Dr. Leonard Yourman
Plant Pathologist
Biological and Economic Analysis Division
Office of Pesticide Programs, EPA
1200 Pennsylvania, Ave NW
Washington, DC 20460

Dear Dr. Yourman: October 28, 2008

This addresses the use of MI as a pre-plant soil fumigant in the production of forest tree seedlings used in for the reforestation programs in the southern United States. These comments are written on behalf of the Auburn University Southern Forest Nursery Management Cooperative (SFNMC) and its 17 members as it pertains to the 2011 CUE application and MI as a "technically and economically feasible alternative for methyl bromide." These members include public, private, state, industrial and federal nurseries which grow seedlings in the southern US from Virginia to Texas

Representative User: A member of the SFNMC would produce nursery-grown bare root seedlings used for reforestation. The trees are an annual crop, sown in the spring (April), cultured through the summer growing months, lifted from the nursery and out-planted in the field typically within 9-10 months after sowing (Dec - Feb). A typical nursery operates on a 4-yr growing cycle. Two years of seedling crop, followed by 2 years of cover crop or fallow. Fumigation is typically done in March of each year and thus, a particular soil section within the nursery is fumigated once every four years. Bareroot pine seedling production is fairly uniform between nurseries with an average of 631,000 seedlings produced per acre and a total production area per year close to 1900 acres (1.2 billion seedlings / 631,000 seedling/ac). The Nursery Cooperative average for bareroot hardwoods is 178,000 seedlings per acre on a total of 561 acres in the South. Thus, in any given year, one could expect approximately 2460 acres to be under seedling production in the southern United States.

Alternatives: Research into alternatives to MBr fumigation for forest tree seedlings in the Southern United States has been conducted by the SFNMC which include dazomet (Basamid) and metham-sodium as alternative pre-plant fumigants to MBr. With the exception of MBr, which seems to work well across the geographic region covered by our membership, the alternatives tested have varied widely in efficacy among nurseries. Nursery Cooperative research into MBr/Chloropicrin alternatives began in the 1993 seedling crop studies evaluating only seedling quality in GA and SC. Increases in both size and numbers of seedlings after fumigation with combinations of MBr and chloropicrin are abundantly documented in studies carried out in forest tree nurseries over the last 40 years. For comparisons, beds fumigated with either MC2 or MC33 produced 33% more seedlings than non-fumigated beds. Thus, if nursery growers were to switch to non-Mbr/Chloropicrin fumigants they could expect 6% fewer seedlings per acre over Mbr/chloropicrin. A 6% reduction in seedlings per acre is approximately 38,000 seedlings/acre and at $50/thousand seedlings, the nursery producer could stand to lose $2000 per acre in revenue per year if non-MBr/Chloropicrin fumigants were used. In addition to fewer seedlings, a review of 36 published comparisons conducted over the last 40 years in which some aspect of seedling size was compared between seedlings from non-fumigated and Mbr/Chloropicrin treated beds found that fumigated beds were 14% larger than non-fumigated beds (Carey and McNabb 1996). In 2005, the Nursery Cooperative put in a large-scale (acres) MBr alternative trials that examined MBr, Chloropicrin, and MI under two different plastics (high density and VIF). The goal was to examine seedling production, weed control and soil borne fungi populations over the 2-year growing season. A copy of the final research report is included in this letter (Starkey et al 2007).

MeBTOC's assumption that "iodomethane is a technically and economically feasible alternative for methyl bromide" is incorrect. Their assumption is not correct for the following reasons:

1) Trials demonstrating yield losses when iodomethane is used: While methyl iodide fumigation produced similar sized seedlings when compared to MBr, there were significantly more weeds in soils treated with MI than either MBr or dazomet. MI is not a good fumigant for weed control. In addition to poor weed control with MI, 12 and 18 months following fumigation, Trichoderma soil levels were lower in MI and dazomet treated plots.

There is also the lack of information of MI on this cropping system. One growing cycle in one nursery in Georgia is not a good indicator of performance. Forest seedling nurseries in the southern US will not adopt a new practice until the new treatment has been shown to work for a number of seasons in a number of nurseries. We just don't have the data that would allow nurseries to make an informed decision on MI as an alternative to MBr.

Therefore, the excessive costs of the material (outlined below) and extra equipment requirements (outlined below) has resulted in no other trials testing MI under forest nursery production systems. Thus, until MI is available at a cost similar to currently used soil fumigants, trials using MI will not be undertaken.

2) Information on costs, including the cost of additional machinery or cost of converting machinery: MeBTOC's and/or EPA's current information, looking at a range of methyl bromide and iodomethane rates, (including equipment, film, chemical combination) are approximately equivalent is INCORRECT. Data from one MI supplier (one other MI supplier declined cost estimates) indicates the following data:

Current costs of MBr ai is $3 per lb or about $1000 ai per acre (350 lbs 98/2). Costs for application, tarp, tarp removal is about $800 per acre. Total costs (material and application) is $1800 per acre.

In contrast, MI costs $9 per lb ai or about $1544 ai per acre (175 lbs 98/2). Costs for freight, application, tarp, tarp removal is another $1000 per acre. Total costs (material and application) is = $2544 per acre.
I'm told that due to damage to "new pigs and cylinders can be wasted after a single use, and that the 'real' cost of packaging and distribution have not been factored into the total cost of MI"

(See comments below). Cost or the economics of application, $1800 per acre for MBr vs $2544 per acre for MI. MBr and MI are not economically similar as MI is almost 30% higher in cost per acre.

MI and MBr are not technically similar. There is the machine/application requirement on the Midas label that is required by the label.

"The treated ground must be sealed using closing shoes, roller, compaction roller, cultipacker or other equivalent equipment that will sufficiently cover chisel marks left after soil injection. The equipment shall cover the chisel marks with soil immediately prior to the placement of the tarpaulin being laid down (with fumigant injection) by tarpaulin-laying equipment mounted on the application tractor"

There is only one commercial applicator in the southern US that applies soil fumigants in forest tree nurseries and there is currently no such equipment available as described above to apply MI in a broadcast or flat fumigation process. I am not in a position to determine what it would cost to covert current applicators' machinery to allow MI fumigation as dictated by the Midas label.

Another item for EPA and MeBTOC to consider; the only study that examined MI was 150 lbs ai under VIF. This rate was chosen to see if we could get seedling production, weed and disease control at a lower rate (150 lbs vs 350 lbs MBr). Weed control was not good (perhaps due to the low 150 lbs ai rate) and MI was detrimental to the soilborne Trichoderma spp. Studies looking at higher rates should have been initiated, but the cost, and now the MI label do not allow this. In addition, there is still no way to operationally glue sheets of VIF in a broadcast system, thus, we would be forced to use MI under high density plastics, which have never been tested in a broadcast system. So, we really don't have any data using MI under the current production system.

3) Differences in market timing (missed market windows), fruit quality, etc: Current buffer restrictions on the MI label would make multiple fumigations a necessity and thus interfere with the available biological window for proper soil and temperature requirements.

4) Differences in requirements for certification: State certification needs would need to be determined by state pest boards.

5) Other information that you feel is relevant to justify your critical need for methyl bromide: Empirical data from MI users indicate that Methyl Iodide in combination with chloropicrin is corrosive on equipment. Brand new flow meters used to treat Midas 50/50 applications in the field was wasted after a single use. So far, the problem has not been observed in grower equipment, but this is because MI is typically (flushed out of the system) followed by applications of other fumigants like methyl bromide. Damage to applicator equipment will most likely occur if MI were to be exclusively applied. Plant managers, who bottle the material, will quickly tell you that new pigs and cylinders can be wasted after a single use, and that the 'real' cost of packaging and distribution have not been factored into the total cost of MI. Others that have had the opportunity to view equipment from a private contract research company paid to develop the Symetry system for Arysta, indicated that the material is even damaging to stainless steel.

If you have any questions feel free to contact me.

Sincerely,

Dr. Scott Enebak

Literature Cited:

Cary, W. and McNabb, K. 1996. The loss of methyl bromide as a fumigant in forest tree nurseries and the impact on reforestation programs. Technical Note 96-02. Auburn University Southern Forest Nursery Management Cooperative, Auburn, AL 12 pp.

Starkey, T., Enebak, S. and McCraw, D. 2007. Seeding quality and weed control with dazomet, methyl bromide and methyl idodide at the Glennville Regeneration Center 2005-2006. Research Report 06-05. Auburn University Southern Forest Nursery Management Cooperative, Auburn, AL 6 pp.

RESEARCH REPORT 06-05

SEEDLING QUALITY AND WEED CONTROL WITH DAZOMET, METHYL BROMIDE AND METHYL IODIDE AT THE GLENNVILLE REGENERATION CENTER 2005 - 2006

Tom Starkey[1*], Scott Enebak[1] & Dean McCraw[2]
[1] School of Forestry and Wildlife Sciences, Auburn, AL 36849
[2] Rayonier Regeneration Center, Glennville, GA, 30427

INTRODUCTION

These studies are part of a long-term effort by the Auburn University Southern Forest Nursery Management Cooperative to identify and evaluate alternatives to methyl bromide. Fumigation with methyl bromide has been the most commonly used method for producing high quality, pest-free forest nursery seedlings in the southeastern United States. This study is a large production scale trial of three fumigants and two types of tarps managed under normal best management nursery practices. The data discussed in this report covers 1.5 growing seasons.

METHODOLOGY

A nine section (9 bedrows each) fumigation trial was established at Rayonier Regeneration Center in Glennville, GA. The objective was to examine alternative fumigants for the production of seedlings over a typical two-year rotation. In November 2004, three nursery sections were treated with dazomet (Basamid®) (490 lbs/ac), tilled and water applied via irrigation pipeline as per manufacturer's recommendations. In April 2005, six nursery sections were fumigated with either methyl iodide (MI) or methyl bromide (MBr) and were covered with either virtually impermeable film (VIF) or high density plastic (HD). The three MBr sections received two rates; 150 lbs/ac 98:2 and covered with VIF or 350 lbs/ac 98:2 and covered with HD. Three nursery sections were fumigated with MI (150 lbs 98:2) and covered with either VIF or HD. In each of the fumigated sections, families of loblolly pine *(Pinus taeda)* and slash pine *(P. elliottii*) were sown so that each soil treatment were sown with the same pine families.

History plots were placed throughout the 9 sections and seedling data were recorded by Rayonier Regeneration Center nursery personnel. In addition to seedling counts, hand weeding time by bedrow was recorded for all 81 bedrows (9 sections, 9 bedrows). In November 2005, first year seedling counts were made for each species x fumigation x tarp and seedlings were collected for biomass determination. Data from a total of 78 plots was collected and seedlings were measured for RCDs, height and root/shoot dry weight.

In addition to seedling samples, soil samples were collected in both November 2005 and May 2006 from each of the sections. The samples were diluted and plated onto media selective for *Trichoderma*. Propagules per gram of soil were determined and recorded by fumigation treatments.

RESULTS & DISCUSSION

Seedling Quality: First year data indicated that MI was as effective as MBr in producing seedlings with similar RCD, heights and densities for both loblolly and slash pine (Table 1). Dazomet plots had smaller RCDs, fewer seedlings per bed and were shorter than both MBr and MI. These seedlings were shorter and did not require top-pruning during the first growing season. Pruning is an important cultural practice widely used by nurseries to increase seedling uniformity and increase survival of out-planted seedlings.

Weed Control: Weed control, as measured by biomass and time of weeding, was greater in plots treated with MI than in plots treated with either dazomet or MBr during 2005. In 2006 there were no differences among the fumigants with respect to weed weight or in the amount of time to weed (Table 2).

Soil Fungi: Twelve months after fumigation, plots treated with dazomet contained less *Trichoderma* spp. than plots treated with either MI or MBr (Table 3, Figure 1). There was a dramatic reduction of *Trichoderma* colonies on the dazomet plates. The reduction of *Trichoderma* spp. in dazomet-treated soil was also reported by Carey (1996) and Fraedrich & Dwinell (1997).

Eighteen months (May 2006) following dazomet fumigation, the total number of fungal propagules per gram of soil had increased to levels similar to MI and MBr (Table 3). However, the fungal species growing on the MI and MBr plates were predominantly *Trichoderma* whereas, colonies on the dazomet plate were primarily *Penicillium* spp. (Figure 2). When colony counts by fungal species were made, dazomet still had significantly fewer *Trichoderma* colonies than MI or MBr (Table 4). *Trichoderma* is a beneficial soil fungal genus that is found in nearly all agricultural soils. Fungi in this genus have been utilized for years as a bio-control for plant diseases (Papavizas 1985; Mousseaux *et.al.* 1998; Samuels 1996). *Trichoderma* has also been shown to increase germination and promote growth in plants (Bailey and Lumsden 1998) including pine (Dong *et al.* 1987). The lower seedling quality (numbers and size) following the first growing season in the dazomet plots and the appearance of lower quality (numbers and size) seedlings at the beginning of the second growing season may be due to the lower populations of soil-borne *Trichoderma*.

Key Study Summary Points:

- Methyl iodide fumigation produced similar sized seedlings when compared to MBr.
- Methyl iodide fumigation had more weeds than either MBr or dazomet.
- The increase in weeds in methyl iodide plots may be due to the low rate (150 lbs/acre) of fumigant used.
- Dazomet fumigation had fewer and smaller seedlings than either MBr or MI.
- After 12 and 18 months following fumigation, *Trichoderma* soil levels were significantly lower in dazomet plots than either MBr or MI treated plots.
- At the 18-month sampling, VIF tarping significantly reduced the recovery of total fungal colonies when compared to plots covered with HD.

- There were no significant differences between HD and VIF related to fungal genera recovered on selective media.
- VIF tarping of MBr at 150 lbs/acre produced seedlings similar to the 300 lbs/acre MBr under HD plastic.
- There is still no operational method for gluing VIF in broadcast (flat tarp) system.

MANAGEMENT IMPLICATIONS

Despite the new application methods and rates for dazomet, the fumigant produced fewer and smaller-sized pine seedlings when compared to either MI or MBr. There is also the long-term, negative affect of *Trichoderma* suppression in plots treated with dazomet. The ability of MI to produce seedlings similar to those in plots treated with MBr was encouraging as this is the first large-scale test of this potential alternative. There still remains the problem of availability (not yet registered in the US), cost (it is very expensive) and rate (150 lb/acre) may not be adequate to control weeds. The different plastics (VIF vs HD) used also indicated that a reduction in MBr rates under VIF still results in similar-sized seedlings when compared to a higher rate under HD. This was encouraging, as it indicates that nurseries could reduce the amount of MBr used under VIF and still get adequate weed control and seedling growth. However, there still remains the problem of VIF and glue. There is no system to glue it together in a flat tarping system used in nurseries and there is no U.S. source, so it is expensive.

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Table 1. Seedling characteristics by species and soil fumigation - 2005

	Loblolly Pine			Slash Pine		
	MBr [1]	MI	Dazomet	MBr	MI	Dazomet
Density (ft^2)	21.6	22.9	20.3	20.6	20.0	18.5
RCD (mm)	4.9 a	4.7 a	4.3 b	5.3	5.2	5.4
Height (cm)	32.0 a	31.0 a	23.6 b	30.4 a	30.3 a	27.1 b
Root Bio (g)	0.65	0.65	0.61	0.64	0.66	0.78
Shoot Bio (g)	4.3 a	4.2 a	3.3 b	5.0 a	5.3 a	5.9 b

[1] Letters within a row and species indicate significant differences at the 0.05 level.

Table 2. Hand weeding time and weed biomass by soil fumigant - 2005 and 2006

		Fumigant		
Year	Weeds	MBr[1]	MI	Dazomet
2005	Weight (g/riser)[2]	14.0 a	20.9 b	12.0 a
2005	Time (seconds/riser)	35.2 a	59.3 b	39.1 a
2006	Weight (g/riser)	86.7 a	169.7 a	133.4 a
2006	Time (seconds/riser)	60.3 a	61.2 a	60.7 a

[1] Letters within a row indicate significant differences at the 0.05 level.
[2] Riser = sections between sprinkler heads – approximately 40'.

Table 3. Soil borne fungi populations by soil fumigant – 2005 and 2006

Fumigant	Mean cfu/g[1] soil of *Trichoderma* 2005 [2]	Mean cfu/g soil of Total Fungi - *2006*
MBr	155.6 a	140.2 a
MI	32.6 b	106.4 b
Dazomet	15.3 b	142.6 a

[1] cfu/g=colony forming units per gram.
[2] Letters within columns indicate significant differences at the 0.05 level.

Table 4. Percentage of dilutions on a plate with fungal genera present in 2006 soil samples

Fumigant	*Penicillium* sp. [1]	*Trichoderma* sp.	Other
MBr	98.4% a	47.7% a	0.08% a
MI	83.8% b	69.2% a	0.09% a
Dazomet	100% a	0.1% b	0.09% a

[1] Letters within a column indicate significant differences at the 0.05 level.

Figure 1. Representative dilution plates first growing season.

MI **Dazomet** **MBr**

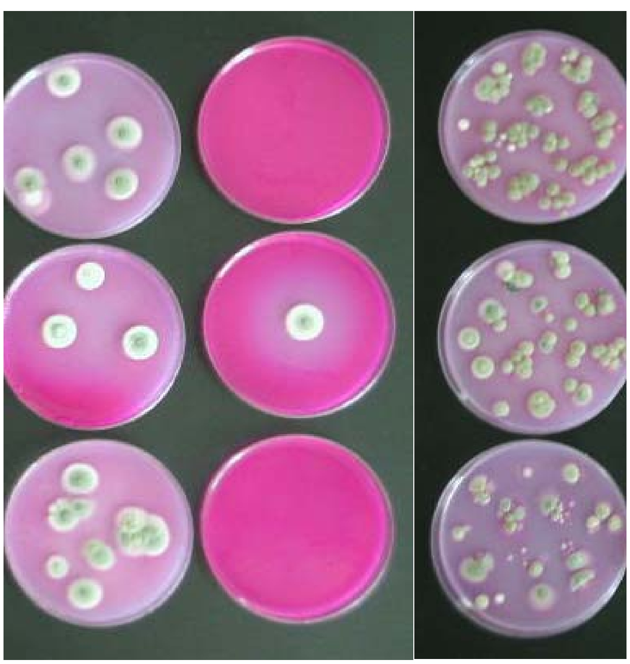

Figure 2. Representative dilution plates second growing season.

MI **Dazomet** **MBr**