Using fumigants to control interior decay in waterfront timbers

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Abstract

Large horizontal Douglas-fir timbers with interior decay fungi were used to evaluate the effectiveness of Vapam (sodium N-methyl dithiocarbamate) and chloropicrin in controlling decay fungi. Fumigants were applied in holes drilled in the timbers or flooded into checks. The efficacy of the fumigants in arresting interior infection was evaluated by comparison of the fungal population after fumigation to that prior to fumigation for a 16-month period. Both chloropicrin and Vapam controlled the growth of decay fungi in the interior of Douglas-fir timbers. Neither fumigant was as effective in controlling molds as in controlling decay fungi.

Large exterior structural timbers are usually pressure treated with a preservative but the treatment may be shallow. Weather checks often develop that expose untreated interior wood to decay as in large penta- (pentachlorophenol) and creosote-treated Douglas-fir timbers used for pier curbing. Such timbers were decayed in checks as early as 4 to 5 years after installation in the Seattle, Wash. area (8).

Even flooding checks of creosoted Douglas-fir curbs with liquid preservative before decay was evident did not stop decay (8). Preservatives applied by ordinary flooding penetrate wood only slightly; the interior may have already been too deeply infected for the preservative to be effective. Thus, in exterior members with internal decay or deep infections, a preservative treatment that penetrates deeply into wood is necessary to arrest decay successfully.

High-vapor-pressure fungicides (fumigants) penetrate deeply into wood and have successfully stopped internal decay in Douglas-fir transmission poles (5, 6). Fumigants such as sodium N-methyl dithiocarbamate, methyl bromide, ammonia, sulfuryl fluoride, ethylene dibromide, chloropicrin, and others have been tested in utility poles.

Much of this work has been summarized by Graham (6). Vapam (sodium N-methyl dithiocarbamate), Vorlex (methylisothiocyanates and chlorinated hydrocarbons), and chloropicrin were tested most extensively. All three compounds were found to effectively prevent decay in Douglas-fir poles. Graham (7) recommends a retreatment cycle of not less than 10 years.

However, it has not yet been demonstrated that fumigants can effectively control decay in large horizontal Douglas-fir timbers in which horizontal movement of fumigants is of primary importance. In addition, the fungal flora found in horizontal timbers used aboveground may well differ from that found in poles. Eslyn and Highley (4), in cooperation with the Navy, fumigated Douglas-fir curbs with Vorlex and Vapam. Unfortunately, the results were inconclusive apparently because of inadequate infection of material by decay fungi. However, the marked success of fumigant application to utility poles justifies further experimentation to determine whether or not fumigants can prevent or arrest interior decay in large members. Our objective was to determine the effectiveness of two fumigants in controlling decay fungi in horizontal, above-water timbers.

The authors are Plant Pathologists, USDA Forest Serv., Forest Prod. Lab., P.O. Box 5130, Madison, WI 53705. The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Dept. of Agriculture of any product or service to the exclusion of others that may be suitable. PRECAUTION: This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate state and/or federal agencies before they can be recommended. We wish to express special thanks to Frances Lombard, Center for Forest Mycology Research FPL, for identification of basidiomycetes; to Art Schick, Forester, Naval Submarine Base Bangor Bremerton, Wash., for aid in treatment of wharf timbers; and the Osmose Chemical Co. for technical advice and donation of fumigants used in this study. This paper was received for publication in March 1981.

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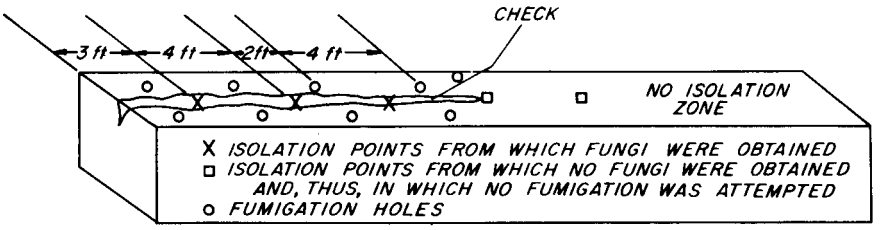

Figure 1. - Location of holes for decayed curb fumigation and fungal isolation points. Vapam was applied only in holes 4 feet apart while chloropicrin was applied in holes 2 and 4 feet apart.

Materials and methods

Selection of timbers and isolation of fungi

Moderate to deeply checked curbs on Pier 1, U.S.N. Torpedo Base, Keyport, Wash., were selected for inclusion in this experiment. The curbs were 7 by 8 inches, 20 to 30 feet long, and penta- or creosote-treated. They had been in service approximately 12 years and had no obvious surface decay.

Increment borings were taken at distances of 3 feet in from the end and every 4 feet thereafter prior to fumigation to determine the original fungal population (Fig. 1). A total of 132 isolations were made from 22 timbers. Borings were made either in or close to checks. The area to be bored was flame-sterilized with a propane torch. A core was then extracted with a sterilized increment borer; half of the core was placed in a test tube containing 2 percent malt agar and the other half into a tube containing a modified Taylor's (9) growth medium.

The modified Taylor's consisted of the following basic medium: a) 1 gram (g) KH_2PO_4, 1 g $(NH_4)_2SO_4$, 0.5 g $MgSO_4 \cdot 7H_2O$, 10 g glucose, 0.001 g thiamine-HCl, 15 g agar, and 900 milliliters (mL) distilled water; b) 100 mL of sterile 0.1 percent agar to which was added 0.05 g neomycin sulfate, 0.05 g streptomycin sulfate, and 0.01 g benlate. Component (a) was subsequently autoclaved and then aseptically combined with (b). The latter medium was used because it was selective for basidiomycetes.

Tubes containing cores were returned to the laboratory and incubated at 27°C and 70 percent relative humidity. Subsequent growth was removed and examined microscopically to determine the type of fungi present. All test tubes were held for a period of at least 3 months to provide ample time for any slow-growing micro-organism to be detected.

Basidiomycetes, as well as mold fungi in many cases, were isolated from all 22 curbs. These curbs were used to test the efficacy of fumigation in remedial treatment of naturally infected Douglas-fir timbers.

Fumigation

Ten of the infected curbs were treated with chloropicrin while the remaining 12 were treated with Vapam (33% sodium N-methyl dithiocarbamate in water).

Six curbs were treated by pouring Vapam into each of four holes (0.24 pint/ft.^{3}) equally spaced about an area from which fungi were isolated (Fig. 1). The lineal distance between holes was 4 feet. Each hole was immediately plugged with a treated-wood dowel. The number of treatments per curb depended upon the number of points on the curb from which fungi were previously isolated. Six other curbs were treated by pouring Vapam (0.34 pint/ft.^{3}) directly into infected checks.

Half of the remaining 10 curbs were treated by pouring chloropicrin from a pressurized tank into four holes (0.18 pint/ft.^{3}) as described for Vapam. The rest were treated in holes 2 feet apart (0.36 pint/ft.^{3}). Each hole was immediately plugged with a treated-wood dowel.

Evaluation

The criterion for determining the effect of the fumigants in decay eradication was that used by Graham (5): viability of fungi isolated from fumigated members. Three, 6, and 16 months following treatment, the presence of viable fungi was determined through re-isolation in close proximity to where decay fungi were isolated prior to fumigation. Comparison of the fungal population after fumigation to that prior to fumigation indicated the efficacy of the fumigants in arresting interior infection.

Results and discussion

Table 1 lists the decay fungi isolated from infected Douglas-fir timbers. *Poria carbonica* and *P. placenta,* the most frequently isolated decay fungi, are commonly associated with decay in Douglas-fir structures (2, 3). The identities of the mold fungi were not ascertained.

As was found in fumigated Douglas-fir poles (5, 6) with interior decay, fumigation achieved a high degree of control against decay in large horizontal Douglas-fir timbers (Table 2). All concentrations of chloropicrin and Vapam used were effective. Vapam essentially eliminated decay fungi in the Douglas-fir curbs within 3 months after treatment. Chloropicrin was about 70 percent effective in eradication of decay fungi at 3 and 6 months and at 16 months no decay fungi were isolated.

TABLE 1. - Decay fungi isolated from Douglas-fir curbs.

Fungal species	Frequency (No. of curbs)
Poria placenta (Fr.) Cke.	6
P. carbonica Overh.	9
P. placenta and *P. carbonica*	4
P carbonica and *P. rivulosa* (Berk. and Curts) Cke.	1
P. xantha (Fr.) Cke.	1
Unknown basidiomycete	1

TABLE 2. - *Efficacy of fumigants in eradication of fungi in Douglas-fir timbers.*

Treatment	Fumigant concentration	No. of infected cores before fumigation[a]	Percent of cores free of infection at various periods after fumigation		
			3 months	6 months	16 months
	Pints/ft.^{3}				
Vapam (in check)	0.34	13 (D)	100	92	100
		12 (M)	83	75	92
Vapam (in holes)	0.24	8 (D)	100	100	100
		12 (M)	83	50	67
Chloropicrin (in holes)	0.18	6 (D)	67	67	100
		9 (M)	89	33	56
Chloropicrin (in holes)	0.36	7 (D)	71	86	100
		9 (M)	33	22	44

[a]D=cores containing viable wood decay fungi.
M=cores containing viable mold fungi.

Graham (5) found that Vapam was not quite as effective in the early isolations in fumigated Douglas-fir poles. However, after 2 years he reports Vapam and chloropicrin to be about equally effective in controlling decay fungi.

Variability in movement and effectiveness of fumigants might be due to differences in number and sizes of voids in timber. Cooper, Graham, and Lin (1) found that amounts of chloropicrin vapor reaching sampling sites varied greatly around a pole at each sampling level because of the presence of checks and decay pockets. Chloropicrin in holes 2 feet from the point of infection controlled decay fungi as effectively as chloropicrin in holes 1 foot away.

Vapam, applied only in holes 2 feet from the point of isolation, was effective. Vapam applied directly to infected checks arrested decay fungi about the same as Vapam applied in holes 2 feet from the point where the decay fungus was initially isolated. Additional isolations away from checks would be worthwhile to determine how far the fumigants travel transversely to eradicate decay fungi. Cooper et al. (1) reported poor transverse movement of chloropicrin in Douglas-fir poles.

Neither fumigant controlled molds as effectively as the decay fungi (Table 2). This was also observed in Graham's (5) work and our earlier work (4). Graham (5) proposed that the role of various fungi in the recolonization of wood treated with fumigants deserves further research because early invasion by nondecay fungi could decrease the rate of colonization by decay fungi or promote the growth of decay fungi by reducing toxicity of the fumigant.

In light of these possibilities, the nondecay fungi isolated from the fumigated Douglas-fir curbs in this study will be identified. Although records were not kept, numerous bacteria isolated along with the fungi in fumigated curbs could also affect reinfestation by decay fungi.

Graham (7) estimates the retreating cycle for fumigation to be 10 years or longer in Douglas-fir poles. Thus, we will continue to isolate from the fumigated Douglas-fir curbs to determine the long-range protection against recolonization in these large horizontal timbers.

Chloropicrin and Vapam are registered under trade names with the U.S. Environmental Protection Agency and are used extensively for controlling the growth of decay fungi in the interior of poles (7). However, these materials are hazardous and extreme care must be employed, particularly where these liquids might spill or leak into the surrounding environment producing serious consequences, such as in waterfront structures of buildings. Graham (7) discusses overcoming this difficulty by using solids that emit fungitoxic gases in structures where liquids may be too hazardous to use.

Conclusions

1. The fumigants chloropicrin and Vapam both controlled the growth of decay fungi in the interior of large, horizontal Douglas-fir timbers.

2. Neither fumigant was as effective in controlling molds as in controlling decay fungi.

3. To efficiently use these fumigants in horizontal timbers, additional information is needed on optimum concentrations and transverse and longitudinal movement in wood.

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