, are of concern.	No
COMBINATIONS OF ALTERNATIVES		
(1,3-D) + chloropicrin	In areas with moisture restrictions (e.g., >12% at 1-1.5 meters) (or under township caps) would not be able to meet standards for pest-free nursery stock; nurseries with no such restrictions should be able to use 1,3-D as an alternative	Where soil conditions and township caps allow use
(1,3-D) + metam-sodium	In areas with moisture restrictions (e.g., >12% at 1-1.5 meters) (or under township caps) would not be able to meet standards for pest-free nursery stock; nurseries with no such restrictions should be able to use 1,3-D as an alternative Metam-sodium may be helpful where weeds are problems.	Where soil conditions and township caps allow use

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

WESTERN RASPBERRY NURSERIES - TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
As listed in Table 13.1	As listed in Table 13.1

WESTERN RASPBERRY NURSERIES - 15. LIST PRESENT *(and Possible Future)* REGISTRATION STATUS OF ANY CURRENT AND POTENTIAL ALTERNATIVES:

WESTERN RASPBERRY NURSERIES. 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:
Sodium azide	No registration has been requested	No	Unknown
Propargyl bromide	No registration has been requested	No	Unknown
Iodomethane	Not registered in U.S.	Yes	Unknown
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

WESTERN RASPBERRY NURSERIES - 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

As with other nursery commodities, yield is not the only (and possibly not the most important) factor in the production of raspberry nursery stock. What is of primary importance is pest-free stock that is of sufficient quality to meet government standards and comply with standards for intra- and interstate plant transit. Consequently, for nurseries restricted in the use of 1,3-D, there is a critical need for MeBr for the 2008 use season.

WESTERN RASPBERRY NURSERIES. TABLE 16.1: EFFECTIVENESS OF ALTERNATIVES – DISEASES

KEY PEST: DISEASES	AVERAGE DISEASE % OR RATING AND YIELDS IN PAST 3~5 YEARS				
METHYL BROMIDE FORMULATIONS AND ALTERNATIVES	# OF TRIALS	DISEASE (% OR RATING)	# OF TRIALS	ACTUAL YIELDS (T/HA)	CITATION
[1] MB (263 kg/ha) + chloropicrin (129 kg/ha) [2] chloropicrin (140 kg/ha) [3] no fumigation		No pests identified	12 reps	Runners/mother plant (strawberry) [1] 18.0a [2] 15.7b [3] 7.9c	Larson and Shaw, 2000
[1] MB (314 kg/ha) + chloropicrin (78 kg/ha) [2] chloropicrin (191 kg/ha) [3] chloropicrin (303 kg/ha) [4] no fumigation		No pests identified	4 reps	Runners/mother plant (strawberry) [1] 29.7a [2] 27.0a [3] 29.7a [4] 11.2b	Larson and Shaw, 2000
[1] MB (263 kg/ha) + chloropicrin (129 kg/ha) [2] chloropicrin (157 kg/ha) [3] chloropicrin (314 kg/ha) [4] no fumigation		No pests identified	24 reps	Runners/mother plant (strawberry) [1] 18.8a [2] 16.7b [3] 18.9a [4] 10.3c	Larson and Shaw, 2000
[1] MB (263 kg/ha) + chloropicrin (129 kg/ha) [tarped, noble plow] [2] chloropicrin (168 kg/ha) [3] chloropicrin (336 kg/ha) [4] 1,3-D (134 kg/ha) + chloropicrin (314 kg/ha) [5] 1,3-D (361 kg/ha) + chloropicrin (155 kg/ha) [6] no fumigation		No pests identified	12 reps (MB trt, 11 reps)	Runners/mother plant (strawberry) [1] 39.2a [2] 28.6bc [3] 33.8abc [4] 35.8ab [5] 33.0bc [6] 15.8d	Larson and Shaw, 2000

N.B.: some studies were with strawberry research, a crop with similar pest problems and because of the large size of the industry, a greater resource for research data.

WESTERN RASPBERRY NURSERIES. 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 (225 kg/ha)+ chloropicrin (123 kg/ha)	(fungal) pathogens (strawberry nursery)	2-15% (ref.: CDFA, 2001; Gullino et al., 2002)	14%
Chloropicrin (300 kg/ha)	(fungal) pathogens (strawberry nursery)	5-16% (ref.: CDFA, 2001; Gullino et al., 2002)	9%
Metam-sodium (350 kg/ha)	(fungal) pathogens (strawberry nursery)	13-57% (Gullino et al., 2002)	30%
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			9% plus certification issues

More important than yield for raspberry nurseries, as well as other nurseries, is their dependence on certification of stock as 'pest-free' in order to meet state requirements to sell to commercial outlets.

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

Raspberry nurseries have spent $100,000 on research, including $20,000 on screening resistance for *Phytophthora* and *Verticillium*, and over $60,000 over the last decade studying various alternatives in the large Watsonville, California area. Studies are also ongoing to discover how application methods can improve efficacy of chemical alternatives such as 1,3-D and metam-sodium, and mixes of chemicals. Moisture constraints, both too much and too little, can reduce efficacy of effective chemicals such as 1,3-D, especially when soil textures are not optimal for their physical chemistry. Iodomethane is a potential replacement for MB, but it has not been registered in the U.S.

The use of virtually impermeable film (VIF) may offer a means of reducing fumigant use rates while maintaining efficacy and production goals, although VIF use is currently restricted in California. There is also interest in examining the effects of certain fertilizer salts (e.g., ammonium thiosulfate, see Gan and Yates, 1998), which may act as barriers to volatile compounds (e.g., 1,3-D, MB) when applied to the soil surface, thus reducing emissions and improving efficacy.

WESTERN RASPBERRY NURSERIES 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE?:

Under some conditions (where soils are appropriate and regulations do not prohibit use) alternative chemicals are used and research is ongoing to increase efficacy, as has been described above.

WESTERN RASPBERRY NURSERIES SUMMARY OF TECHNICAL FEASIBILITY

The raspberry nursery industry faces the same problems that other nurseries face in their need to produce nearly pest-free plant stock to their respective growers. Quality of stock plants may have a greater place in the requirements of the nursery managers than quantity since there can be an exponential increase in pest pressure when infested nursery stock is transferred to production fields. Therefore, the threshold for nurseries to manage pest problems is higher than might be for field production and critical need for effective pest management tools is paramount. Because locations of nurseries vary and soil, climate, and water situations are variable, alternatives such as 1,3-D, may be acceptable substitutes for MeBr under some conditions. Results of meta-analyses (Larson and Shaw, 2000; Shaw and Larson, 2000) of numerous research studies indicate that for the nurseries unable to use 1,3-D, other alternatives are not sufficiently effective to meet their production needs.

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS. TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
California Deciduous Fruit & Nut Tree Growers	**Nuts:** Nematodes—*Pratylenchus vulnus* (root lesion), *Meloidogyne* spp. (root knot), *Helicotylenchus dihystera* (spiral), *Xiphinema americanum* (dagger). **Stone Fruit:** Nematodes—*Helicotylenchus dihystera* (spiral), *Tylenchus mexicanus* (Tylenchus), *Tylenchorhynchus* spp. (stunt), *Trichodorus* spp. (stubby root)	Nurseries providing stock for orchards are required to provide the stock that is pest-free (and particularly nematode-free). 1,3-D is an effective nematicide, but its use is restricted in California. Compounds producing methyl isothiocyanate (MITC) have been tested as possible alternatives (e.g., metam-sodium and dazomet) but nematode control was not sufficient to meet certification requirements. The goal in the orchard nursery industry is 99.9% control when sampled within 30-60 days after treatment, so certification can be met when stock is harvested 18 months later (McKenry, 2000). Generally, less than 98% control in the 30-60 day sampling period will yield unacceptable stock plants. Field moisture is a carefully monitored factor. A site (e.g., walnut nursery in Davis, California) with silty clay loam over sandy loam or clay loam has moisture differential with the lighter textured soils holding more moisture (>12%), which can impede distribution of an alternative such as 1,3-D (McKenry, 2000) and make it ineffective. In California deciduous tree nurseries, approximately 30% have silt or clay loam soils requiring MB. The remaining 70% have sand or sandy loam soils. Approximately one half of these areas have a critical need for MeBr due to moisture requirements. According to the applicant, approximately 65% of nursery soils in California have a critical need for MB. Township caps for 1,3-D may further limit the use of the best alternative.

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

Deciduous tree nurseries range from 15 to over 600 hectares. The median operation in California ranges between 80 and 120 hectares. While some nurseries concentrate on specific tree crops, most nurseries grow and sell a variety of different trees. Nursery stock is grown on a cropping system that includes crop rotation or cover cropping between tree production cycles; therefore, not all of the nursery land is in production in a given year.

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Nursery tree stock
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Perennial (1 to 2 years in nursery)
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	The tree production cycle can be anywhere from 1 year to several years depending on the type of tree crop. Nursery production of trees takes from 1-4 years. Almonds take one year, walnuts take at least two years. Also, desired tree size determines how long it is grown in the nursery. A typical cycle is for the tree crop to be in the ground for either 1 or 2 years. A typical nursery cycle starts by digging the current tree crop (to be sold) then planting a cover crop for 1 or 2 years, followed by replanting with a tree crop. Fields are disked, deep ripped, leveled, and then fumigated to meet certification standards set by the California Department of Food and Agriculture (CDFA, 2001). A shank is used to apply a fumigation of 75% MeBr and 25% chloropicrin, typically at a rate of 340 kg per hectare. The treated area is covered with a high barrier tarp. The fumigation is carried out around August and September, and planting begins in October, and may continue through January. The deciduous nurseries are subject to mandates set forth by the CDFA, that trees must be pest-free.
SOIL TYPES: *(Sand, loam, clay, etc.)*	Mostly sandy loam (also sandy clay loam, sandy loam, silt loam, clay loam); light soils (20%), medium (50%), heavy (30%)
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Typically once in 3-5 years, depending on crop
OTHER RELEVANT FACTORS:	Nursery stock is inspected by county agricultural commissioners through the California Department of Food and Agriculture (CDFA). Stock must be "found free of especially injurious pests and disease symptoms" to qualify for the CDFA Nursery Stock Certificate for Interstate and Intrastate Shipments (CDFA, 2001). 1,3-D is a legally acceptable treatment where township restrictions and physical limitations (e.g., moisture greater than 12% in many soils reduces efficacy of 1,3-D) do not prevent its use.

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 8a, 9a, 9b											
RAINFALL *(mm)*	16	72.1	17.3	0	trace	1.0	trace	0	44.7	56.9	9.9	30.5
OUTSIDE TEMP. *(°C)*	14.4	14.8	20.8	25.7	30.3	27.4	25.1	18.4	13.4	9.6	10.3	10.6
FUMIGATION SCHEDULE						X	X					
PLANTING SCHEDULE								X	X	X	X	

*For Fresno, California.

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS - 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Soil moisture content of greater than 12% reduces efficacy of 1,3-D. Soils that are so dry are unusual at 1.5 meters (the depth required to be nematode-free) (CDFA, 2001) especially with moderate to heavy subsoils. Approximately 65% of nurseries require MeBr to meet certification requirements (especially in wet years). Areas with light soils and dry conditions generally have good results from 1,3-D (where township caps allow its use) and combinations with chloropicrin and/or metam-sodium. (See Section 10, above.)

CALIFORNIA DECIDUOUS FRUIT & NUT TREE GROWERS - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

Approximately 30% of nursery soils are clay or silt loam and require MB, while one half of the remaining sand or sandy loam soils do not meet the moisture requirements of less than 12% for use of 1,3-D. Therefore, approximately 65% of the nurseries have a critical need for MB. MB, 1,3-D and some solarization treatments are the only approved fumigants for treatment of nematodes in nurseries to meet California Department of Food and Agriculture standards. However, MeBr is critical to the production of nematode-free stock where 1,3-D is not feasible (estimated by industry as approximately 65% of the area) because of incompatible soil moisture or soil type, or township cap limitations.