Soil Fumigation: The Critical Use Exemption, Quarantine Pre-shipment Rules, Re-registration Decision and Their Effect on the 2012 Growing Season

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Enebak SA. 2012. Soil fumigation: the critical use exemption, quarantine pre-shipment rules, re-registration decision and their effect on the 2012 growing season. In: Haase DL, Pinto JR, Riley LE, technical coordinators. National Proceedings: Forest and Conservation Nursery Associations—2011. Fort Collins (CO): USDA Forest Service, Rocky Mountain Research Station. Proceedings RMRS-P-68. 26-30. Available at: http://www.fs.fed.us/rm/pubs/rmrs_p068.html

Abstract: This article gives a brief history of the importance of methyl bromide in the production of forest tree seedlings in the southern United States and the timeline for the Montreal Protocol and Clean Air Act to phase out ozone depleting compounds. In addition, the process, steps used, and current status under the Critical Use Exemption and Quarantine Pre-shipment articles within the treaty are discussed. A summary of the re-registration decisions proposed by the Environmental Protection Agency for the re-registration of all soil fumigants under the Food Quality Protection Act for the 2012 production season is outlined as well as the current status of MBr alternatives.

Keywords: Methyl bromide, soil fumigation, forest nursery, disease management

Introduction

In the early 1980s, scientific circles reached a consensus that the concentration of the stratospheric ozone was declining and that chlorinated fluorocarbons (CFCs) were the cause. To address this issue, the Montreal Protocol was signed in 1987 to bring about the eventual phase-out of all CFCs as well as other substances that deplete the ozone layer. In 1991, methyl bromide (MBr) was added to the list of ozone-depleting compounds, and the amount of MBr produced and imported in the U.S. was reduced incrementally until it was phased out by 1 January 2005, under the Montreal Protocol and the Clean Air Act (CAA). Within these two agreements, were two allowable exemptions to the phase-out of MBr that included the Critical Use Exemption (CUE) and the Quarantine and Pre-shipment (QPS) exemption, both designed for agricultural users with no technically or economically feasible alternatives.

Methyl Bromide

MBr is an odorless, colorless gas that has been used as a soil fumigant in most southern forest tree nurseries to control a wide range of soilborne pests (Carey and McNabb 1996). Over the past 50 years, MBr has proven to be a reliable pesticide that enhances seedling production and has been the industry standard for nearly all pest management programs in forest tree nurseries. The use of MBr to control nursery pests reduced the demand for more specific herbicides, fungicides, and insecticides. Prior to the MBr phase-out in 2005, 96% of southern forest tree nurseries used soil fumigation, 90% of which was MBr (Jang and others 1993). Generally, MBr was applied once every 3 to 5 years, allowing 2 to 3 years of pine production followed by 1 to 2 years of cover crop. The total amount of MBr used annually in forest-tree nurseries was 1,600,000 lbs and was approximately 0.33% (1/3 of 1%) of the MBr used for soil fumigation in the U.S. in 1990 (Anonymous 1993). The extensive use of MBr in forest tree nurseries across the southern United States was the best indication of its consistent effectiveness across a wide range of soil and environmental conditions.

Critical Use Exemptions

CUE are described by the Environmental Protection Agency's (EPA) website under the following guidelines (EPA 2012):

> The CUEs are permitted under Section 604(d) of the CAA and the Montreal Protocol. Under Decision IX/6 of the Protocol, the "use of MBr should qualify as critical use only if the nominating Party determines that:
>
> (a) The specific use is critical because the lack of availability of MBr for that use would result in a significant market disruption; and
>
> (b) there are no technically and economically feasible alternatives or substitutes available to the user that are acceptable from the standpoint of environmental and public health and are suitable to the crops and circumstances of the nomination."

Thus, beginning in 2004, the Environmental Protection Agency (EPA) requested applications for CUEs from consortiums or groups of growers/users that continue to need and use MBr in their production systems. A CUE application includes a number of questions on current MBr use, production data, pest issues, research and efficacy on alternatives, methods to reduce MBr emissions, etc. that can be used by EPA to determine the "critical use." These documents can be onerous; the 2010 Southern Forest Nursery Management Cooperative's CUE application was 79 pages in length. After reviewing the CUE applications, EPA develops a Methyl Bromide Usage Numerical Index (BUNI /BUNNIE) for each consortium/group. The review takes into account each request, subtracts double reporting and quarantine pre-shipment uses, and nominates an amount of MBr for that consortium to the State Department. From the various BUNI/BUNNIEs, the U.S. Government requests authorization for those critical uses from the Parties (Methyl Bromide Technical Options Committee - MeBTOC) to the Montreal Protocol. Once the Parties of the Protocol authorize 1) the request for a critical use and 2) an amount of MBr for those critical uses, EPA publishes a rule in the Federal Register allowing for the additional production of MBr for that critical use in that year. Each application for a Critical Use round takes up to 3 years and is conducted annually. As the timeline dictates, those forest tree nurseries that use CUE MBr in 2011 began the application process in 2008; accordingly, those that want to use CUE MBr in 2014, must apply in 2011.

As growers adopted different pest management systems, the number of Critical Users has decreased over time. In 2010, there were 11 pre-plant and 3 post-harvest users/growers authorized to use MBr under the CUE process as outlined under the Montreal Protocol. Within the pre-plant users, is the Forest Nursery Seedling group that includes 6 different forest nursery consortiums throughout North America approved to use MBr in their production systems. Some of the other Critical Users include commodities, orchard replant, sweet potato slips and fruit, and nut and flower nurseries. The primary objective of the Montreal Protocol and the CAA was to reduce, and eventually eliminate, the use of all ozone-depleting compounds, including MBr. Since the first CUE in 2005, the amount of MBr requested by U.S. growers, the amount authorized by the State Department, and the amount approved by the Parties has steadily declined from 20.8 million lbs in 2005 to 2.5 million lbs in 2011, representing an 88% reduction in MBr use in the United States.

Quarantine and Pre-shipment Exemption

As part of the Montreal Protocol, the Quarantine and Pre-shipment (QPS) rule implements a permissible exemption for production and consumption of MBr for quarantine and pre-shipment purposes. Article 2H of the Montreal Protocol, paragraph 6 states that "the calculated levels of consumption and production under this Article shall not include the amounts used by the Party for quarantine and pre-shipment applications." The QPS exemption is based on self-certification of the individual Parties and EPA agreed to the Montreal Protocol's definitions of quarantine and pre-shipment, as described in the Handbook for the International Treaties for the Protection of the Ozone Layer (EPA 2012).

With respect to MBr, QPS applications are:

> treatments to prevent the introduction, establishment, and/or spread of quarantine pests (including diseases), or to ensure their official control, where: (a) Official control is that performed by, or authorized by, a national plant, animal, or environmental protection or health authority; (b) quarantine pests are pests of potential importance to the areas endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (EPA 2012).

An example of a quarantine application of MBr is the fumigation of a commodity, such as potatoes in Idaho. In this case, potatoes are subject to infestation by a specific and officially recognized quarantine pest (pale cyst nematode, *Globodera pallida*); therefore, the fumigation is conducted before commodity transport to meet official quarantine requirements.

> The purpose of quarantine fumigation is to prevent the introduction of specific quarantine pest(s) into a defined geographical area, such as an importing country. 'Pre-shipment applications,' with respect to methyl bromide, are those non-quarantine applications that are within 21 days of export that need to meet the official requirements of the importing country or the existing official requirements of the exporting country. Official requirements are those which are performed by, or authorized by, a national plant, animal, environmental, health or stored product authority (EPA 2012).

As part of the CUE application and approval process, when EPA develops the BUNI/BUNNIE for each critical user, they routinely deduct a percentage of the MBr requested for each user for QPS. For example, in 2009 the Southern Forest Nursery Management Cooperative (SFNMC) requested 246,000 lbs of MBr for use in 2011 for all forest seedling producers in the southern United States. From that amount, EPA deducted 83,000 lbs for QPS uses, or 66%, and submitted 163,000 lbs to MeBTOC for CUE approval. Since the phase-out of MBr use in 2005, there has been a reported increase in the amount of MBr assigned as "QPS MBr" by the United Nations (Figure 1). Correspondingly, there has been a push by European Union (EU) nations to significantly reduce QPS use worldwide. Some claims have been made by other nations that the United States is playing games with the EU and that pre-plant uses lack efficacy data to adequately get control based on EU standards. Thus, at the International Plant Protection Convention, there were plans to rework definitions as outlined in the Montreal Protocol. At the heart of the matter, the EU claims that state boundaries, as listed and used by the United States, do not qualify for usage as QPS and that the definitions as outlined in the Montreal Protocol were for International Boundaries. Specifically, any rule put into place in the U.S. after 1993 does not count based on international rules.

In early 2010, representatives within the EPA, USDA – APHIS, and the State Department contacted the SFNMC, to clarify the role the Nursery Cooperative plays in the CUE application process as it pertains to QPS. The question posed to the Cooperative was, "If the production of forest tree seedlings falls under the QPS umbrella for

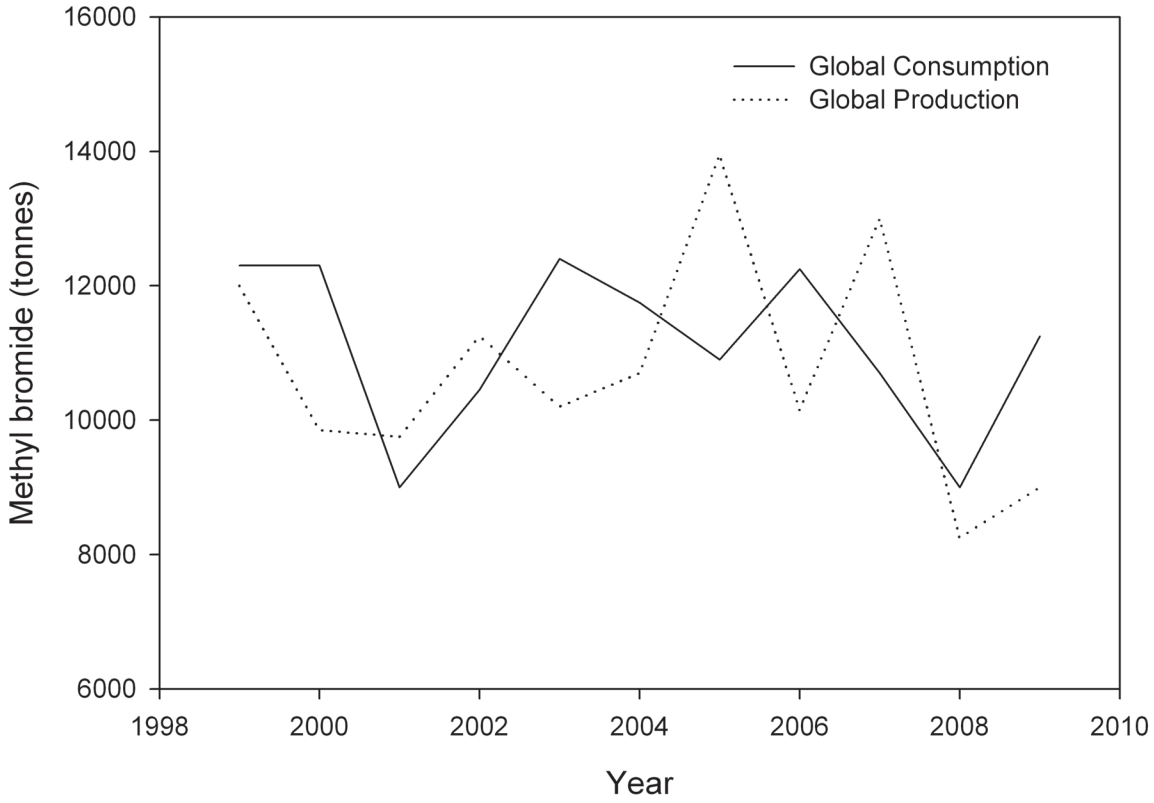

Figure 1. Worldwide production and consumption of methyl bromide classified as Quarantine and Pre-shipment use from 1999 to 2009 (adapted from UNEP 2010).

MBr use, why does the Nursery Cooperative even file the request for a CUE MBr use?" To that end, copies of the 12 southern State Plant Pest Requirements for Pest-Free Certification on forest tree seedling production were forwarded to those agencies for their use in negotiating CUE and QPS MBr use with the EU and MeBTOC.

The CUE and the QPS amendments were not intended to be a permanent solution for continued MBr use. While there is no "cut-off" date for either of these programs, there are still a few chlorofluorocarbons (CFCs) in use 15 years after their phase-out. The overall objective of the Montreal Protocol and the Clear Air Act was to eventually phase out and stop all uses of MBr. In July 2010, EPA announced that the agency was considering ending the CUE program by 2014, with 2013 the last year MBr would be available under the CUE process which has provided U.S. growers an additional six years beyond the 2005 phase-out of methyl bromide to implement ozone-safe alternatives. According to EPA, production and consumption of methyl bromide has "declined significantly over the last 20 years," particularly since the substance was phased out in 2005. The CUE since that time was meant to give affected industries time to develop viable alternatives to ozone-depleting substances. Developing countries have until 2015 to phase out methyl bromide. The United States was one of only five countries to request the critical use exemptions for methyl bromide in 2011. Israel has announced it will end its critical use program after 2011, while Japan has indicated it will no longer request exemptions after 2013.

In June 2011, however, EPA again requested critical users interested in requesting MBr beyond 2013 to apply for the 2014 growing season. It was at this time (June 2011) that forest nurseries discovered EPA's decision to deny their 2010 application for MBr use in 2013. Caught totally off-guard, as no notification was made to any of the 7 Forest Seedling applications, EPA's official response to their rejection of the Forest Nursery applications was:

> m sodium), 1,3-D plus chloropicrin, and iodomethane plus chloropicrin. In addition, DMDS (Paladin) will be available starting in 2011 and provide an additional technically and economically feasible option. Methyl bromide will still be available as a quarantine treatment in many states.

The 2010 rejection of the CUE applications from all Forest Seedling applications by EPA means: 1) that they will not consider any new CUE applications from the Forest Nursery Sector unless it is accompanied by 5 years of research data showing that an alternative soil fumigant does not work, 2) those nurseries without any state QPS rules can use MBr in 2011 and 2012, and 3) unless a particular nursery is located in a state with appropriate QPS rules, MBr cannot be used after 2012. Furthermore, quarantine pre-shipment (QPS) use will now come under even more scrutiny than before by EPA, the State Department, and the Parties of the Montreal Protocol.

While the official EPA response has no merit research-wise, it is my opinion that the various state regulations forwarded to EPA in 2010, gave ammunition to reject the Forest Seedlings request for CUE MBr. The lack of notification (burying the rejection in the Federal Register) to those Forest Seedling applicants also raises serious questions as to the working relationship between the Office of Pesticide Programs and the Forest Nursery Industries. If EPA continues to support QPS, then the political sacrifice might be worth it; however, if EPA backs down to the European Union, then QPS use of MBr for forest seedlings is over.

Methyl Bromide Alternatives

It is an understatement to mention that significant time, effort, and dollars have been spent within the agricultural community in an attempt

to identify an economical and technical alternative to MBr. Since 1991, when the Southern Forest Nursery Management Cooperative began to look, in earnest, for a replacement, over $2,000,000 of its annual dues has been spent on research to find an alternative to MBr. In early 1991, the choices for an MBr replacement were chloropicrin, 1,3-dichloropropene, dazomet, and metam/potassium sodium, either alone or in combinations (Carey and McNabb 1996). Since that time, data collected from numerous trials on seedling production, pest control and application issues have narrowed that list to just chloropicrin and 1,3-dichloropropene (Telone®), alone or in combinations. Fortunately, there has been new chemistry developed and these new soil fumigants include Pic + (chloropicrin + a solvent), dimethyldisulfide + chloropicrin (DMDS = Palidin®), and methyl iodide (MI; iodomethane = Midas®). A few compounds that are currently under examination in other crop systems that use MBr, but not yet tested by the Nursery Cooperative include sulfuryl fluoride, phosphine, halosulfuron, furfural, and napropamide. However, recently another office of EPA expressed concern about fluoride getting into ground water and raised questions about fluoride sources. Consequently, all alternative soil fumigant tests in forest tree nurseries that contained fluoride (Vikane®) were discontinued by the Nursery Cooperative.

As far as a drop-in replacement for MBr, none of the soil fumigants tested by the Nursery Cooperative have performed equally in all nurseries in all situations. While producing decent seedling characteristics, Palidin® (DMDS + chloropicrin) has significant odor issues that last long into the growing season. Unless the odor is eliminated, adoption of this particular alternative is doubtful. Since its labeling in 2008, restrictions on the availability and application of Midas® (methyl iodide + chloropicrin) have limited research to 1 study in 1 nursery in 2009. Studies with other alternatives have shown that soil type, pest pressures, cropping history, and nursery location affect the efficacy of soil fumigants (Starkey and Enebak 2008; Enebak and others 2012, 2011). More studies with this compound in other nurseries and soils are needed. Data collected in 2005, prior to the Midas® label approval, resulted in iodomethane with decent seedling characteristics, but poor weed control and significant reduction of *Trichoderma* spp. (Starkey and others 2006). Despite these data, Midas® is yet to be labeled for use in either New York or Washington. Recently, (May 2011) EPA (at the request of Earthjustice) opened up a formal 30-day comment period (that was later extended due to pressure from NY Attorney General) to address the safety of iodomethane on women and children. While EPA was not legally required to do so, several other organizations are concerned about iodomethane's safety and given the pressure on EPA, it is entirely possible that the label for Midas® could be revoked. Update: In March 2012, Arysta LifeScience, the sole distributor of iodomethane in the U.S., suspended all sales of Midas® and requested that all compounds containing Midas® be returned to their distribution centers. According to a company press release, "The decision (to suspend sales) was made as part of an internal review of the fumigant and based on its economic viability in the US marketplace."

The soil fumigant Pic + (chloropicrin + a solvent) has been one of the better MBr alternatives, across a wide range of soils and nurseries where it has been tried (Starkey and Enebak 2008; Enebak and others 2012, 2011). Weed control issues have occurred in some nurseries with this compound, which is not surprising since chloropicrin is not known for its weed control (Carey and McNabb 1996; South 2006). The eventual loss of MBr is going to result in individual nurseries needing to fine-tune their seedling production and pest (weed, insect, fungi, and nematode) control treatments more carefully because the use of MBr in forest tree nurseries previously allowed for a greater degree of control due to its broad spectrum capacity.

Reregistration Eligibility Decisions (REDs)

Superimposed over the CUE process, the QPS rules, and the agencies that fall under the Montreal Protocol and the Clear Air Act, was the enactment of the Food Quality and Protection Act (FQPA) of 1996. With the passage of the FQPA, congress presented EPA and all producers and users of pesticides with the challenge of implementing the most comprehensive and historic overhaul of the nation's pesticide and food safety laws in decades. Some of the major requirements include stricter safety standards, especially for infants and children, and a complete reassessment of all existing pesticide tolerances for all uses and users, applicators, handlers, and bystanders.

Thus, in 2006, the EPA began the process of reviewing the safety of all compounds that are used as soil fumigants in an attempt to mitigate bystander exposure. This process took into consideration application methods, soils, compounds, rates, crops, etc. and developed rules on usage and application methods as part of the reregistration of each soil fumigant. The compounds examined in this reregistration process included chloropicrin, dazomet, metam/potassium sodium, methyl bromide, 1,3-dichloropropene (Telone®), methyl isothiocyanate (MITC), and iodomethane as a group to ensure that similar risk assessment tools and methods were used for all and that risk management approaches were consistent across all soil fumigants.

It would be an understatement to suggest that the EPA's first proposed rules in February 2007 were a major setback to over 15 years of MBr alternative research in the forest seedling arena. For example, using the newly proposed EPA rules for soil fumigants, a 10-acre block (nursery average) fumigated with 350 lbs chloropicrin under a High Density Plastic, the best alternative to MBr (see: South 2006; South and others 1997) would require a buffer zone of 1400 m (4200 ft or 3/4 of a mile). The buffer zone footprint alone represents 1874 additional acres, an unfeasible amount to control for a 10-acre block of trees. Along with the other proposed rules, the SFNMC estimated that within three years, 50% of the forest tree nurseries would have ceased operations due to a loss of production areas, with the remaining nurseries having to significantly increase seedling costs (Southern Forest Nursery Management Cooperative Internal Data: EPA-HQ-OPP-2007-0350-0226.1). It turns out that the best "alternative" to the 2007 proposed Soil REDs was the soil fumigant MBr, as it required a smaller buffer zone than straight chloropicrin. For someone who has been working on soil fumigants since 1985 (Enebak and others 1990a, 1990b, 1990c), the irony of identifying a soil fumigant as an alternative to MBr under the Montreal Protocol and work under the 2007 Soil REDs was simply a bitter pill to swallow.

Fortunately, after a number of EPA "comment periods" that included new soil flux data, information on seedling production systems, identification of high barrier tarps, evaluation of new technologies, and shareholder input, a revised and amended Soil RED was released in May 2009. These new rules will affect all aspects of soil fumigation for years to come and will require that producers, applicators and users play a role in the safe and proper application of soil fumigants for the production of forest tree seedlings. These steps include buffer zones, posting requirements, agricultural worker protection, applicator and handler training programs, tarp perforation and removal, good agricultural practices, application methods/practices and rate restrictions, new restricted use designation for dazomet, site-specific fumigation plans, emergency preparation and response requirements, compliance assistance and assurance measures, and community outreach and education programs. All of these measures are going to take a lot of time, effort, and money on someone's part to comply. Thus, the cost to use soil fumigants in the production of forest tree seedlings is going to increase more than it already has.

Prior to the implementation of the Montreal Protocol and the phase-out of MBr, the average cost to fumigate nursery soil was just over $1500/acre. After 2005, there were two sources of MBr (CUE and

QPS) of which the cost to use was less for QPS than CUE MBr. These two sources of MBr have increased in cost since 2005 to $3100 and $1900 per acre in 2010, for CUE and QPS MBr, respectively. Neither producers nor applicators have any idea of what these new rules will do to the price of any of the soil fumigants (chloropicrin, MBr, Telone®) available for 2012 and beyond. Suffice to say it will cost more to fumigate soils in 2012 than it will in 2011.

While these new rules will change the way nurseries use soil fumigants, the lifting of the buffer zone overlap restrictions to 24 hr, the incorporation of the new soil flux data into the buffer tables, new plastic tarp technologies that allow the gluing of high barrier plastics (virtually or totally impermeable films – VIF or TIF), and other soil credits should allow nurseries to continue their use of soil fumigants in the production of forest tree seedlings with minimal disruptions and loss of production acreage. Without these changes, many forest-seedling nurseries would have ceased to exist, unable to comply with the bystander safety restrictions. The 10-acre field with a 4200' buffer under EPA's first rule is now reduced to 53 ft. Slated for enforcement in 2012, to date (July 2011) many of these requirements have not yet been agreed upon by the registrants and EPA. Full enforcement of all new soil rules and corresponding pesticide labels is scheduled for the 2012 growing season. That should give producers, applicators, and users a few more months to work out the kinks as EPA plans to consider the soil fumigants together (all over again) during Registration Review that begins in 2013.

Summary

The continued availability and use of MBr for the production of forest tree seedlings is limited to those who have access to a Critical Use Exemption through 2012 or whose nurseries reside in states that fall under the Quarantine Pre-shipment rules. Both of these MBr sources (CUE and QPS) are limited and under scrutiny by a number of U.S. governmental and international organizations. A number of soil fumigants have been examined as alternatives to MBr, none as drop-in replacements as each has its own unique properties and challenges that will need to be tweaked by individual nursery managers under their own production systems. These include chloropicrin, iodomethane, di-methyl disulfide, chloropicrin & 1, 3-dichloropropene, either alone or in some combination. The new Soil Fumigation REDs that come in full force in the spring of 2012 will require a concerted effort by producers, applicators and users to ensure the safety of bystanders and document each application of soil fumigant. While the costs to fumigate will probably increase, at least the amended rules allow the continued use of soil fumigants in the unique production systems that are forest tree nurseries.

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