Will the Real Alternative to Methyl Bromide Please Stand Up?

Fumigation facts you should know if your golf facility is considering putting green renovation.

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Without methyl bromide, currently the only hot gas fumigation option, simple gas-and-regrass renovations will be gone, too. "Gas and regrass" refers to establishing putting greens with a new stand of turfgrass without reconstruction or even significant soil cultivation.

For some time now it has been known that the industry standard for soil fumigation of golf course putting greens would become unavailable. Methyl bromide was the preferred choice because of its broad-spectrum control of weeds, insects, nematodes, and diseases, but it will likely be phased out under the Clean Air Act and the Montreal Protocol because it was identified as an ozone-depleting substance. A potential ban on its use by the U.S. Environmental Protection Agency (EPA) now appears to be fast approaching, and we have yet to find a suitable alternative . . . or have we?

Considerable research has been performed over the last decade or so to evaluate many different fumigation products and methods, albeit very little within the golf and turf industries. These studies have included products that are currently labeled for use on turfgrass and those that are not, products in combination to achieve the desired levels of efficacy, and non-chemical methods, such as solar and steam disinfestation.

This article is written in regard to the use of methyl bromide for renovating putting greens and not for golf course fairways or sod farms. It is not intended to dispute or advocate the availability of methyl bromide, nor is it intended to validate the importance of effective fumigation for successful, long-term putting green renovation. Rather, it is hoped that information in this article will serve as a guide to golf courses currently or soon to be considering putting green renovation. For some, this article may spur a push forward to complete renovation plans sooner so that they can still use methyl bromide while it is available, whereas for others, it will help identify factors to consider when selecting an alternative soil fumigation option in the future.

A summary of possible alternatives to methyl bromide, along with pertinent details regarding each, is provided below. The options are listed in no particular order.

The key to successfully establish a new, pure stand of turfgrass on greens is minimizing pest pressure and competition from existing vegetation, weeds, nematodes, insects, and disease pathogens at the time of planting.

Dazomet (trade name: Basamid) is a dry, granular soil fumigant with fungicidal, herbicidal, and nematicidal properties. It must be incorporated into the soil or applied to the soil surface and watered in to be activated. Tarping is optional and would require a means of getting water under the tarp. Dazomet has been used to renovate turfgrass areas in the past, including golf course fairways and greens. Studies in 2000, 2001, and 2002 showed it to be a good candidate as a methyl bromide alternative, given its ability to suppress *Poa annua* during the grow-in of bentgrass greens (Landschoot and Park, 2004). It is not nearly as effective on warm-season turf (i.e., bermudagrass). Although the cost of dazomet is similar to the cost of methyl bromide, it produces less consistent results across a variety of soil and environmental conditions. Additionally, the product moves during heavy rainfall and is toxic to surrounding turf and aquatic life. Given that its residual is moderate in the soil, the label recommends waiting a minimum of 10 days before planting, depending on soil temperature.

Methyl iodide (trade name: Midas) is the first new soil fumigant to be registered by the EPA in more than two decades. Research done in other industries has shown it to be as effective or more effective than methyl bromide in controlling weeds, soil-borne fungi, and nematodes when applied at rates comparable to methyl bromide. A waiting period of 10 to 14 days is required after application before planting can begin. The recommended rates for turf sites are approximately half that of methyl bromide, but methyl iodide costs considerably more than methyl bromide to be as effective, so methyl iodide may not be economical for some uses.

Dimethyl disulfide or **DMDS** (trade name: Paladin) appears to be a suitable alternative to methyl bromide, given research conducted outside the turf industry. It is of similar effectiveness and cost and has been shown to be comparable to methyl bromide in its broad-spectrum control of nematodes, disease pathogens, and weeds. Although little information is available on DMDS, research on turf is currently being conducted at the University of Florida (Unruh, personal communication). Reportedly, a longer waiting period is necessary prior to planting when compared to methyl bromide. Additionally, a horrendous sulfur smell is reported to linger for up to several days, which could be problematic for courses within residential areas. The labeling for DMDS will likely be targeted for areas of vegetable production and other food crops, with

potential availability in turf markets sometime in 2009 or 2010.

Chloropicrin (tear gas) is registered as a broad-spectrum soil fumigant that exhibits excellent control of fungi, but does very little to control weeds. For this reason, it is commonly used in conjunction with methyl bromide or 1,3-D. This product is either injected into the soil or applied via drip irrigation. These applications can either be tarped or not tarped, and planting can begin approximately seven days after application.

Dichloropropene or **1,3-D** (trade name: Telone II) is a liquid, pre-plant soil fumigant registered for use on commercial turf farms to control nematodes and mole crickets. When used at rates that target nematodes (9 to 18 gallons per acre), there is limited impact on some soil-borne insects and no impact on weeds or pathogens. Only rates greater than or equal to 35 gallons per acre will effectively control weeds. This is why it must be combined with other fumigants, such as chloropicrin, to achieve broad-spectrum control. 1,3-D is applied using tractor-drawn rigs that inject it 12 to 18 inches beneath the soil surface. The soil surface must be sealed after application by compacting the top layer of soil, applying a water seal, or covering with tarps. The label suggests an application rate of 9 to 18 gallons per acre and a waiting period of one week for every 10 gallons applied per acre before planting.

Metam sodium (trade name: Vapam, Sectagon) is a broad-spectrum soil fumigant registered for use on turf. As with dazomet, water is required to activate it, and thus its efficacy and expectations for consistent results are oftentimes jeopardized when soil moisture and temperature are not ideal. Given its sporadic control and the waiting period of 14 to 21 days before planting, it is not ideal for putting green renovations.

Combining the products listed above to achieve improved, broad-spectrum fumigation control is another option that makes sense for fumigants that are not effective against all pests. Unruh and Brecke (2001) found several combinations that offered moderate to good control of most turfgrass pests, such as chloropicrin/1,3-D, chloropicrin/dazomet, chloropicrin/metam sodium, and 1,3-D/metam sodium. To ensure that there are no toxic effects for the germinating turfgrass seedlings or sprigs, it is best to defer to the product with the longest waiting period.

Soil solarization involves covering soils with clear plastic so that the heat derived from solar energy disinfests the soil over time. This process requires six to eight weeks to kill most nematodes and fungi. Due to an absence of research, its efficacy on weeds is unknown and, therefore, its value to turfgrass sites is also unknown. Given the time required for this option, it is impractical for most golf course uses, although sod farms may be potential candidates (Unruh, 1998).

Steam or **hot water** technology has been researched in some detail for nematode control, but given the amount of water and other inputs (i.e., diesel fuel) necessary, this option has not been shown to be economical, practical, or environmentally sound. Furthermore, it offers limited disease and weed control (Unruh, 1998). Dr. Unruh at the University of Florida is currently assessing its potential for use on putting greens, as advances continue within this technology.

Other alternatives include **soil amendments**, such as compost (the large quantities necessary make this impractical and economically unrealistic), **experimental products** not yet registered as soil fumigants, and, for an alternative to fumigation in general, registered **pre- and post-emergent herbicides** (Unruh, 1998).

Looking forward, it is anticipated that most, if not all, soil fumigants available for turf application will come with varying degrees of restrictions (if they even continue to be available for use on turf) following re-registration with the EPA. One such restriction is likely to be buffer zones extending anywhere from a minimum of 300 feet and up to a quarter-mile beyond treated areas. This could mean that fumigation for putting greens located in residential neighborhoods and urban communities where people are in close proximity to the course may require evacuating the premises for some period of time and/or closing local businesses and schools. This could prove to be more than a challenging proposition, to say the least. With these possibilities looming, research is currently underway to minimize gas permeability through plastic covers and tarpaulins used to seal fumigated areas. Product effectiveness should improve so that reduced application rates can be used, possibly shrinking buffer zones.

Since applying methyl bromide to turf does not fall under food production, its continued use is unlikely, and it may be dropped from the label

soon. Even if it remains, buffer zones as previously described will likely be required, in addition to other safety restrictions. As it currently stands, methyl bromide can be purchased in advance for use at a later date, but this, too, is restricted. More specifically, methyl bromide will likely be re-registered with a new label in early 2010. If it is purchased with its current label, say anytime in 2009, it might still be used for up to 18 months after the new label is issued. With a new methyl bromide label in February 2010, for instance, those who purchased it in advance can use it anytime during the next 18 months or through August 2011. The legalities for physical storage of methyl bromide between when it is purchased and when it would be applied have not yet been determined.

As one can see, there are a number of fumigation options available. Unfortunately, as discovered during extensive research by Unruh and Brecke (2001), along with numerous researchers in a wide range of agricultural sectors, none of the current alternatives appear to meet all of the criteria once met by methyl bromide: that is, economical, consistently effective, and easy to use. While some products appear to be just as or more effective than methyl bromide in killing weeds, disease pathogens, or nematodes, they are either not economical or practical and, in some cases, not labeled for turfgrass use. Others, while easy to use or economical, do not measure up in terms of efficacy. Some require specific soil and environmental conditions, whereas others are not suited for residential areas or require too much time before seeding is allowed. Perhaps most discouraging is that methyl bromide, when applied as a hot gas, is the only soil fumigant that does not require extensive rototilling or soil cultivation. This means that the simplest and easiest method of reestablishing greens to newer stands of turfgrass would also be lost, as none of the other fumigants, including methyl iodide, can be applied in the same manner.

Life without methyl bromide will make successful putting green renovation more challenging. Science has always served as the foundation for improvements in product chemistries and techniques and, once again, we must rely on research and innovation to show

Course officials and staff at the Country Club of Peoria in Illinois inspect the results of successful fumigation using methyl bromide on a putting green.

Table 1
Available and Potentially Available Soil Fumigant Options

	Chemical							Non-Chemical		Chemical Combinations			
Product	Methyl bromide	Dazomet	Methyl iodide	Dimethyl disulfide (DMDS)	Chloropicrin (tear gas)	Dichloro-propene (1,3-D)	Metam sodium	Soil solarization	Steam (hot water)	Chloropicrin & 1,3-D	Chloropicrin & Dazomet	Chloropicrin & Metam sodium	1,3-D & Metam sodium
Trade Name		Basamid	Midas	Paladin		Telone II	Vapam, Sectagon						
Registered for use on turf?	•	•	•	Possibly in 2009 or 2010	•	Commercial turf farms only	•	•	•	Commercial turf farms only	•	•	Commercial turf farms only
Undergoing reregistration with the EPA[1]	•	•			•		•			•	•	•	•
Typical waiting time before planting	5 Days	10-17 Days	10-14 Days	Unknown	7 Days	7-14 Days	14-21 Days	42-56 Days	Unknown	7-14 Days	10-17 Days	14-21 Days	14-21 Days
Pests Controlled[2]													
Weeds[3]	•	•	•	•			•			•	•	•	•
Nematodes	•	•	•	•		•	•	•	•	•	•	•	•
Insects	•	•	•	•		•	•	•		•	•	•	•
Disease pathogens	•	•	•	•	•		•	•		•	•	•	•

[1]Reregistration Eligibility Decisions (REDs) for soil fumigants can be found at http://epa.gov/oppsrrd1/reregistration/soil_fumigants/.

[2]Simply indicates whether or not pests are controlled, but does not specify the level of control achieved. For instance, methyl bromide achieves good to excellent control for the target pests listed, whereas other fumigants may provide only poor to moderate control for the same pests.

[3]Weeds include broadleaf species, sedges (*Cyperus* spp.), and grassy weeds, such as annual bluegrass (*Poa annua*) and common and off-type bermudagrasses (*Cynodon* spp.).

A quick reference guide that compares available and potentially available soil fumigant options. This information was compiled primarily from registered product labels, the EPA website and fact sheets, and research by J. B. Unruh and B. J. Brecke of the University of Florida.

us the way. Fortunately, newer products and chemistries are becoming available. Today, we have the selective herbicide Velocity, which can be used approximately four weeks after bentgrass germination to control *Poa annua* invasion during fairway renovations. This is one example of how a newer product helps take the pressure off when attempting to control *Poa annua* contamination at the time of seeding, thereby reducing our dependency on soil fumigation in cool-season climates. In this particular instance, Velocity is not labeled for use on putting greens, but perhaps an option will soon be available.

If you are currently considering a putting green renovation at your facility, it may well be worth doing so sooner rather than later. And, while no project should ever be rushed, moving up the date to ensure that methyl bromide can be used may be worthwhile. The long-term success of your greens may even depend on it.

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