Auburn University Southern Forest Nursery Management Cooperative

RESEARCH REPORT 98-2

PINE SEEDLING PRODUCTION AS AFFECTED BY FUMIGATION AND PLANT GROWTH PROMOTING RHIZOBACTERIA AT A GEORGIA NURSERY

by
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INTRODUCTION

Although methyl bromide (MBr) fumigation satisfactorily controls most soil-born pests at southern forest seedling nurseries its use may be withdrawn or limited after the year 2,000. Alternative fumigants usually have less activity against some category of pests (weeds, nematodes or pathogens) controlled by MBr and their efficacy will vary between nurseries depending on the relative importance of endemic problems. It may be possible to enhance seedling growth without chemical treatments. Plant growth promoting rhizobacteria (PGPR) applied as seed treatments have promoted growth and controlled some soil-born pathogenic fungi on forestry species (Chanway, 1997). This report summarizes seedling production and differences between selected soil fungi (*Trichoderma* and *Fusarium*) and weeds for two 1-0 loblolly and slash pine seedling crops after a single fumigation.

METHODOLOGY

The fumigants, MC2 (300 lbs/ac 98% MBr 2% chloropicrin), and chloropicrin (300 lbs/ac) were each applied to a one third section of two blocks on February 16, 1996 and the remaining (middle) third was not fumigated. On April 9, 1996, seed from four half-sib seedlots of loblolly and from four of slash pine were removed from stratification and half of each was treated with a PGPR preparation of *Burkerholdia cepecia* at the rate of 0.3 ml bacteria per gram of seed. On April 1, 1997, the same PGPR preparation was applied to seed from three of the same loblolly families and to two of the same slash families as in 1996 plus a previously not treated slash family. PGPR treated and not treated of each family was sown in each fumigation treatment. Seedling development was assessed October 1996 and November 1997. Seedbed densities were assessed within two 1-foot-wide frames across beds (4 ft^2) within each fumigation by seedlot by PGPR

treatment. Weeds were counted when seedbed densities were assessed. Each fall, the center six drills of each seedbed density plot were harvested and 25 seedlings were randomly selected from each. Root collar diameters (RCD) were measured before tops were separated from roots, oven dried, and weighed.

Fumigation effects on soil fungi in the genera *Trichoderma* and *Fusarium* were assessed as colony forming units (cfu's) / gm soil at three and eight months after fumigation. Soil samples were bulked by treatment across three transects and 0.005 gm subsamples, in 2% water agar, transferred to selective media.

RESULTS AND DISCUSSION

With the exception of initial seedbed density (35 days after sowing) no measured parameters differed ($\alpha \leq 0.05$) by PGPR treatment. Initial seedbed densities differed between treated and not treated seeds for slash but not lob in 1996 and for lob but not slash in 1997. Final seedbed densities did not differ (by PGPR) and initial seedbed densities may reflect changes in germination rate.

Seedling production by fumigation treatment is presented in Table 1. Treatments improved mean RCD, stem weights per bed foot, and numbers of grade one seedlings (RCD > 4.7 mm) in the first crop after fumigation for both species. At the second harvest, only seedling weights differed among lob seedlings and chloropicrin plots produced the largest seedlings. Second crop RCD's no longer differed among lobs but a strong ($p=0.01$) positive ($r=0.81$) correlation to first year treatment by family means continued. Among slash seedlings, RCD's differ both years and were positively correlated ($r=0.72$, $p=0.03$). Slash seedlings were heaviest in MBr plots.

In May 1996, there were fewer weeds in MBr than chloropicrin fumigated plots (0.5 vs 5.6 / 4 ft^2). By November that year, most of these weeds appeared to have been eliminated by post emergent herbicides. However, by October 1997 weed numbers, and differences between treatments were again similar to initial counts with MBr plots containing fewer weeds than chloropicrin plots (0.25 vs 5.9 / 4 ft^2). Final weed numbers (Oct. 1997), in spite of regular herbicide treatments, were very similar ($r=0.87$, $p=0.02$) to initial counts (May 1996).

Data for soil fungi are presented in Table 2. More cfu's of *Trichoderma* were recovered from fumigated than not fumigated soils at both 87 and 235 days after treatment. Similar increases have been common after MBr or chloropicrin fumigation at forest tree nurseries and for other crops. *Trichoderma* is associated with the biological control of several plant diseases and is considered beneficial for nursery seedlings (South and others 1997).

Cfu's of *Fusarium* decreased with either fumigant and remained low through October 1996, however, by October there were increases among chloropicrin compared to MBr fumigated plots. *Fusarium* is a common plant pathogen often associated with damping-off in pine nurseries. The effects of either fumigant on this fungus should help control damping-off.

MANAGEMENT IMPLICATIONS

This study indicates that chloropicrin substitutes adequately for MBr for some but not all of its normal fumigation benefits. Both fumigants enhanced seedling growth during the first crop and influenced the monitored soil fungi, particularly *Trichoderma*, similarly. Chloropicrin did not (as usual) give the weed control associated with MBr and this could become more serious with subsequent crops depending on the effectiveness of available herbicides for the endemic weeds. There was no indication that seed treatments with the tested PGPR enhanced seedbed densities, seedling rcd's, or biomass.

ACKNOWLEDGMENTS

Hendrix and Dail, Inc. applied the fumigants to the experimental design; Rayonier provided and sowed seed and did all standard practices for both crops.

LITERATURE CITED

Chanway, C. P. 1997. Inoculation of tree roots with plant growth-promoting soil bacteria: An emerging technology for reforestation. For. Sci. 43:99-112.

South, D. B., W. A. Carey, and S. A. Enebak. 1997. Chloropicrin as a soil fumigant in forest nurseries. The Forestry Chronicle 73-4: 489-494.

Table 1. Effects of fumigation in 1996 on two years of loblolly and of slash pine seedling production at a Georgia nursery.

			Seedlings Parameters		Stems/ft^2 by rcd class		
Pine	Year	Fumigant[a]	rcd(mm)	weight(gm)[†]	all	>3.2mm	>4.7mm
Lob	96	None	5.1a	36a	9.3a	8.9a	6.4a
		MBr	5.5ab	51 b	13.5 b	13.4 b	11.5 b
		Chloropicrin	6.0 b	52 b	11.0ab	10.9ab	9.8 b
	97	None	4.3a	49a	13.3a	12.0a	3.9a
		MBr	4.5a	50a	13.7a	12.2a	4.5a
		Chloropicrin	4.5a	63 b	15.1a	13.5a	5.5a
Slash	96	None	4.9a	46a	14.9a	14.1a	8.7a
		MBr	6.0 b	61 b	14.1a	13.8a	11.5 b
		Chloropicrin	5.5ab	58ab	14.2a	13.8a	10.3ab
	97	None	5.4a	65a	13.6a	12.7a	9.6a
		MBr	5.8ab	78 b	13.6a	12.9a	9.7a
		Chloropicrin	6.0 b	73ab	12.2a	11.8a	9.2a

† This is dry weight of seedling stems /ft^2 of nursery bed.

Table 2. Fungal populations after a February 16 fumigation at a Georgia nursery.

		cfu's[†] / 0.1 gm soil by days after fumigation	
Fungal Genus	Treatment	87 after	235 after
Trichoderma	None	121a	136a
"	MBr	237 b	250 b
"	Chloropicrin	254 b	206 b
	lsd	*36*	*46*
Fusarium	None	119a	116a
"	MBr	16 b	16 b
"	Chloropicrin	6 b	59 c
	lsd	*26*	*32*

†From 1:200 dilutions.