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Effect of Wrapping on Movement of Chloropicrin, Vapam, and Vanicide TH in Southern Pine Timbers

By

Terry L. Highley

Forest Products Laboratory, Madison, WI, U.S.A. 53705-2398

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Terry L. Highley[1]
Forest Products Laboratory, Madison, WI, U.S.A. 53705-2398

SUMMARY

Important fungi that decay wood products were "inoculated" into Donpressure-treated southern pine timbers as vapor-senring agents to evaluate the effect of wrapping on the movement and persistence of fungitoxic concentrations of chloropicrin, Vapam, and Vanicide TH in the timbers. Fumigant movement and persistence in the timbers was enhanced by wrapping the timbers in polyethylene after fumigation. Chloropicrin moved fastest and exhibited the highest fungitoxicity at the greatest distance from the treatment center (CL). Almost 100% of fungal cultures implanted into chloropicrin-treated timbers died up to 1.22 m (4 ft) from CL by 4 months after treatment. Vapam was the next best with good fungitoxicity at 0.61 m (2 ft) from CL within 4 months; most cultures were killed at 1.22 m from CL by 8 months. Vanicide TH killed most cultures at 0.30 m (1 ft) from CL by 4 months and at 0.61 m from CL by 8 months. Fungitoxicity of Vanicide TH at 1.22 m from CL was variable. By 12 months, fungitoxicity decreased for all treatments, although chloropicrin and Vapam continued to kill all cultures at 0.30 q from CL. Bioassay of cores extracted from chloropicrin-and Vapam-treated timbers at 12 and 24 months exhibited a fungistatic effect at 0.30, 0.61, and 1.22 m from CL. Cores from Vanicide TH-treated timbers exhibited little fungistatic effect at 12 months but good fungistatic effect up to 0.61 m from CL at 24 months.

Key words: Fumigation, southern pine, decay fungi, chloropicrin, Vapam, Vanicide TH

INTRODUCTION

We have been investigating the use of fumigants for remedial control of decay in large, horizontally oriented Douglas-fir and southern pine timbers (Eslyn and Highley, 1985; Highley 1986, 1987; Highley and Eslyn, 1982, 1986). Fumigants have shown less longitudinal movement and persistence in nonpressure-treated southern pine and Douglas-fir timbers compared to pressure-treated Douglas-fir timbers. We felt that pressure treatment might retard escape of the fumigants from wood, and therefore fumigants may escape from nonpressure-treated timbers before they have an opportunity to move through the wood (Highley and Eslyn, 1986). The purpose of this study was to determine if wrapping timbers to minimize escape of fumigants would enhance movement and persistence of thefumigants.

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MATERIALS AND METHOOS

Efficacy of fumigants to move through timbers was evaluated by open- and closed-tube bioassays previously described (Highley, 1987; Highley and Eslyn, 1986; Scheffer et al., 1982).

Preparation of Test Timbers

Twelve southern pine timbers, 15.2-cm x 15.2-cm x 4.26-m, were brushed with 5% sodium pentachlorophenoxide. A cluster of holes (each hole 2.54 cm in diameter and 13 cm deep) was drilled in the upper surface about the center (CL) of each timber for containment of fumigants. The number of treatment holes varied according to the amount of fumigant applied to a given timber.

On the opposite face from fumigation holes, three sets of four holes each were drilled at distances of 0.30, 0.61, and 1.22 m from CL in both directions. These inoculation holes were 3.80 cm deep. A screwtop test tube cap with a hole drilled in the center was glued into each of the inoculation holes. The timbers were wrapped in polyethylene (6 mil).

Preparation of Inoculum

The following eight important wood-decay fungi were used as test organisms: Poria placenta (Fr.) Cke. (MAD-6981, Poria carbonica Overh. (MD-141), Lentinus lepideus Fr. (MAD-5341, Poria xantha (Fr.) Cke. (MAD 5096-35), Antrodia serialis Fr. (FP-104443-sp.), Fibroporia vaillantii (DC:Fr.) Parm. (FP-90877-R), Serpula incrassata (Berk. & Curt.) Donk (W-563), and Gloeophyllum trabeum (Pers.:FR.)Murr. (MAD-617).

Screwtop tubes (16- x 125-mm) containing malt agar were inoculated with one of the eight test fungi and incubated until growth was well established. A white pine stick (0.47- x 0.47- x 2.54-cm), previously soaked in distilled water and steam sterilized, was placed into each tube. The tubes were incubated again until the fungi became established in the sticks.

Inoculation of Timbers

Screwtop test tubes containing pine sticks decayed by test fungi over malt agar were screwed into the caps glued into the inoculation holes. Each of the four holes in one set, i.e. 0.30-, 0.61-, or 1.22-111left ana right of midcenter, received a different fungus. For example, at 0.31, 0.61, and 1.22 m to the left of midcenter, the first hole was inoculated with Poria placenta, the second with Poria carbonica, the third with Lentinus lepideus, and the last with Poria xantha. In the same order to the right of midcenter, holes were inoculated with Antrodia serialis, Fibroporia vaillantii, Serpula incrassata, and Gloeophyllum trabeum.

Fumigation and Exposure of Timbers

Fumigants[2] used were chloropicrin (355 ml/timber), Vapam (33% sodium-N-methyldithiocarbamate) (473 ml/timber), and Vanicide TH (hexahydro-1,3,4-triethyl-S-triazine) (473ml/timber). Polyethylene

covering fumigation holes was removed prior to application of fumigant. Holes were sealed with rubber stoppers following treatment and recovered with polyethylene.

The timbers were exposed at the Harrison Experimental Forest near Gulfport, Mississippi, on racks to elevate them above ground. The timbers were placed with the screwtop test tubes facing down to protect the tubes from the sun.

Inspections

Screwtop test tubes with fungal inoculum were removed from each timber every 4 months and replaced with a fresh test tube culture. The removed test tubes were transported back to the laboratory where the decayed wood stick was transplanted to a fresh tube of malt agar. These tubes were incubated at 27°C for 6 weeks to determine whether the test fungi remained viable or had been killed, presumably by the fumigant. Controls (test tubes in nonfumigated timbers) were also replaced at each inspection to ensure that each of the eight test fungi remained viable during its 4-month incubation in the field.

The presence of residual fumigant in the timbers was assessed at 4, 12, and 24 months after treatment using a bioassay with the wood-decay fungus Gloeophyllum trabeum. Twelve-cm increment-core samples were taken from timbers at 0.30, 0.61, and 1.22 m from the fumigant holes and placed immediately into screwtop tubes (16- x 150 – mm). The tubes were returned to the laboratory, sterilized, and placed into screwtop tubes containing malt-agar slants inoculated with G. trabeum. The tubes were incubated at 27°C and 70% relative humidity until growth of the assay fungus in tubes containing untreated core samples reached the end of the tube. Inhibition of fungal growth was used as the measure of residual fumigant.

RESULTS AND DISCUSSION

The ability of fumigants to kill fungal cultures implanted into timbers is given in Table 1. With the exception of Serpula incrassata, cultures implanted into the control timbers generally survived the 4-month incubation periods during all seasons of the year. This fungus also did not survive well in control timbers in a previous study (Highley and Eslyn, 1986).

Wrapping the southern pine timbers with polyethylene improved effectiveness of chloropicrin, Vapam, and Vanicide TH in killing

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Table 1 Viability of fungus cultures following fumigation of southern pine timbers wrapped with polyethylene

Treatment[1]	Distance from treatment (m)	Timber No.	Time lapse since treatment (months) and viability of cultures[2]																							
			4								8								12							
			1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Control	0.30	C-1	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	-	+
(No fumigant)	.61	C-2	+	+	+	+	+	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	-	+	-	+
	1.22	C-3	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-	-	+	-	+	+	+	+	-	+
Vapam[3]	.30	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
473 ml		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	.61	1	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	+	-	+
		2	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+	+	+	+	-	+	-	+
		3	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	+	+	-	-
	1.22	1	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	-	+
		2	+	+	+	-	-	-	+	+	-	-	+	-	-	-	-	-	+	-	+	+	-	+	-	+
		3	+	+	+	+	+	+	-	-	-	-	+	+	-	+	-	-	+	+	+	+	+	+	-	-
Chloropicrin	.30	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
355 ml		5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	.61	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
		6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
	1.22	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
		5	-	-	-	-	-	+	-	-	-	-	+	-	-	+	-	-	+	+	+	-	+	+	-	-
		6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	+

Part 1 of 2

Table 1 Viability of fungus cultures following fumigation of southern pine timbers wrapped with polyethylene (continued)

Treatment[1]	Distance from treatment (m)	Timber No.	Time lapse since treatment (months) and viability of cultures[2]																							
			4								8								12							
			1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Vanicide TH[4] 473 ml	.30	7	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-	+	-	-	-	+	-	+	-	-
		8	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	-	+	-	+
		9	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	+	+	-	+	-	-
	.61	7	-	-	-	+	+	+	+	+	-	-	-	-	-	+	-	-	-	-	+	+	+	+	-	+
		8	-	+	-	+	-	+	+	+	-	-	+	-	-	-	-	-	-	+	-	-	-	+	-	-
		9	-	-	+	+	-	+	-	+	-	-	-	-	-	-	-	+	-	+	-	-	+	+	-	-
	1.22	7	-	+	+	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-	+
		8	+	+	+	+	+	+	-	+	-	-	+	+	+	+	-	-	+	+	+	-	+	+	-	+
		9	+	+	+	+	+	+	+	+	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	+

[1]Fumigants were poured into 2.54-cm-diameter holes clustered about the center of the timber The number of holes depended on the amount of fumigant implanted

[2]Culture No. 1 = *Poria placenta*; No. 2 = *P. carbonica*; No. 3 = *Lentinus lepideus*; No. 4 = *P. xantha*; No. 5 = *Antrodia serialis*; No. 6 = *Fibroporia vaillantii*; No. 7 = *Serpula incrasata*; No. 8 = *Gloeophyllum trabeum*. Viability: - = no growth, culture presumed dead: + = positive growth

[3]Vapam = 33% sodium N-methyl-dithiocarbamate

[4]Vanicide TH = hexahydro -1,3,5-triethyl-S-triazine

Part 2 of 2

fungal cultures implanted into the timbers (Table 1). In a previous study (Highley and Eslyn, 1986) in which southern pine timbers were not wrapped, Vapam and chloropicrin consistently killed cultures only at 0.30 m from CL, and fungicoxicity dropped markedly by 8 months. Vanicide TH was ineffective in killing fungi at any distance from CL.

In the present study, chloropicrin moved fastest and exhibited the highest fungitoxicity at the greatest distance from CL (Table 1). Almost 100% of fungal cultures implanted into timbers died up to 1.22 m from CL by 4 months. Vapam was the next best fumigant with good fungitoxicity at 0.61 in within 4 months. By 8 months, most fungal cultures had died at 1.22 m from CL. Vanicide TH performed the poorest of the three fumigants; good fungitoxicity at 0.30 m from CL persisted for only 4 months, but good fungitoxicity at 0.61 m from CL occurred by 8 months. Fungitoxicity of Vanicide TH at 1.22 m from CL was quite variable. By 12 months, survival of replacement cultures had increased for all treatments, indicating a reduction in toxic quantities of the fumigants between 8 and 12 months. However, chloropicrin and Vapam continued to kill 100% of fungal cultures at 0.30 m from CL.

In a previous study (Highley and Eslyn, 1986), cores removed from unwrapped southern pine timbers exposed near Gulfport, Mississippi, one year following fumigation had no residual fungitoxicity at 0.30, 0.61, and 1.22 m from CL. In the present study, bioassay of cores extracted from wrapped chloropicrin- and Vapam-treated timbers exhibited fungistatic effect at 0.30, 0.61, and 7.22 m from CL after 1 year (Table 2). Cores from Vanicide TH-treated timbers had a

Table 2 Inhibition[1] of fungal[2] growth by cores of pine timbers treated with Vanicide TH, Vapam, and chloropicrin and wrapped in polyethylene

Treatment	Distance from treatment (m)	Time lapse since treatment (months)		
		4	12	24
Vapam 473 ml	.30	3	2	3
	.61	0	3	2
	1.22	0	3	2
Chloropicrin 355 ml	.30	3	3	3
	.61	2	3	3
	1.22	0	2	2
Vanicide TH 473 ml	0.30	1	1	3
	.61	0	0	3
	1.22	0	0	1

[1]0 = No inhibition
1 = Slight inhibition
2 = Severe retardation of growth
3 = No growth
[2]*Gloeophyllum trabeum* assay fungus

slight fungistatic effect at 0.31 from CL after one year but no effect beyond this distance. For all treatments, however, cores extracted from timbers at 24 months exhibited a fungistatic effect up to 1.22 m from CL.

CAUTION

Vapam and chloropicrin are registarad with the U.S. Environmental Protection Agency, and ate used extensively for controlling interior decay in poles. However, the fumigants used in there field trials are hazardous and extreme care must be employed, particularly where the chemicals might spill or leak into the surrounding environment. Furthermore, fumigants should not be used on timbers located within structures or poorly ventilated areas.

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