FIVE YEARS OF METHYL BROMIDE ALTERNATIVES RESEARCH IN FOREST TREE NURSERIES

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Since 2007, the Southern Forest Nursery Management Cooperative at Auburn University has evaluated methyl bromide (MBr) alternatives using various rates and plastics in large-scale nursery demonstrations across the southern US (Table 1). Area-wide trials have been completed at forest tree nurseries in Jesup, GA (2007), Glennville, GA (2007 & 2010), Blenheim, SC (2008), Trenton, SC (2008), and Elberta, AL (2009) with two trials currently being monitored in Camden, AL (2009 & 2010). Each trial spanned two to three growing seasons with emphasis on determining which MBr alternatives would work best in producing plantable seedlings using each nursery's standard operational practices. The trials were a randomized complete block design with four replications of each fumigation treatment. Loblolly pine (*Pinus taeda*) seedling quality was determined by measuring seedling density, root collar diameter, and root morphology along with levels of soil-borne fungi, nematodes, and weeds. The following report summarizes the observations from each MBr alternative tested based on completed and current USDA-ARS South Atlantic Region Area-wide trials.

Pic +®: The soil fumigant Pic +® is composed of 85% chloropicrin and 15% solvent. When applied at 300 lb/acre, Pic +® has been one of the best soil fumigant alternatives tested, consistently producing quality loblolly pine seedlings and reducing soil-borne nematodes, pathogens and some weeds while providing beneficial *Trichoderma* levels. At Glennville, GA, Pic +® at 100 lb/acre produced fewest number of cull seedlings and the largest root diameters compared to other soil treatments under low density polyethylene (LDPE). However, at Camden, AL in 2010, Pic +® at 150 lb/acre under totally impermeable film (TIF) resulted in a reduction in seedling density after the first growing season (Table 2).

Chloropicrin: Soils fumigated with 100% chloropicrin at 300 lb/acre under high density polyethylene (HDPE) produced loblolly pine seedlings similar to MBr treatments. However, using chloropicrin at 100 lb/acre under LDPE reduced seedling quality by producing 36% cull seedlings at Glennville, GA. At Camden, AL the lower rate of 250 lb/acre under TIF produced seedlings similar to MBr by the end of the second season. These results show that lower rates of chloropicrin under TIF can be used and still produce seedlings comparable to higher rates of chloropicrin under HDPE.

DMDS + Chlor (Paladin®): The compound DMDS + Chlor is composed of 79% dimethyl disulfide and 21% chloropicrin. Loblolly pine seedlings grown in soils treated with DMDS + Chlor were similar to those grown using MBr. This soil fumigant also provided some control of soil-borne pathogens, nematodes and weeds. However, nursery managers are hesitant to use DMDS + Chlor due to a significant odor problem that persists in the soil throughout the growing season.

Chlor 60: Chlor 60 is composed of 60% chloropicrin and 40% 1, 3 dichloropropene. The fumigant has performed comparatively well to MBr treatments for producing quality loblolly pine seedlings, however, nutsedge (*Cyperus* spp.) control is lacking. Nursery managers that have a nematode problem at their nursery may choose to fumigate with Chlor 60 rather than Pic +, 100% chloropicrin, or DMDS + Chlor if nutsedge is not an issue.

New Pic +: The soil fumigant New Pic + contains 85% chloropicrin and 15% solvent and is a re-formulation of Pic +®. New Pic + was tested at both Jesup, GA and Glennville, GA and produced similar seedling characteristics, control of nematodes and soil-borne pathogens, and promotion of *Trichoderma* to that of Pic +®. However at Glennville, New Pic + did not control annual sedge (*Cyperus compressus*), which became an issue. Consequently, New Pic + was dropped as a soil fumigant from further trials.

Midas®: Two formulations of Midas® (methyl iodide plus chloropicrin) are currently being tested at Camden, AL. At the end of the first growing season, seedling densities were below the nursery target density. The Midas® 98/2 treatment resulted in 43% cull seedlings, indicating a significant decrease in seed efficiency (Table 3). Further monitoring of the current trial is necessary before an adequate evaluation can be made on the efficacy of this compound. Due to limitations set by the distributor, the availability of methyl iodide for testing and further evaluation in forest tree nurseries will be difficult.

Summary

Results from the Area-wide trials indicate that some MBr alternatives could be used in forest tree nurseries. The most efficacious alternative fumigants are those with higher levels of chloropicrin (i.e. 100% chloropicrin, Pic +®, DMDS + Chlor, Chlor 60). However, the long-term use (multiple rotations) of any MBr alternative may result in unknown pest issues. An increase in the use of pesticides will be required to compensate for any MBr alternative short falls, especially for controlling weeds. An MBr alternative that works in one nursery may not work in another nursery, which is why managers must be diligent in identifying the best alternative for growing forest tree seedlings in their nursery.

Table 1. MBr alternatives, rates and plastics used, and number of Area-wide demonstration trials conducted over the last five years in southern forest tree nurseries.

MBr Alternative	Components	Rate (lbs/acre)	Plastic	# of Trials
Chloropicrin	100 % chloropicrin	100	VIF	1*
		150	TIF	1
		200	LDPE	1*
		250	TIF	1
		300	HDPE	6
Pic +®	85% chloropicrin + 15% solvent A	100	VIF	1*
		150	TIF	1
		200	LDPE	1*
		250	TIF	1
		300	HDPE	6
Chlor 60	60% chloropicrin + 40% 1,3 dichloropropene	100	VIF	1*
		150	TIF	1
		150	HDPE	1*
		200	LDPE	1*
		250	TIF	1
		250	HDPE	1*
		400	HDPE	6
New Pic +	85% chloropicrin + 15% solvent B	300	HDPE	2
DMDS + Chlor (Paladin®)	79% DMDS + 21% chloropicrin	731	HDPE	6
Midas® 98/2	98% methyl iodide + 2% chloropicrin	100	VIF	1
Midas® 50/50	50% methyl iodide + 50% chloropicrin	160	VIF	1

* The USDA-ARS low disturbance coulter injection rig was used in these trials. All other trials used a standard shank injection rig.

Table 2. Seedling density, root collar diameter (RCD), and number of new root tips at the end of the first growing season (2010) in the current Area-wide trial fumigated in 2010 at Camden, AL.

Trial Design				Loblolly Pine Seedling Quality		
Fumigant	**Components**	**Plastic**	**Rate (lbs/acre)**	**Density (ft^2)**	**RCD (mm)**	**# Root Tips**
MBr 80:20	80% MBr + 20% chloropicrin	TIF	150	20 abc*	4.08 abc	483 bc
			250	22 abc	3.96 bcd	586 ab
Chloropicrin	100% chloropicrin	TIF	150	18 c	4.47 a	612 a
			250	19 bc	4.34 ab	514 abc
Pic +®	85% chloropicrin + solvent A	TIF	150	18 c	4.19 abc	492 bc
			250	24 ab	4.01 bcd	520 abc
Chlor 60	60% chloropicrin + 40% 1,3 dichloropropene	TIF	150	21 abc	4.23 abc	541 ab
			250	21 a	3.99 bcd	563 ab
		HDPE	150	24 a	3.60 d	358 d
			250	23 abc	3.85 cd	419 cd

* Means (within a column) followed by the same letter are not significantly different based on Duncan's Multiple Range Test ($p \leq 0.05$).

Table 3. Percentage of plantable and cull seedlings produced at the end of the second growing season (2010) in the current Area-wide trial fumigated in 2009 at Camden, AL.

Trial Design				Loblolly Pine Seedling Quality	
Fumigant	**Components**	**Plastic**	**Rate (lbs/acre)**	**Plantable seedlings (%)**	**Cull seedlings (%)**
MBr 67/33	67% MBr + 33% chloropicrin	HDPE	350	73	27
Chloropicrin	100% chloropicrin	HDPE	300	75	25
Chlor 60	60% chloropicrin + 40% 1,3 dichloropropene	HDPE	400	80	20
Pic +®	85% chloropicrin + 15% solvent A	HDPE	300	76	24
MBC 70/30	70% MBr + 30% chloropicrin	HDPE	400	70	30
DMDS + Chlor (Paladin®)	79% dimethyl disulfide + 21% chloropicrin	HDPE	731	82	18
Midas® 98/2	98% methyl iodide + 2% chloropicrin	VIF	100	57	43
Midas® 50/50	50% methyl iodide + 50% chloropicrin	VIF	160	74	26