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An Evaluation of Dazomet and Metam-Sodium Soil Fumigants for Control of *Macrophomina phaseolina* in a Florida Forest Nursery

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Field trials with dazomet (Basamid®-Granular) and metamsodium (Busan®1020) soil fumigants were conducted under operational conditions in a Florida forest tree nursery for control of Macrophomina phaseolina *Tassi (Gold.), the causal agent of charcoal root rot. Both materials significantly reduced soil populations of the pathogen; dazomet appeared more effective than metam-sodium. Tree* Planters' Notes 45(3):91-95; 1994.

Forest tree nurseries in the United States are routinely fumigated (on varying schedules) with various formulations of methyl bromide and chloropicrin for control of soilborne pathogens, insects, and weeds (Boyer and South 1984, Cordell and others 1989, Dixon and others 1991, Fraedrich and Smith 1994, Kelley and Cordell 1984). In recent years, however, interest in alternative chemical soil fumigants has increased due to the costs, safety concerns, and possible environmental hazards associated with methyl bromide. Most recently, concerns regarding the ozone-depleting potential of methyl bromide have led the Environmental Protection Agency to ban production, importation, and use of methyl bromide in the United States by the year 2001 (EPA 1993), in accordance with the Clean Air Act (Civerolo and others 1993).

Dazomet (under such brand names as Basamid® and Mylone®) and metam-sodium (under such names as Vapam®, Soil-Prep®, and Busan®1020) are currently among the most popular and perhaps most promising chemical alternatives to methyl bromide. These materials have been tested in a number of North American forest tree nurseries, with varying results (Alspach 1989, Campbell and Kelpas 1988, Chapman 1992, Enebak and others 1990a and 1990b, Fraedrich and Smith 1994, Hildebrand 1991, Hildebrand and Dinkel 1988, Hoffman and Williams 1988, McElroy 1986, McIntyre and others 1990, Shugert 1989, Tkacz and Ramirez 1988).

Researchers often indirectly assess the suitability of soil fumigants for forest tree nurseries by evaluating crop production parameters such as seed germination and/or the survival and quality of seedlings grown in treated soils. A more direct method of evaluating fumigant efficacy is to assess pre- and posttreatment populations of soilborne pests. This method has been employed in several studies on the efficacy of dazomet and metam-sodium in forest tree nursery soil fumigation (Campbell and Kelpas 1988, Enebak 1990a, Hildebrand 1991, Hildebrand and Dinkel 1988a and 1988b, Hoffman and Williams 1988, McElroy 1986, Tkacz and Ramirez 1988). However, most of these trials have been limited to assessments of *Fusarium, Pythium*, and nematode populations.

In the South, especially in Florida, *Macrophomina phaseolina* (Tassi) Goid., the causal agent of charcoal root rot and a factor in the development of black root rot (together with *Fusarium* spp. and, possibly, nematodes), has been and still is considered a problem in some forest tree nurseries (Barnard and Gilly 1986, Fraedrich and Smith 1994, Hodges 1962, Rowan 1971, Seymour and Cordell 1979, Smith and others 1989). The labeling for Basamid®-Granular lists *M. phaseolina* among the organisms against which it is active. However, we were (and are) unaware of any published data comparing pre- and postfumigation populations of *M. phaseolina* in forest tree nursery soils operationally treated with dazomet or metam-sodium. Accordingly, we conducted two field trials to evaluate the relative efficacy of Basamid® Granular (dazomet) and Busan®1020 (metam-sodium) soil fumigants for control of *M. phaseolina* under operational conditions at the Florida Division of Forestry's Andrews Nursery. This paper summarizes our results.

Materials and Methods

Field trials were conducted in 1988 and 1989. The Andrews Nursery was selected for study due to its history of *M. phaseolina*-related root disease. Trials were established in seedbeds where losses of loblolly pine *(P. taeda* L.) seedlings due to charcoal root rot were severe in 1987.

In 1988, test seedbeds were disced, and on July 7 prefumigation soil samples were collected. Samples were taken from each of 18 plot centers, with 6 plot centers for each of 3 treatments. Plot centers were distributed linearly at 8.1-m (26.6-ft) intervals along the length of 3 parallel seedbeds (1 seedbed per treatment). Each sample consisted of composites of 10 2.5- by 10-cm (1- by 4-in) soil cores collected at random around each plot center (1 composite sample for each plot center).

On July 8, the study area was preirrigated for 1 hour (from 7 to 8 a.m.). With irrigation continuing, metam sodium was then applied to one set of 6 plots at 467.3 L/ha (50 gal/acre) and to another set of 6 plots at 934.6 L/ha (100 gal/acre). A tractor-drawn sprayer was used, operating at 2.9 kg /cm^2 (40 lb/ in^2) of pressure. For about 1 hour (from 8 to 9 a.m.). The third set of 6 plots were irrigated but left untreated, as a check. Irrigation was continued for about 1 to 2 hours after treatment. Thus there was continuous irrigation from 7 to 10 a.m., and fumigant application from 8 to 9 a.m. In the afternoon, irrigation was resumed for an additional hour (from 2 to 3 p.m.). On July 20, 12 days after fumigation, posttreatment soil samples were taken in the same manner as for pretreatment samples.

On May 17, 1989, test seedbeds were disced, and on May 18 prefumigation samples were collected as described above. Treatment plots were 2.4 by 4.6 m (8 by 15 ft) in size, with 8 replicates for each of 3 treatments. Plots were deployed in a randomized complete block design, and samples were taken around each of the 24 plot centers. The study site was then periodically irrigated during the week of May 22 to ensure adequate soil moisture.

On May 26, a hand-held applicator was used to apply dazomet soil fumigant at 392.5 kg/ha (350 lb/ acre) to one set of 8 plots. A tractor-drawn rototiller was then used to incorporate the fumigant into the soil. On the evening of May 30, metam-sodium was "chemigated" at 373.8 L/ha (47 gal/acre) onto another set of 8 plots using the nursery's irrigation system. During chemigation, the 8 dazomet plots and the 8 check plots were covered with polyethylene tents. On June 13, posttreatment soil samples 0-10 cm (0-4 in) deep were collected, and on June 26, a second set of samples 0 to 15 cm (0 to 6 in) deep were collected.

All soil samples were immediately carried to the laboratory and assessed for *M. phaseolina* as described by Barnard and others (1995), following procedures developed by McCain and Smith (1972). Comparative populations of the fungus were evaluated on the basis of colony-forming units (CFU) per gram of air-dried soil. Data were subjected to ANOVA, and differences among treatment means were analyzed by comparing these differences to calculated least significant differences (LSD's) at P # 0.05 (Snedecor and Cochran 1967).

Results and Discussion

In the 1988 trial, metam-sodium significantly (P # 0.05) reduced soil populations of *M. phaseolina* (figure 1). However, differences between the two rates of application were not significant, and in neither treatment was the pathogen completely eradicated from treated soils. In the 1989 trial, both dazomet and metam-sodium significantly reduced *M. phaseolina* populations (figure 2). Soils treated with dazomet were almost pathogen-free, but due to the high level of variability among individual samples, differences between soils treated with dazomet and those treated with metam-sodium were not statistically significant (P # 0.05).

Our data indicate that both materials show promise as alternatives to methyl bromide for the control of *M. phaseolina,* and that dazomet appears somewhat more effective than metam-sodium. However, these data should be treated with caution in view of their limited applicability. Different results may and undoubtedly will be obtained when other methods and rates of application are used, and where soil types, temperatures, and moisture content are different. Nonetheless, the results of these trials are encouraging, especially in light of the fact that *M. phaseolina* typically survives in soil by means of potentially fumigation-resistant microsclerotia (Barnard and Gilly 1986, Seymour and Cordell 1979, Smith and others 1989).

Since 1989, both metam-sodium and dazomet have been employed operationally as soil fumigants for certain crops in compartments of the Andrews Nursery, with no significant adverse effects. Other forest nurserymen in Florida have conducted trials with dazomet, and no major biological drawbacks to its use have emerged from these studies that we know of to date. In a recent field trial, we found dazomet to be as effective as methyl bromide, if not more so, in reducing soil populations of *Fusarium* and *Pythium* spp. *(M. phaseolina* was not detected; Barnard and others 1992). However, some forest nursery managers have found dazomet less effective than methyl bromide in controlling weeds, especially nut sedges *(Cyperus* spp.*)* (Fraedrich and Smith 1994). Nonetheless, our data should encourage forest nursery managers facing the

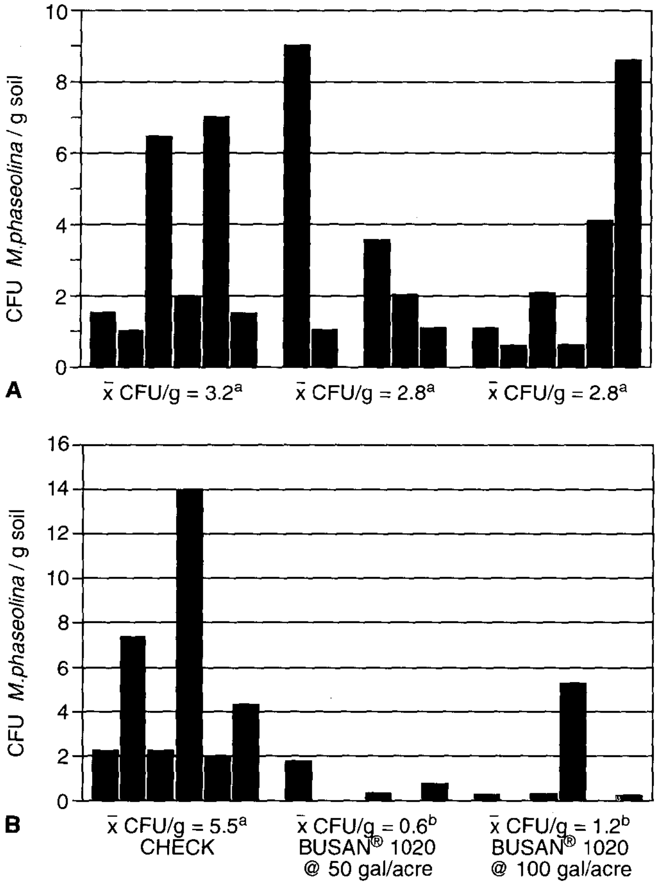

Figure 1—*Colony-forming units (CFU) of* Macrophomina phaseolina *in soil from a Florida forest nursery before (on July 7, 1988 [**A**]) and after (on July 20, 1988 [**B**]) treatment with Busan®1020 (metam-sodium) soil fumigant. Each bar represents an individual soil sample. Within sample dates, treatment means ($\bar{x}$) accompanied by the same letter do not differ significantly ($P \leq 0.05$).*

loss of methyl bromide as a soil fumigant. We recommend additional field trials and experimentation.

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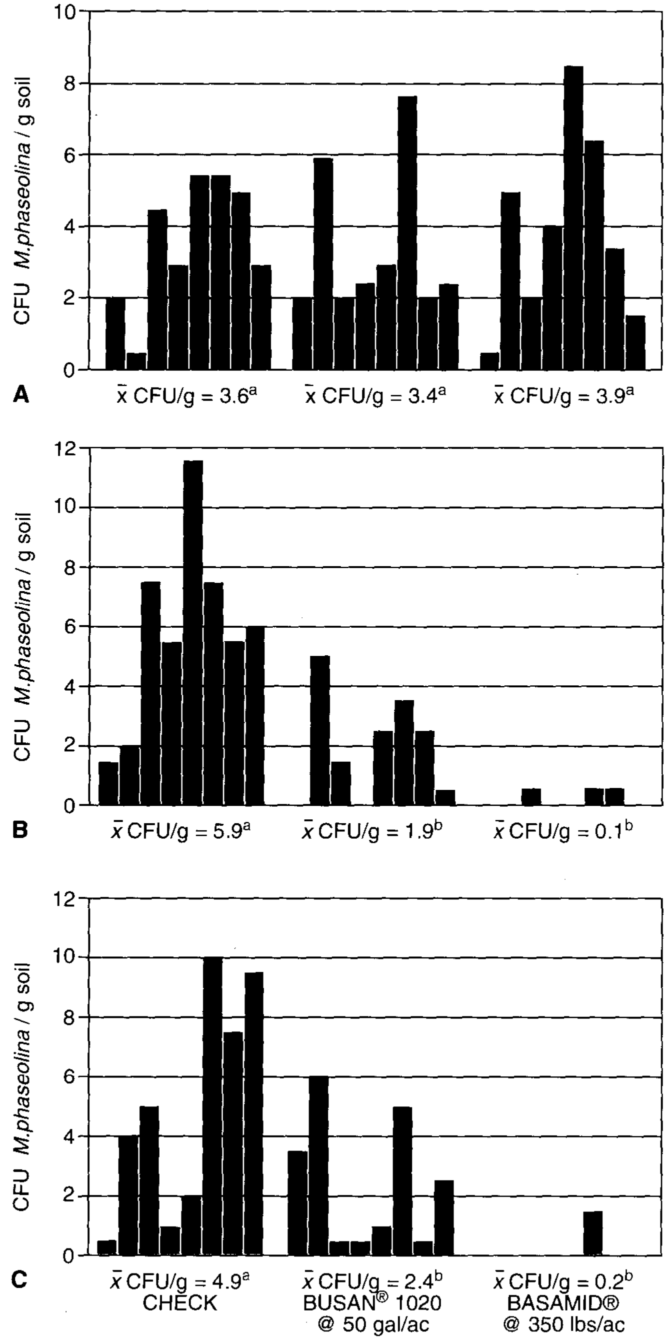

Figure 2—*Colony-forming units (CFU) of* Macrophomina phaseolina *in soil from a Florida forest nursery before (on May 18, 1989 [**A**]) and on 2 dates after (June 13 [**B**] and June 26, 1989 [**C**]) treatment with Busan®1020 (metam-sodium) and Basamid®-Granular (dazomet) soil fumigants. Each bar represents an individual soil sample. Within sample dates, treatment means ($\bar{x}$) accompanied by the same letter do not differ significantly ($P \leq 0.05$).*

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