Organic Soil Amendments as Potential Alternatives to Methyl Bromide for Control of Soilborne Pathogens in Forest Tree Nurseries

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Abstract—In a multi-year project, pine seedlings are being grown in nurseries in Florida and South Carolina to evaluate the effects of organic amendments on the development of disease and potential management of plant pathogens over time without the use of soil fumigants. Seedling survival, plant quality and outplant performance are being evaluated. The study in South Carolina is currently in its first year and the study in Florida is midway through its second year. Although pathogenic fungi, including species of Fusarium, Macrophomina, Pythium, and Rhizoctonia, and plant parasitic nematodes (Mesocriconema, Paratrichodorus, and Tylenchorenchus spp.) have been detected, no serious disease development has been observed. At the end of the first growing season in the Florida nursery, seedlings from fumigated plots were taller than plants from control plots. The sizes of seedlings from amended plots, however, did not differ from sizes of plants from either fumigated or control plots.

Keywords: pine bark, compost, Pinus elliottii var. elliottii Engelm., Pinus taeda L.

INTRODUCTION

Over the past several decades, forest tree nurseries, like many agricultural production systems, have relied primarily on fumigation with methyl bromide for the management of soilborne plant pathogens and other pests. The planned elimination of the use of methyl bromide in the near future has emphasized the need to evaluate other potential pest management strategies (Civerolo, et al. 1993). The Technology Development Project reported on herein is funded by the U.S. Forest Service (Region 8, Forest Health) to evaluate the comparative development of disease and the potential management of soilborne pathogens in forest tree nurseries without the use of fumigants and with the addition of organic amendments to the soil. The effects of soil organic amendments on plant pathogens and on the control or suppression of disease have been reviewed by Hoitink and Fahy (1986). Organic amendments have been shown to control by chemical inhibition of pathogens and by antagonism or suppression of pathogens by organisms associ-

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ated with or favored by the organic amendments. In the present study, pine seedlings are being grown under standard nursery conditions in Florida and South Carolina in soils receiving no treatment (control), methyl bromide treatment, pine bark amendment, and aged or composted organic amendments. The study is in its initial year in South Carolina and in the second year in Florida.

MATERIALS AND METHODS

Field tests were initiated in May 1993 in a slash pine *(Pinus elliottii* var. *elliottii* Engelm.) nursery compartment at the Florida Division of Forestry's Andrews Nursery in Chiefland, Florida. Soil treatments in-cluded an application of methyl bromide (67% methyl bromide plus 33% chloropicrin) at 392 kg/ha (350 lbs/A), pine bark, composted yard waste, and a control without treatment. Each organic amendment was applied in a 2.5- and 5.0-cm-thick layer with a manure spreader and tilled into the soil to a depth of 15-20 cm. Plots were arranged in a split block design with four replications of each treatment. Each plot was three seedbeds wide by 36.6 m (120 ft) long, and plots were separated by fumigated buffer areas. Seed-ling stand counts were made in three permanent subplots (31 cm x 123 cm) that were established approximately 123 cm apart in the center of the middle bed of each plot. Soil samples were taken from each plot prior to treatment, at planting, and when seedlings were lifted. Each soil sample consisted of a bulk of 20 cores (2.5-cm-diam) from the top 15 cm of soil. Soil dilutions were plated in potato dextrose agar amended with 1 ml Tergitol NPX, 0.1 g streptomy-cin sulfate, and 0.5 g chlortetracycline hydrochloride per liter (Steiner and Watson 1965) to establish background fungal counts and in 1/10th-strength tryptic soy agar plus 50 mg cycloheximide per liter to quantify bacteria and actinomycete populations. The following media were used to isolate specific plant pathogenic fungi: Komada's medium for *Fusarium* spp., *Phytophthora* selective medium (PAR) for species of *Pythium* and *Phytophthor*a, tannic acid benomyl agar (with 2 mg metalaxyl / L substituted for pyroxychlor) for *Rhizoctonia* spp., and *Macrophomina* semi-selective medium (MP) for the isolation of *Macrophomina phaseolina* (Singleton, Mihail and Rush (eds.) 1992). Standard chemical soil nutrient analyses and nematode assays also were performed.

Plant samples were taken from each plot 3 wk after planting (40 seedlings per plot), at midseason (10 seedlings per plot) and at lifting in Jan. 1994 (10 seedlings per plot). Whole small seedlings or roots and stems of larger plants were plated on potato dextrose agar amended with 0.1 ml Tergitol NPX, 0.25 g ampicillin and 0.01 g rifampicin per liter to deter-mine the fungi associated with plants from the various treatments. Additional seedlings were taken to measure plant growth parameters and for chemical tissue analyses. Seedlings exhibiting disease symptoms also were examined and plated on selective media as they were observed. Fungi isolated from plants are being evaluated in growthroom tests to determine their pathogenicity.

To assess their field survival and growth, seedlings from the various treatments were planted on an operationally cutover and bedded, flatwood forest site. Fifty seedlings from each plot were planted at a 1.23 x 3.1 m (4 x 10 ft) spacing in each of three replicated rows at the outplanting site. Plant growth will be evaluated on a yearly basis.

This year the project is continuing at the Andrews Nursery with the same treatments superimposed on the plots. Sampling is being conducted as described for 1993. A similar trial has been established in 1994 at the International Paper Company Nursery in Bleinheim, SC. In this nursery, the study was initiated with loblolly pine (P. *taeda* L.) in a field in the third consecutive year of production following fumigation. Treatments are fumigation with methyl bromide, 2.5 cm of pine bark, 2.5 cm of aged hardwood bark (bark was piled on site for 4 mo), and a nontreated control. Amendments were applied as described above. Plots were three plant beds wide by 12.2 m (40 ft) long. Plant survival and growth characteristic will be measured. Seedling samples will be plated at midseason (August) and at the time of lifting (December) to determine the fungi associated with the plant roots.

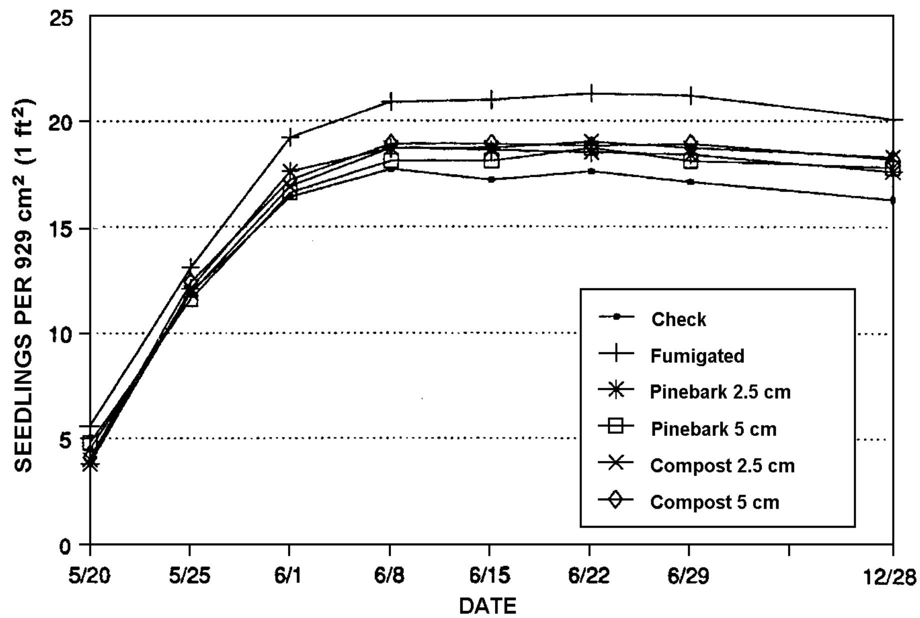

Figure 1. Slash pine seedling density over time at Andrews Nursery, Chiefland, Florida in 1993. Numbers of plants in fumigated plots were significantly greater (P<0.05) than in control plots. Plant densities in plots with organic amendments did not differ from those in either the fumigated or control plots.

RESULTS AND DISCUSSION

Plant pathogenic fungi deTected by soil plating and isoLated from seedling roots from the 1993 study at Andrews Nursery include: *Pythium myriotylum, Athelia rolfsii, Macrophomina phaseolina, Fusarium* spp., *Rhizoctonia* sp., *Phoma* sp., *Alternaria* sp., and *Aspergillus* sp. Ring *(Mesocriconema* spp.), stubby root *(Paratrichodorus* spp.), and stunt *(Tylenchorenchus* spp.) nematodes also were detected in soil from Andrews Nursery. Despite the detection of these potential plant pathogens little disease was observed in the field after the first year of the study. Seedling densities in each treatment remained fairly constant from June to the end of the growing season (Fig. l). After the completion of germination, seedling density was significantly greater in the fumigated treatments than in the nontreated

Table 1. Effects of soil treatments in 1993 on slash pine seedling morphology at the time of lifting at Andrews Nursery in Chiefland, Florida.

Treatment	Height [a] (cm)	Stem [a] Diameter (mm)	Dry Weight [b] Shoots	Roots	SR [c]
Check	19.5 x [d]	4.6 x	5.8 x	2.4 x	2.4 x
Fumigated	25.2 y	4.9 x	7.1 x	2.5 x	2.9 x
Pine bark 2.5 cm	21.8 xy	4.5 x	6.0 x	2.2 x	2.8 x
Pine bark 5 cm	22.5 xy	4.4 x	6.0 x	2.4 x	2.4 x
Compost 2.5 cm	23.6 xy	4.7 x	7.0 x	2.4 x	2.9 x
Compost 5 cm	21.1 xy	4.6 x	5.6 x	2.2 x	2.5 x

[a] Value is an average from 50 seedlings.
[b] Value is an average from 20 seedlings.
[c] Represents the ratio of average dry shoot weight to average dry root weight.
[d] Values followed by the same letter are not significantly different (P<0.05).

controls ($P< 0.05$), while there were no differences among plant densities in amended treatments and those from either the fumigated or the control plots.

When plant growth parameters were compared at the end of the season (Table 1.), plants from the fumigated treatment were taller than all other plants except those from the treatment with 2.5 cm of composted yard waste ($P< 0.05$). Seedlings in plots with 5 cm of pine bark and 2.5 cm of composted yard waste also were taller than the control seedlings. No differences were observed in stem diameters, shoot weights, root weights, or the shoot/root ratios among plants from any of the treatments.

These field tests for the evaluation of the development of disease without the use of soil fumigation have been established in areas that already had been in plant production without fumigation for several years to increase the likelihood of detection of plant pathogen populations that may already have started to build up. The study will be continued over several years to simulate what may happen over time without fumigation and to assess the long term effects that organic amendments may have on any developing disease problems caused by soilborne plant pathogens. Results also may be useful in assessing the economic feasibility of using organic amendments in the large scale production of pine seedlings.

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