Use of Metam-Sodium and Dazomet Fumigants[1]

Fred D. McElroy[2]

Controlling disease causing microorganisms in the soil environment prior to seed sowing is a difficult task. When a chemical is used for this purpose it must not only be capable of killing the organisms, but also be able to penetrate areas where those organisms are, remain there long enough to be effective, and leave the soil without a residual which might damage subsequently planted seed.

A number of soil fumigants have been used for this purpose over the years. In the last decade Methyl bromide-chloropicrin has became the standard since it very effectively meets the above criteria. However, it also has several disadvantages (e.g. cost, overkill, handling danger, etc.) as discussed in my previous talk on "options in Controlling Soilborne Pests".

Peninsu-Lab is continually investigating new methods for dealing with soilborne pest problem, and as a part of this program has tested a number of soil fumigants. Over the last three years two of these chemicals tested under contract by Peninsu-Lab, have shown promise for use in forest nurseries. These compounds are Metam-sodium (Vapam, Soil-Prep) and Dazomet (Basamid-Granular).

With sane minor differences, both compounds form the active ingredient Methyl isothiocyanate (MIT) when in contact with moist soil. This gas diffuses through the soil pore spaces moving mainly upward, killing the living organisms with which it comes into contact. This substance has a broad spectrum of activity against soil organisms such as insects, fungi, nematodes, and weeds.

Because of the differences in formulation, the two chemicals are applied by different means. Dazomet is a fine white granular material which is applied to the soil surface by means of a shaker, Gandy, or similar applicator. It is then tilled into the soil with a cultivator or hoe, and the soil surface sealed by compacting and irrigating.

Metam-sodium is a liquid and is applied through the irrigation system. The chemical is applied in about an inch of water and must be metered in during the entire time of irrigation (5-6 hours).

In caparison, Methyl branide-chloropicrin is a gas which is injected into the soil to a depth of about 8-10" using shanks drawn behind a tractor. The soil must immediately be sealed with a polyethylene tarp to prevent rapid escape from the soil.

With all of these chemicals the soil must be tilled 1-2 weeks after treatment to allow escape of the gas prior to planting. This time interval is determined by a number of factors such as chemical, temperature, moisture, etc.

The following summarizes our findings over the past three years in several nurseries, and presents data from the 1985-86 tests. In all studies with Dazomet and Metam-sodium, Basamid-Granular and Soil-Prep respectively were the commercial products used.

----

lPaper presented at Western Forest Nursery Council Meeting, Tti water, WA, Aug. 12-15, 1986.

[2]Fred D. McE1roy, Ph.D., Owner/Director, Peninsu-Iab, Box 3000, Kingston, WA 98346.

1984 - Spring Application

At nursery A, Dazomet, Metam-sodium, and MC-33 were applied at 531, 100 and 350 lbs. per acre (ppa) respectively. Pre-treatment populations of Pythium and Fusarium were low and were significantly and equally reduced by all treatments. Because of the law population of soilborne fungi there was no significant difference in dapping-off amongst the plots.

Based on paired sampling studies conducted by Peninsu-Iab of several nursery soils containing healthy and diseased seedlings, we consider populations of Fusarium and Pythium in excess of 1000 and 100 propagules per gram (ppg) of soil to be potentially damaging to conifer seedlings.

Approximately 1" of rain fell 3 days after treatment with Dazomet, which resulted in moving the material deep into the soil profile. The chemical did not escape from the soil until after sawing, resulting in phytotoxicity to the seedlings.

In nursery B, Dazomet at 350 ppa was compared to MC-33 at 350 ppa. In this nursery Fusariun, Pythiun, Phytophthora, and 5 genera of plant parasitic nematodes were present in moderate to high populations. MC-33 and Dazomet reduced soil fungus populations by 88% and 70% respectively, which were both significantly below the untreated plots. Both treatments eliminated all nematode genera. Dapping-off in the Dazomet treated plots was 1.8% compared to 12% in the untreated. A combination of a lower rate of Dazomet and minimal rainfall following treatment resulted in no phytotoxicity in these plots.

1985 Studies

Dazomet Rate Study - No Sowing

Dazomet was tested as a spring application at 0, 95, 187, 267, and 367 ppa. The material was applied operationally using a Gandy 1-bed (4') drop spreader, immediately tilled to 8", rolled with a bed roller and irrigated. Soil fungus populations and weed growth were evaluated and are shown in Tables 1-3.

The three highest rates all reduced both Pythium and Fusarium populations significantly below the untreated plots. Given the initial soil populations and the time of year, the 187 pea rate would have been sufficient to reduce populations below damaging levels. All rates reduced weed populations significantly below the untreated controls. There was little difference between the 95 and 187 ppa rates, and between the 267 and 367 ppa rates.

For forest nurseries, it appears that a rate of 267 ppa may be as effective in reducing fungus populations as higher rates. It may even be possible to reduce this rate to near 187 ppa and still obtain adequate control. %bile weed control at 95 and 187 ppa was not as good as the two higher rates, it was significantly better than the untreated and may be adequate for a nursery program.

Dazomet Rate Study - No Post Treatment Herbicides, No Sowing

To determine the effectiveness of Dazomet alone in controlling weeds, 2 rates of material were applied with no post treatment herbicides.

Both rates of Dazomet gave good soil fungus control (Table 4) and weed control (Table 5). Although weed control was significantly better in the treated plots 4 weeks after sowing, by 6 weeks all plots were heavily infested with weeds. This demonstrated that while Dazomet is effective in significantly reducing weed seed populations in the soil, the standard nursery practice of applying a pre-emergence herbicide (such as Goal) is essential. Dazomet reduces the total weed population to a more manageable level using the pre-emergence herbicides.

1985-86 STUDIES

A series of tests were set up at each of four nurseries comparing different rates of Dazomet with other soil treatments. Two rates of Dazomet were selected for each nursery based on pretreatment soil fungus populations in that nursery. This was an attempt to determine if the level of soil fungus populations within a nursery could be used to select the lowest effective rate of Dazomet.

TABLE 1.--EFFECT OF 5 RATES OF BASAMID-GRANULAR ON FUSARIUM SOIL POPULATIONS - NURSERY A

TREATMENT (ppa)*	FUSARIUM (ppg)** PRE TREAT	POST TREAT	% CHANGE
0	1833	1075	41.4
95	1674	684	59.1
187	1193	51	95.7
267	1209	193	84.0
367	1259	0	100

Values are an average of 3 replications
*ppa = pounds/acre
**propagules/gram of soil

TABLE 2.--EFFECT OF 5 RATES OF BASAMID-GRANULAR ON PYTHIUM SOIL POPULATIONS - NURSERY A

TREATMENT (ppa)*	PYTHIUM (ppg)** PRE TREAT	POST TREAT	% CHANGE
0	87	178	+104.6
95	82	102	+24.4
187	371	38	89.8
267	33	0	100
367	119	0	100

Values are an average of 3 replications
*ppa = pounds/acre
**propagules/gram of soil

TABLE 3.--EFFECT OF 5 RATES OF BASAMID-GRANULAR ON WEED POPULATION 5 WEEKS FOLLOWING TREATMENT - NURSERY A

TREATMENT(ppa)*	TOTAL WEEDS/50' BED
0	50
95	17
187	14
267	1
367	1

Values are an average of 3 replications
*ppa = pounds/acre

TABLE 4.--EFFECT OF BASAMID-GRANULAR ON SOIL POPULATIONS OF FUSARIUM AND PYTHIUM - NURSERY A

TREATMENT (ppa)*	PRE TREAT** FU	PY	POST TREAT FU	PY
0	1000+	213	1000+	100+
267	1000+	147	44	0
490	1000+	100	4	0

Values are an average of 3 replications measured in propagules/gram of soil.
*ppa = pounds/acre
**FU = Fusarium, PY = Pythium

TABLE 5.--EFFECT OF BASAMID-GRANULAR ON WEED POPULATIONS 12 WEEKS FOLLOWING TREATMENT - NURSERY A

TREATMENT (ppa)*	WEEDS/1 FT. OF BED** TOTAL	CHK	COT	GRASS	OTHER
0	826	808	3	12	3
267	19	15	4	0	0
490	12	7	5	0	0

Values are an average of 3 replications
*ppa = pounds/acre
**Chk = untreated, Cot = cottonwood, Other = unidentified weeds

Soil fungus populations were evaluated in mid September of 1985, and treatments applied in late September or early October of the same year. Post-treatment soil fungus evaluations were made in late October of that year, and March and June of 1986. Seed was sown into the plots in May of 1986. Results from the various nurseries are shown below.

Nursery A

Treatments at this nursery consisted of MC-33 (350 ppa), Vorlex (35 gpa), Dazomet (150 and 300 ppa), and an untreated check. Fusarium populations (Table 6) declined significantly for all chemical treatments. Populations in all plots, including the untreated check, continued to decline until March of 1986. By June all populations had risen slightly, but all chemical treatments remained below the untreated check. Also, all remained below the damage threshold level of 1,000 ppg.

MC-33 gave the best control, followed by Vorlex, Dazomet 300, Dazomet 150, and untreated check. Pythium populations followed a similar pattern.

There was no significant difference in number of live seedlings or damping-off in any of the treatments. This correlates well with the soil populations of Fusarium and Pythium, all of which were below threshold levels at time of sowing. While all chemical treatments reduced soil fungus populations, soil treatment of any kind was probably not justified at this nursery.

Nursery B

Dazomet was applied at three rates (0, 250, and 300 ppa), applied as the only treatment at this nursery. A procedure similar to nursery A was followed here. Similar declines in soil fungus populations (Table 8) were observed at this nursery in the 250 and 300 ppa Dazomet plots.

By spring, populations of both Pythium and Fusarium in all treatments had declined to below threshold levels. As a result there was no significant difference in number of live seedlings or mortality.

Nursery C

Treatments at this nursery consisted of MC-33 (325 ppa), Metam-sodium (100 gpa), Telone II (30 gpa), Dazomet (150 and 300 ppa), and an untreated check. All chemical treatments reduced soil fungus and nematode populations below the untreated check (Tables 9, 10, and 11).

Telone II and Metam-sodium were not originally included in this test, so pretreatment samples were not collected. However, these treated areas were close to the other plots, so it can be assumed that pretreatment populations of soilborne organisms were within the range of those shown for the other plot areas. Further, Metam-sodium was not applied in the prescribed manner. A prescribed rate of material was all applied during a 15 minute period, and was followed by approximately 1 hours irrigation.

The first post-treatment sampling for Fusarium showed lowest populations in the Telone plots, followed by Metam-sodium, MC-33, Dazomet 300, Dazomet 150, and untreated check. However, by March 1986, lowest populations were in the MC-33 plots followed by Dazomet 300, Dazomet 150, Metam-sodium, Telone, and untreated check. Both Telone and Metam-sodium applied in this manner theoretically should not have had significant affect on Fusarium populations. This eventually proved to be true by the March sampling. The unexpected initial drop in populations is unexplained.

MC-33 gave the best overall control. There was little difference between the two rates of Dazomet by spring of 1986. Similar trends occurred with Pythium populations.

At this test site there were five plant parasitic genera of nematodes present. Only the Root-lesion nematode (Pratylenchus penetrans) is of importance to conifers, and so is the only one reported on here (Table 11). MC-33 gave best control, followed by Dazanet 300, Dazanet 150, Telone, Metam-sodium, and untreated check.

Nursery C

At this nursery Dazomet at 200 and 350 ppa were compared with Vorlex for control of soilborne fungi. Pretreatment samples were collected by nursery personnel, and therefore only one composite was collected for the Dazomet and check plots, and one composite for the Vorlex plot which was applied operationally to another portion of the block. The Vorlex treated area had almost 9 times the level of Fusarium, as did the Dazomet treated areas. This should be kept in mind in evaluating the results in Table 12.

Both rates of Dazomet and the Vorlex treatment all reduced populations by approximately the same percentage (97-99%), at the first post treatment sampling. By sowing time populations under all chemical treatments had reached approximately the same level. This was approximately 1/2 that of the untreated plots.

Both Dazomet treatments reduced Pythium populations to 0 at the first post treatment sampling, and they remained at that level until sowing. The Vorlex treatment reduced populations to below 10 ppg of soil and this too remained at that level until sowing.

There was no significant difference in seedling stand or mortality amongst *the* plots. Again, populations at sowing were below threshold levels, which would probably explain this situation.

SUMMARY AND CONCLUSIONS

Efficacy

All the soil fumigants tested, (MC-33, Vorlex, Dazomet, and Metam-sodium), at appropriate rates gave equal control of soilborne microorganisms. Vorlex is *somewhat* less effective in weed control.

Ease of Application

Each fumigant has its own advantages and disadvantages. MC-33 requires very specialized equipment both for injecting the material into the soil and for immediate tarping. Further, tarp removal and disposal must be considered. However, because it is injected as a gas, treatment time is very short and is less prone to subsequent phytotoxicity problems, although seedling stunting has been associated but not demonstrated to be related.

TABLE 6.--EFFECT OF SOIL FUMIGATION TREATMENTS ON SOIL POPULATIONS OF FUSARIUM - NURSERY A

TREATMENT	FUSARIUM/SAMPLE DATE 9-13-85	10-29-85	3-19-86	6-2-86
0	1198	1043	410	837
MC-33	1698	7	10	53
VORLEX	722	97	63	80
BG 150ppa	1303	813	360	543
BG 300ppa	1547	400	203	213

Values are an average of 3 replications and reported as propagules/gram of soil. Sampling date 9-13-85 is pretreatment, remainder are post-treat.
Treatments: 0 = no treatment; MC-33 = Methyl bromide-chloropicrin @ 350 #/ac (ppa); Vorlex = @ 100 gal/ac; BG = Basamid-Granular @ 150 & 300 ppa.

TABLE 7.--EFFECT OF SOIL FUMIGATION TREATMENTS ON SOIL POPULATIONS OF PYTHIUM - NURSERY A

TREATMENT	PYTHIUM/SAMPLE DATE 9-13-85	10-29-85	3-19-86	6-2-86
0	91	70	154	113
MC-33	84	0	0	0
VORLEX	60	0	0	13
BG 150ppa	89	90	0	23
BG 300ppa	97	47	17	22

(See notes Table 6).

TABLE 8.--EFFECT OF BASAMID-GRANULAR ON SOIL POPULATIONS OF PYTHIUM AND FUSARIUM - NURSERY B

	PYTHIUM & FUSARIUM/SAMPLE DATE					
	10-17-85		10-29-85		3-19-86	
TREATMENT	PY	FU	PY	FU	PY	FU
0	122	1677	108	525	3	205
250 ppa	140	3703	35	160	90	420
300 ppa	147	1528	5	50	10	180

Values are an average of 4 replications and reported as propagules/gram of soil. Sampling date 10-17-85 was pretreat, remainder post treat.

TABLE 9.--EFFECT OF SOIL FUMIGATION TREATMENTS ON SOIL POPULATIONS OF FUSARIUM - NURSERY C

TREATMENT	FUSARIUM/SAMPLE DATE 10-2-85	10-29-85	3-19-86
0	1402	1575	453
MC-33	1297	123	65
TELONE	-	58	430
SP	-	120	238
BG 150	1120	980	168
BG 300	1370	720	155

Values are an average of 4 reps and reported as propagules/gram of soil. Sampling date 10-2-85 was pretreat, remainder post-treat.
Treatments: 0 = untreated; MC-33 @ 325 #/ac; Telone II @ 30 gpa; SP = Soil-Prep @ 100 gal/ac; BG = Basamid-Granular @ 150 & 300 #/ac; - = no sample taken.

TABLE 10.--EFFECT OF SOIL FUMIGATION TREATMENTS ON SOIL POPULATIONS OF PYTHIUM - NURSERY C

TREATMENT	PYTHIUM/SAMPLE DATE 10-2-85	10-29-85	3-19-86
0	125	77	183
MC-33	121	3	3
TELONE	-	40	123
SP	-	20	65
BG 150	126	30	60
BG 300	113	13	35

(See notes Table 9).

TABLE 11.--EFFECT OF SOIL FUMIGATION TREATMENTS ON ROOT LESION NEMATODES - NURSERY C

TREATMENT	NEMATODE/SAMPLE DATE 10-2-85	10-29-85	3-19-86
0	294	463	200
MC-33	387	1	33
TELONE	-	69	88
SP	-	257	100
BG 150	513	156	44
BG 300	356	1	0

Values are an average of 4 replications and reported as number/pint of soil.
(also see notes Table 9).

TABLE 12.--EFFECT OF SOIL FUMIGATION TREATMENTS ON SOIL POPULATIONS OF FUSARIUM & PYTHIUM - NURSERY D

	FUSARIUM & PYTHIUM/SAMPLE DATE							
	10-14-85		11-8-85		3-19-86		6-3-86	
TREATMENT	FU	PY	FU	PY	FU	PY	FU	PY
0	656	97	393	149	333	3	497	63
BG 200	656	97	3	0	40	0	265	0
BG 350	656	97	13	0	3	0	203	0
Vorlex	5827	142	210	7	-	-	148	8

Values are an average of 3 reps and reported as propagules/gram soil
Sample date 10-14-85 is pretreat, remainder are post-treat.
Treatments: 0 = untreated; BG = 200 & 350 #/ac; Vorlex = 35 gal/ac.
- = no sample taken.

Vorlex also requires special soil injecting equipment, but does not require tarping. Treatment time and evacuation from the soil is somewhat longer than MC-33, but about equal to Dazomet and Metam-sodium.

Metam-sodium requires large quantities of water applied over a long period of time, it further requires a well designed irrigation system with proper sprinkler overlap to get complete coverage. It is also subject to wind displacement of the irrigation water, and volatilization under high temperatures. However, if properly set up, it is actually an easy and inexpensive method of application.

Dazomet is a very find granual and is subject to being wind blown at application if proper equipment is not available. Calibration can also be a problem without proper equipment.

This chemical is actually the easiest to apply as it may only require slight modification of standard nursery equipment. Our tests have shown that bed treatments can be applied in the fall and still remain effective by sowing the following spring.

Safety

MC-33 and Vorlex are the host dangerous chemicals of those tested. They both carry a danger-poison label, and are restricted use pesticides. Special protective gear is required during application of these chemicals.

Dazomet and Metam-sodium carry only warning labels, and are much safer to handle. Less specialized safety equipment is necessary during the application of these chemicals.

Cost

Treatment costs depend a lot upon whether or not a nursery owns the specialized pieces of equipment needed to apply the chemicals. Treatment with MC-33 is probably the most expensive, followed by Metam-sodium, Dazomet, and Vorlex. These costs will vary somewhat according to rate used and whether total area

• bed treatments are employed.

The selection of a soil fumigant will depend upon the soilborne problems within a nursery. Once the problems have been clearly defined, selection of a fumigant can be based

• the above criteria, i.e. ease of application, efficacy, safety, and cost. All of this should be done in light of the processes outlined in my previous presentation

• "Options in controlling Soilborne Pests".