Influence of Mechanical Incorporation Method on Dazomet Distribution in Conifer Nursery Soil

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Four mechanical incorporation methods were evaluated for their ability to distribute dazomet (Basamid®), a granular soil fumigant, in soil during a spring nursery field trial. Dazomet distribution downward in soil was determined by radish seed bioassay and soil analysis for fungal pathogens. Discing and other treatments adequately moved dazomet down to 15 cm (6 in), and marginally deeper. The disc, Roterra®, and combination disc and cultipak treatments gave complete control of Pythium *and* Fusarium ***species down to 10 cm (4 in), and partial control down to 20 cm (8 in). The cultipak by itself provided inferior mixing, resulting in the least amount of pathogen control.*** Tree Planters' Notes 45(2):53-57; 1994.

The gaseous fumigants methyl bromide and chloropicrin have been widely used in conifer nurseries because they give consistent control of fungi and weed seed. Although these compounds have performed well operationally, in the mid-1980's a number of people began to evaluate the performance of alternative fumigants because of environmental and worker safety concerns with methyl bromide (Campbell and Kelpsas 1988, Landis and Campbell 1991, McElroy 1985, McElroy 1986, Tanaka and others 1986). Now, the performance of these alternatives has been made even more crucial by the 1993 decision by the U.S. Environmental Protection Agency (EPA) to ban the use and production of methyl bromide in the United States by 2001.

Dazomet (Basamid® Granular) has received attention as an alternative fumigant because it is labeled for forest nurseries and is used extensively in Europe. Unlike methyl bromide, the fine granular compound is spread on the soil surface and incorporated with conventional tillage equipment. The resulting granule breakdown releases the gas methyl isothiocyanate, the primary fumigating agent.

Because tillage equipment differs between nurseries, we wondered about the suitability of different mechanical incorporation implements for mixing dazomet in the soil. European data exist for some types of equipment (BASF 1984), but there are few or no regional data for commonly used forest nursery implements. A fumigation trial was installed at the USDA Forest Service's J. Herbert Stone Nursery (Central Point, Oregon) in the spring of 1987 to address dazomet incorporation. Two objectives were established:

1. To determine the influence of different incorporation implements on dazomet distribution in the soil.
2. To determine the effects of each incorporation treatment on pathogen control.

Methods

Incorporation treatments. In early April, four incorporation treatments were selected to mix dazomet into nursery soil, representing a wide range of currently available mechanical implements (figure 1). The choice of implements was based on their potential for good incorporation and their availability. The incorporation treatments are summarized as follows:

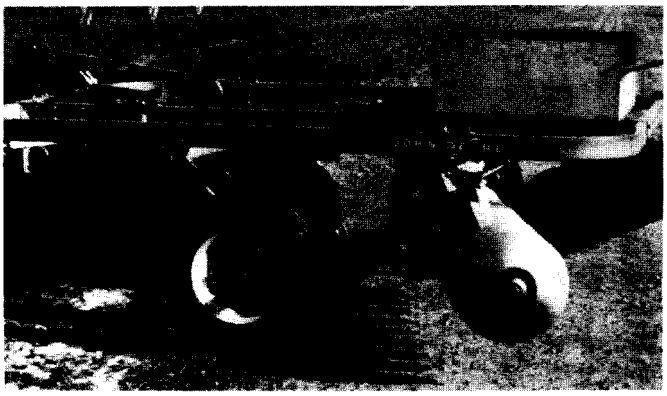
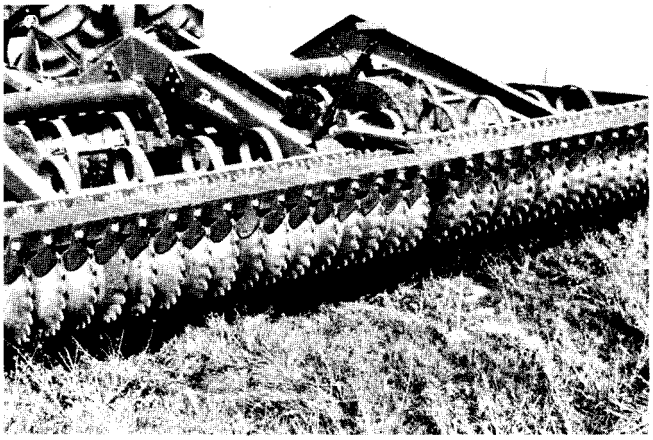


Figure 1—*Implements used to incorporate dazomet: disc (**above**),*
[Figure continued on next page.]



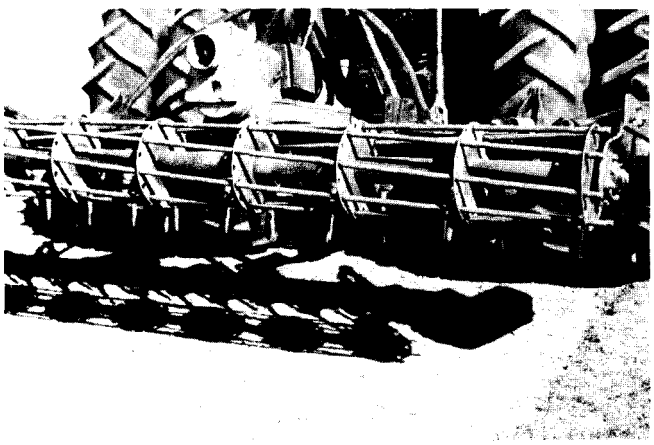


Figure 1 (continued)—*Implements used to incorporate dazomet: cultipak* **(left)**, *Roterra®* **(right)**.

Implement	Description	Maximum incorporation depth*
Disc	Double-gang disc 18-in (46-cm diameter)	9 in (23 cm)
Brillion cultipak	Harrow/roller (spring tines followed by serrated rollers)	6 in (15 cm)
Disc & cultipak	Treatment #1 followed by #2	9 in (23 cm)
Lely Roterra®	Power harrow (vertical rotating tines)	6 in (15 cm)

* Incorporation depth based on tine length or disc radius.

Field soil was preconditioned by cultivation to reduce clod size. In addition, the soil received irrigation and natural rainfall before treatment to enhance fungal development and to ensure adequate moisture for granule breakdown. Treatment plots 12.2 by 24.4 m (40 by 80 ft) in size were established in one portion of one field and replicated twice. An application of dazomet at the rate of 392.3 kg/ha (350 lb/acre) was broadcast over the entire treatment area with a droptype granule spreader and was followed immediately by the four incorporation treatments. To evaluate the effect of water sealing, half of each plot was irrigated with 6 mm (.25 in) of water after incorporation, and the other half was left unirrigated (unsealed).

Within each treatment plot, six sample points (three in each irrigation half) were established for soil collection. To determine dazomet movement downward in the soil profile, soil was stratified and collected from three sampling depths10, 15, and 20 cm (4, 6, and 8 in)-at each point.

Assay methods. Dazomet's presence was evaluated using two assay methods. The first consisted of a bioassay using radish seeds, similar to one described by Semer (1987). One pint of soil was collected from each depth immediately after pesticide incorporation and placed in canning jars. Untreated soil from an adjacent field was used as a control. About 20 to 24 seeds were sown in each jar, tightly capped, and placed indoors, in ambient light and temperature, at the nursery. Two weeks after sowing, the germinants were counted. Little or no germination of seeds indicated the presence of dazomet at biologically active concentrations (figure 2).

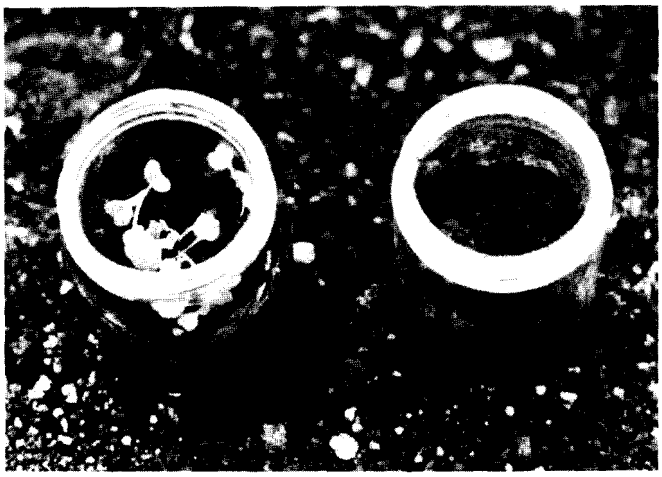


Figure 2—*Bioassay for the presence of dazomet in untreated* **(left)** *and treated* **(right)** *soil.*

The second method for determining dazomet distribution consisted of soil pathogen analysis. Soil from each point was evaluated for population levels of the fungi *Pythium* and *Fusarium* before treatment in 0-to 20-cm (0-to 7.9-in) composite samples, and 4 weeks after incorporation at three depths at each sample point. Pathogen sampling methodology followed that used previously by Campbell and Kelpsas (1988).

No statistical analysis was carried out on pathogen and radish germination data due to the high variation in results within treatments, the small sample sizes, and the small number of replications. Preliminary calculations of confidence intervals on the radish germination data were extremely large due to the above factors. (Note: this trial was initially set up as a "quick and dirty" look at how well the various implements performed, with only one replication and the radish seed assay planned. It was later amended to include two replications and to assay for pathogens as well as radish germination. Treatments were not randomized within treatment blocks.)

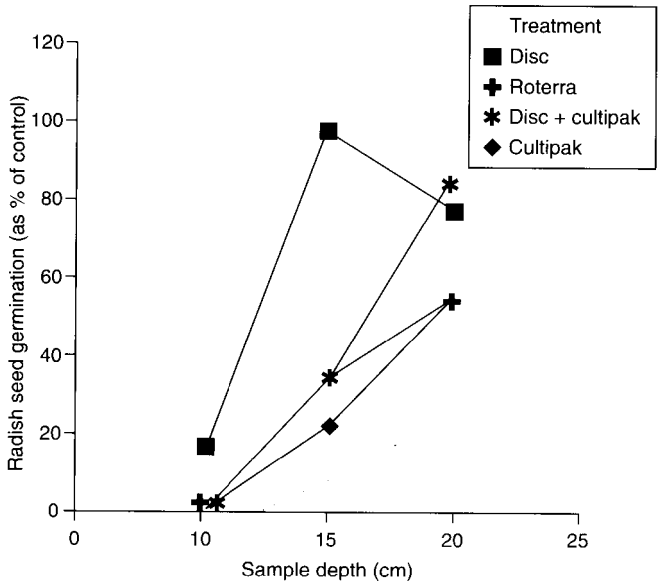


Figure 3—*Radish seed germination in dazomet-treated soil taken at three depths: 10, 15, and 20 cm (4, 6, and 8 in).*

Results and Discussion

Seed bioassay. Little or no radish seed germination in the 10-cm (4-in) soil samples indicated that all incorporation treatments were effective in mixing dazomet down to that depth (figure 3). Similarly, at the 15-cm (6-in) depth, the disc, disc plus cultipak, and Roterra treatments moved the material adequately to prevent or slow germination of radish seeds. The cultipak treatment was inferior to the other methods at this depth, probably because the soil was not mixed well with the narrow single teeth on the implement. All incorporation methods were less effective in moving dazomet to the 20 cm (8 in) depth, but enough material reached this level to provide some fumigation effect, based on inhibition of germinant development.

Soil pathogens. Soil analyses for the pathogenic fungi *Fusarium* and *Pythium* (table 1) revealed pretreatment levels for both genera that were variable and generally low — *Fusarium* levels are often over 1,000 propagules per gram (PPG) and *Pythium* over 100 PPG. The differences between nonirrigated and irrigated areas were variable and showed no apparent differences. As a result, the irrigated and nonirrigated samples for each incorporation treatment were pooled and the means reported here.

All treatments except the cultipak method eliminated *Fusarium* and *Pythium* populations from pretreatment levels at the 10-cm (4-in) depth. The higher incidence of *Fusarium* at 15 and 20 cm (6 and 7.9 in), especially with the cultipak method, and of *Pythium* at 20 cm (7.9 in) by the Roterra, indicates that all the implements did not provide uniform mixing lower in the soil profile.

The percentage of all soil samples containing any level of *Fusarium* or *Pythium* was distinctly reduced by dazomet when compared to the pretreatment sample percentages (figures 4 and 5). The cultipak treatment stands out as the method that provided the poorest pathogen control. This observation is consistent with the radish bioassay results and pathogen analysis noted earlier.

All four incorporation methods may provide enough mixing to impact *Pythium* populations down to the 15-cm (6-in) zone. For *Fusarium*, the disc and Roterra appear to give adequate control down to 20 cm (7.9 in). The actual level of control needed for either *Fusarium* or *Pythium* is specific to each nursery and depends, among other things, on the mix of pathogenic and nonpathogenic organisms present in the soil, seedling species, seedling growth rate, soil temperature, and soil moisture.

Conclusions

All four mechanical methods were effective in mixing dazomet into shallow soil depths down to 10 cm (4 in). The cultipak and Roterra, both with 6-inch (15-cm) tines, did not mix as well as the disc at deeper depths. We would not recommend that they be used alone for dazomet incorporation.

Table 1 -*Mean fungal populations (propagules per gram) at various sampling depths*

Sample depth	Disc	Cultipak	Disc + cultipak	Roterra
Fusarium				
Pretreatment				
0-20 cm	134	129	140	100
Posttreament				
10 cm	0	55	0	0
15 cm	0	103	36	6
20 cm	6	106	48	50
Pythium				
Pretreatment				
0-20 cm	8	45	5	10
Posttreatment				
10 cm	0	0	0	0
15 cm	4	3	0	0
20 cm	0	1	0	25

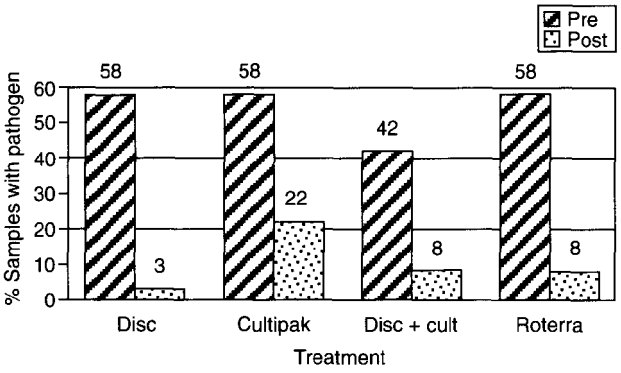


***Figure 4**—Percentage of soil samples for each treatment containing any level of* Fusarium *before (PRE) and after (POST) dazomet application.*

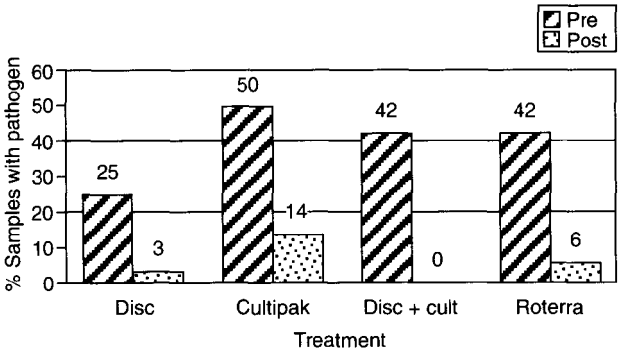


***Figure 5**—Percentage of soil samples for each treatment containing any level of* Pythium *before (PRE) and after (POST) dazomet application.*

Target depths for dazomet treatment depend on specific nursery conditions; however, determining your target depth can be made several ways: aim for the same depth that methyl bromide is applied — 20 cm (7.9 in) or greater; use the typical seedling rooting depth during the period of greatest disease susceptibility; or simply use the depth that seems to provide good control based on several years of experimental or operational use.

Several northwest nurseries now use dazomet operationally. The J. Herbert Stone Nursery incorporates dazomet with an 18-inch disc, followed by a cultipak and roller. The Coeur d'Alene Nursery in Idaho uses a Roterra with 12-in (30.5 -cm) tines (twice as long as the tine used in this trial), with a roller attachment. Both nurseries find that dazomet mixing and subsequent pest control are adequate with these implements.

Although irrigation sealing under these study conditions presented no clear advantage over unsealed soil, it still may be useful in maximizing dazomet performance. This may be especially important in the fall when drier and warmer soils favor rapid fumigant release.

The results of this study, as well as successful experiences in a number of nurseries, indicate that forest nurseries can effectively apply and incorporate dazomet with a number of tillage implements. The performance of the disc treatments in this trial suggests that this common implement can be used successfully to distribute dazomet to soil depths necessary for seedling development.

Literature Cited

BASF. 1984. Basamid Granular. Ludwigshaven, Germany: BASF Aktiengesellschaft Agricultural Research Station. 91 p.

Campbell SJ, Kelpsas BR. 1988. Comparison of three soil fumigants in a bareroot conifer nursery. Tree Planter's Notes 39(4):16-22.

Landis TD, Campbell SJ. 1991. Soil fumigation in bareroot tree nurseries. In: Sutherland JR, Glover SG, eds. Proceedings, first meeting of IUFRO Working Party S2.07-09 (Diseases and Insects in Forest Nurseries). Pacific and Yukon Reg. Info. Rep. BC-X-331. Victoria, BC: Forestry Canada, Pacific and Yukon Centre, Pacific Forestry Centre: 191-205.

McElroy FD. 1985. A newly registered sterilant shows strength in field tests. American Nurseryman Nov: 75-79.

McElroy FD. 1986. Use of metam-sodium and dazomet fumigants. In: Landis TD, ed. Proceedings, Combined Western Forestry and Nursery Council and Intermountain Nursery Association Meeting. Gen. Tech. Rep. RM-137. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 139-146.

Semer CR. 1987. Basamid and methyl bromide compounds as fumigants in carnation and chrysanthemum production in selected propagation media. Proceedings of the Florida State Horticultural Society 100:330-334.

Tanaka Y, Russell KW, Linderman RG. 1986. Fumigation effect on soilborne pathogens, mycorrhizae, and growth of Douglas-fir seedlings. In: Landis TD, ed. Proceedings, Combined Western Forestry and Nursery Council and Intermountain Nursery Association Meeting. Gen. Tech. Rep. RM-137. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station: 147-152.