Soil Fumigation With Metam Sodium at Lawyer Nursery©

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Lawyer Nursery, Inc., of Plains, Montana, established itself on the West Coast in 1988 when the company purchased a 120-acre nursery site in Olympia, Washington. This property was developed as a forest nursery in the late 1960s, and was operated by an industrial forest seedling producer until 1985. During the 3-year period the property was for sale, it was leased by a local farmer to grow carrots. We have added to the land base of the nursery since we started, but it is safe to say that the original 120-acre nursery site has been intensively farmed for nearly 40 years.

We have been able to keep this site reasonably productive by rotating different kinds of crops throughout different locations at the nursery and utilizing winter and summer cover crops between nursery crop cycles. Another management practice we have utilized to control soil pathogens is soil fumigation. We used methyl bromide/chloropicrin in the early days but found it very challenging to grow deciduous seedlings after eliminating mycorrhiza from the soil profile. About 10 years ago, we experimented with the fumigant metam-sodium and experienced excellent results growing seedlings in fumigated seedbeds. We felt that metam-sodium might be less damaging to beneficial soil microflora than methyl bromide. We have continued to use this material for the last 10 years to control soil pathogens. This discussion will focus on our experience with this fumigant during that time.

Metam sodium is a dithiocarbamate aqueous sodium salt. It is an agricultural-use soil fumigant that was developed in the 1950s and was reported as early as 1962 as a soil fumigant in a forest nursery in the southeastern United States (Hodges 1962). Metam sodium is considered to be a methylisothiocyanate (MITC) generator. When liquid metam sodium is applied to moist soil, it is quickly broken down to a gaseous fumigant, MITC. MITC is toxic to annual weed seed, nematodes, and soil pathogens. Metam sodium is the most widely used soil fumigant in the United States. It is used extensively on certain food crops, including potatoes, carrots, tomatoes, onions, and peanuts. Lawyer Nursery became interested in metam sodium as an alternative to methyl bromide and chloropicrin because it is less expensive, it has a lower acute toxicity to the applicator, and it is less harmful to the environment. As I stated earlier, I also believe that this product is less damaging to beneficial mycorrhiza in the soil. Methyl bromide is a very effective soil fumigant, but it is an ozone-depleting compound that is in the process of being phased out of use and production in the coming years as a result of this country's participation in the Montreal Protocol of 1987. Metam sodium is sold under the trade names Metam CLR®, Vapam®, Busan®, Nemasol®, Sectagon 42®, and others. The product we are currently using is Metam CLR®, which contains 4.25% of the active ingredient per gallon. We apply the product at the rate of 50 gal of material per acre.

This fumigant can be applied to soil in several different ways, depending on the crop. It can be injected into irrigation equipment and watered into the soil. Another application method is what's called "rotovate and roll." With this application method, the material is sprayed onto the soil surface or injected below the soil surface just ahead of a rototiller, which incorporates the material into the soil. This set up

usually includes a power driven roller behind the rototiller. This power roller spins faster than the ground speed of the tractor, which effectively seals the soil surface. Another method of application is to apply a portion of the material through a sub soil shank at a depth of 6–8 inches and spray a portion of the material on the soil surface and incorporate that sprayed surface soil and then seal the soil surface with a cultipacker or roller of some sort.

When we began to experiment with this fumigant, we hired contractors to apply the material. We hired contractors who used "rotovate and roll" equipment as well as the 3rd category described above. The contractor that we settled on used a piece of equipment that injected material through subsoil shanks and applied material to the soil surface with nozzles. Directly behind the nozzles he pulled a culti-packer, which pushed a burm of soil over the sprayed material on the surface, which covered the material and provided a seal. This application method was more appealing than the rotovate and roll method, because the rototiller seemed to create a very compacted layer of soil where the bottom of the tines pounded the soil. We had good results when the contractor applied metam sodium fumigation for the first 2 years.

In the Spring 2001, we learned that certain species of pine seedlings were very sensitive to exposure to metam sodium. We learned of this when a neighboring strawberry grower applied metam sodium to fallow ground on his strawberry field, which is adjacent to a portion of our nursery where pine transplants were growing. Following the fumigant application on the strawberry field, I noticed that the needles on a significant number of *Pinus monticola* transplants at the end of the bed closest to the neighbor's farm were bleached out. The occurrence of affected pine seedlings diminished as the distance from the fumigation increased. This occurred in early spring prior to bud break, and the affected trees broke bud and recovered.

When we prepared to fumigate in the fall of that year, we discussed the *Pinus*-phytotoxicity issue with the fumigation contractor. Since we did have pine growing adjacent to some of the areas we intended to fumigate, we decided to take some precautions in those areas. We elected to inject all of the fumigant below the surface and did not apply any fumigant to the soil surface in these areas that were within 50 ft of pine crops. Despite our precautions, this application of fumigant resulted in a significant loss of pine seedlings and transplants. After taking a closer look at the history of metam sodium fumigation in forest nurseries, we found several documented incidents of large-scale damage to pine seedlings as a result of the fumigant escaping from the soil and damaging trees some distance from the application site. In our case, we found that all pines showed some sensitivity to this chemical, but five-needle pines were particularly vulnerable to injury. Crops that were injured were as close as 4 ft from the application area to over 400 ft from the application area. It was never clear exactly what caused the fumigant to escape from the soil, but this incident caused us to re-evaluate our use of this product in the nursery.

Because we did have 2 years of good results with this fumigant without any damage to adjacent crop, I felt that we could continue the program with better application equipment and by doing a more effective job of sealing the soil surface to prevent the fumigant from escaping into the environment. The nursery manager in our central Washington nursery at that time was Phil Rathbun. Phil was an exceptional row crop farmer and a skilled fabricator who was interested in all aspects of crop production. Phil had used metam sodium in the past on potatoes and

became interested in using it on nursery ground. While he did not grow pine at his nursery, he felt that he could build a fumigator that would keep the fumigant in the soil, particularly if we sealed the soil with irrigation water immediately after application. Phil injected metam sodium with his center pivot, but he was motivated to build an applicator so that he could treat the pivot corners that were irrigated by hand lines.

Phil set out to build an application implement that we could utilize to apply metam sodium with our own equipment and our own employees. The machine he built was similar to the one that our contractor had used, only better. It was set up to fumigate a 5-ft-wide swath behind the tractor. It injected material at a depth of 6–8 inches with a series of shanks directly behind the tractor. There were two rows of shanks that were spaced 16 inches apart front to back. There were five shanks in the front row spaced 15 inches apart side-to-side and four shanks in the back row set in between the shanks of the front row. In between the two rows of shanks, there was a tool bar with three flood nozzles to spray material onto the soil surface. A small offset disk followed the two rows of shanks so the sprayed surface soil was incorporated. Finally, the soil surface was rolled with a rubber-tired roller, which formed a reasonably effective seal if the soil moisture was just right. The machine used an electric pump with a Red Ball® spray monitor so the operator could see that all the nozzles and injectors were functioning properly at all times from the safety of an enclosed cab.

When the field to be fumigated is prepped, the irrigation pipe is left in the field so that irrigation water can be applied immediately after the fumigant application to help seal the soil. We put on approximately 0.1 inches of water immediately after fumigation and repeat short sets of water daily for about 3 days. By keeping the irrigation lines in the field during the fumigation process, we end up with a 12-inch swath of untreated soil on either side of the pipeline.

We feel that using our own equipment to apply the fumigant provides several advantages. It gives us the flexibility to fumigate on our schedule and we can do small plots or larger pieces at our discretion. Another advantage is the reduced cost. Metam sodium is relatively inexpensive; we pay about $3.75 per gal and another $1 per gal in freight to have the material shipped to us in 250-gal totes. The total cost of the material and the application is in the neighborhood of $300 per acre. The cost to build the applicator was approximately $2500. When we used a private contractor to apply metam sodium, the cost was $750 per acre.

Based on our experience with metam sodium, I believe this product has a place in the nursery pest control program. We have seen significant reductions in certain soil-borne pathogens, including *Pythium* and *Fusarium* (Table 1).

Table 1. Effect of fumigation on incidence of *Pythium* and *Fusarium* in *Acer*.

Treatment	Crop type	*Pythium* propagules per gram soil	*Fusarium* propagules per gram soil
Fumigated soil	*Acer rubrum* 1-0	80 (vl)	880 (h)
Non-fumigated soil	*Acer circinatum* 1-0	410 (h)	2000 (vh)

(vl) = very low, (h) = high, (vh) = very high.

Soil fumigation of Vapam/tc17 occurred 27 Sept. 2001. Pathogen assay was performed on 27 July 2002 by Ribeiro Plant Lab, Inc., Bainbridge Island, Washington.

Weed control is erratic when compared with the fumigant combination of methyl bromide/chloropicrin. I know we are able to reduce the levels of weed seed in the ground we treat with metam sodium but it by no means eliminates all weed seed. When we fumigate in mid summer, the untreated soil adjacent to the irrigation pipe turns green with weed seedlings shortly after the fumigant is applied, while the treated soil remains clean. It is my feeling that this material is less harmful to mycorrhizal fungi than methyl bromide/chloropicrin, but I do not have concrete evidence of this other than the performance of seedlings planted into fumigated soil.

Like all pesticides, metam sodium is a difficult material to work with from an applicator's perspective. It is a very corrosive material and we are fully protected with personal protective equipment when we handle this product. This includes rubber boots, coveralls, gloves, and a full-face respirator. Another breakdown by product of this chemical is hydrogen sulfide, which is the "rotten egg" smell. While this is a noxious odor, it does alert the operator very quickly if there is an exposure hazard. The matter of phytotoxicity to juvenile *Pinus* sp. is an issue that can be managed with proper application equipment and product placement. Generally, we do not use the material within 100 ft of sensitive crop, but we have reduced this buffer distance successfully by constructing temporary barricades to restrict the movement of any fumigant that does escape. We have not had any issues with phytotoxicity since the incident in 2001. This product is currently undergoing a re-registration review by the EPA, which is likely to result in additional label restrictions.

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