ALTERNATIVES TO PRE-PLANT SOIL FUMIGATION IN WESTERN BAREROOT FOREST NURSERIES

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The objective of this project was to evaluate alternatives to pre-plant soil fumigation with methyl bromide/chloropicrin (MBC) and dazomet (Basamid®) in five USDA Forest Service forest nurseries in the western United States (two in Idaho and one each in Oregon, California and Nebraska). This project was initiated in the early 1990s and results of the first seedling crop cycle were reported in 1997. A second trial was installed to fine tune the treatments to specific requirements of the individual nurseries. This test was concluded during the fall of 2000. In initial tests, bare fallowing for at least one season prior to sowing showed promise as an effective alternative to chemical soil fumigation at some nurseries. Therefore, this treatment was repeated and sometimes supplemented by adding biological control agents (*Trichoderma harzianum*). Some nurseries have successfully substituted MBC with dazomet, which has become the treatment of choice. Soil solarization was also evaluated along with cover/green manure crops of several grasses and *Brassica* spp. (mustard and rape). Steam treatment of soil was evaluated at one nursery.

The major disease-causing pathogen at most nurseries is *Fusarium oxysporum*. *Macrophomina phaseolina* is an important pathogen at the California nursery. Soilborne nematodes are important pathogens at the Nebraska nursery. Most disease losses occur during the first growing season; effects by the end of the second growing season include reduced seedling density and adverse effects on seedling size, which seem related to density. Results at the test nurseries are summarized below:

Idaho Nurseries: at one nursery, seven treatments were evaluated on western white pine: dazomet fumigation, steam treatment, three fallow treatments (one without and two with different formulations of the biocontrol agent *T. harzianum*) and two winter *Brassica* (mustard and rape) green manure crops supplemented with formulations of *T. harzianum*. Seedling densities were statistically the same for all treatments except for reductions in the fallow treatment without biocontrol and the rape cover crop. Highest seedling densities occurred within fumigated plots and those fallowed and supplemented with the biocontrol agent. No significant differences in seedling heights were detected among the treatments. Seedlings in fumigated and steam-treated beds had significantly larger diameters

than those from other treatments. Dazomet fumigation is the current treatment of choice at the nursery. Fallowing with supplemental additions of biocontrol agents and steam treatments are possible satisfactory alternatives. At the other nursery, five treatments were evaluated on ponderosa pine: MBC, solarization, and three fallow treatments with periodic cultivation (one without supplement, one with thiram seed treatment, and the other with *T. harzianum* added at sowing). No statistical differences in seedling density among the five treatments were found. Seedlings produced in MBC-treated beds were significantly larger than those from other treatments. Fallowing and dazomet fumigation are not effective at this nursery and an efficacious alternative to MBC is not yet available.

Oregon Nursery: the treatment design involved three different grass cover crops (fescue, rye, and Sudan) and bare fallowing with or without irrigation upon which dazomet fumigation was superimposed. Five conifers were evaluated: western larch, Douglas-fir, ponderosa pine, lodgepole pine, and red fir. For western larch, no significant treatment effects on seedling density were found. For Douglas-fir, seedling densities were significantly greater in bare fallow with dazomet fumigation than any of the grass cover crop treatments. Seedlings were smaller in treatments with higher densities. For Douglas-fir, the best treatments were bare fallowing and rye or fescue cover crops followed by dazomet fumigation. For ponderosa pine, the best overall treatment was bare fallow with dazomet fumigation. For lodgepole pine, the best treatments were sudan grass cover crop and fallowing with dazomet fumigation. For red fir, the best treatments were rye or fescue cover crops with dazomet fumigation. The different conifer species did not respond the same to grass cover crops, fallowing, or dazomet fumigation. Dazomet is a viable alternative to MBC at this nursery.

California Nursery: four treatments were evaluated on ponderosa pine and red fir: MBC, dazomet, bare fallowing with periodic cultivation, and bare fallowing with frequent irrigation to keep seedlings cool. Pine seedlings grown under the dazomet and frequent irrigation treatments were significantly larger. Fir seedling diameters were statistically the same except those grown following MBC treatment, which were smaller. The bare fallow/frequent irrigation treatment produced significantly taller red pine seedlings. At this nursery, dazomet may be a viable alternative to MBC and frequent irrigation during hot weather is beneficial.

Nebraska Nursery: four treatments were evaluated on eastern redcedar: MBC, dazomet, bare fallowing with periodic cultivation, and solarization. There were no significant differences in seedling density among the four treatments. However, seedlings from beds treated with MBC had significantly larger diameters and greater heights than those from the other treatments. These other three treatments yielded approximately equal-sized seedlings. MBC is the treatment of choice at this nursery, primarily because of the impact of soilborne nematodes. No acceptable alternative to methyl bromide is yet available.