ABILITY OF POLYETHYLENE BOOTS TO PROTECT THE BELOWGROUND PORTION OF SMALL STAKES AGAINST DECAY

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ABSTRACT

With a view to enhancing protection of posts protected by simple preservative treatment, the effectiveness of a 2-mil polyethylene film covering the belowground portion of dip-treated and untreated small sapwood stakes was tested. Stakes with the polyethylene encasement incurred little or no decay over 2 years of in-ground exposure, whereas stakes without the polyethyene barrier were heavily decayed. The evidence warrants extending the testing to conventional posts.

Soil harbors a variety of decay fungi that can invade the wood directly, without depending on spores or hyphal fragments. Soil is a stable medium that provides longer periods of decay-promoting moisture than are present aboveground, and soil nutrients may aid the development of fungi; therefore, wood is more susceptible to attack when exposed to this medium (8,12).

Preservatives protect wood against invasion by fungi, but there are increasing concerns about the use of pesticides because of their inherent toxicity and their ability to migrate from the wood into the surrounding soil. One approach to reducing these risks while still providing a reasonable service life is to add a plastic film to serve as a physical barrier between the wood and soil. For example, plastics can be a partial barrier against movement of moisture, nutrients, and fungi into wood, and when coupled with low levels of topically applied biocide, may provide good protection against fungal invasion from the soil. Biocide-laden plastic wraps have been used for many years to supplement the protection of previously treated utility poles (3,4,6,7,9-11,13,14), but there are few data describing benefits of barriers on untreated or topically treated wood (1,2).

Given the decay-promoting aspects of soil, it seemed worthwhile to consider whether a fungus-impermeable membrane enclosing the belowground portion of a post might materially increase the service life of the post. The membrane, hereafter called a "boot," would not replace preservative treatment, but it could permit simpler treatment, such as on-site dipping. A water-impermeable boot was visualized as both protecting against fungus invasion and inhibiting leaching of the preservative. To examine the potential of protecting posts with a polyethylene boot, a preliminary test was made using small stakes with and without boots.

METHODS AND MATERIALS

Ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) sapwood stakes were chosen because this species has low decay resistance; 90 stakes (12.5 by 25.0 by 225 mm) were used in this study. To simulate seasoning checks as might be present in seasoned posts, a 1.25-mm-wide by 3.13-mm-deep sawkerf was made on both broad faces, running the entire length of one-third of the stake. The 30 kerfed and 60 nonkerfed stakes were each divided into three equal groups. One-third of the stakes (10 kerfed; 20 nonkerfed) were dipped for 1 minute in a mineral-spirits solution of copper naphthenate (1% as copper; OMG Inc., Cleveland, Ohio); one-third were dipped for 3 minutes in a water solution of disodium octaborate tetrahydrate (10% boric acid equivalent; U.S. Borax, Valencia, Calif.); and the final one-third remained untreated and served as the control group. After treatment, the stakes were air-dried and weighed (nearest 0.01 g). For half the stakes in each treatment group, the portion of the stakes to be inserted in the ground was then covered with a 2-mil (0.05-mm) flat polyethylene boot ("Poly Bag"; Associated Bag Co., Milwaukee, Wis.) that was 75 mm wide by 169 mm long.

The stakes were randomly set (boot end down) in sifted forest soil held in plastic bins in a greenhouse. They were set about 50 mm apart and 152 mm deep. This depth allowed the stakes to project 73 mm above the soil (**Fig. 1**). The soil moisture was maintained by spraying to a

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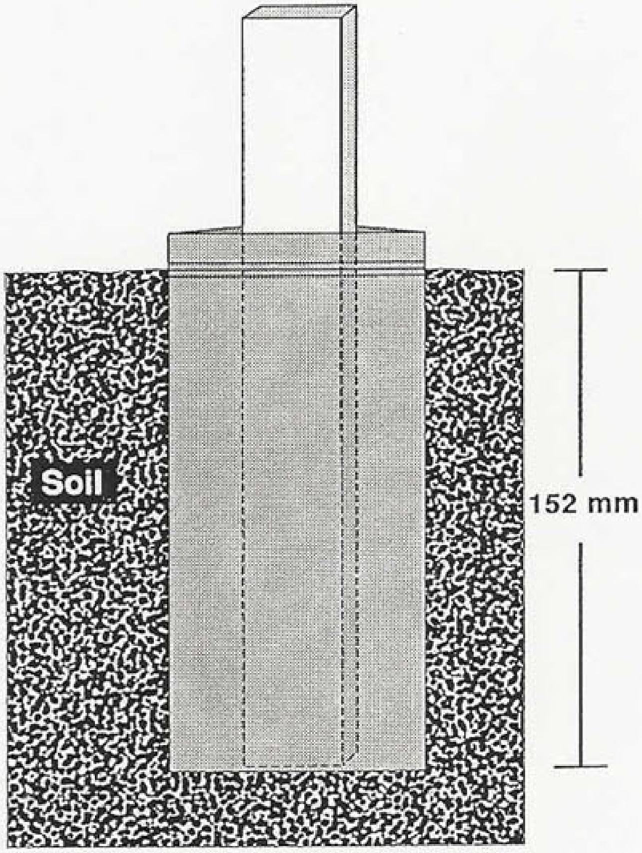

Figure 1. — Test stake with polyethylene boot set in soil.

TABLE 1. — Weight losses in test stakes after 2 years in soil.

		Without boot				With boot		
		Losses < 25%		Losses > 25%		Losses < 25%		Losses >25%
Sawkerf	Treatment	*n*	Avg. loss	*n*	Avg. loss	*n*	Avg. loss	*n*
Nonkerfed			(%)		(%)		(%)	
	Copper naphthenate	7	2	3	30	10	2	0
	Boron	9	12	1	37	10	2	0
	Control	8	15	2	36	10	2	0
Kerfed	Copper naphthenate	3	7	2	35	5	1	0
	Boron	4	10	1	42	5	2	0
	Control	3	12	2	35	5	2	0

level that would generally be suitable for gardening. No attempt was made to keep water from entering the boots at the upper end. The temperature of the greenhouse was maintained at approximately 27°C.

The stakes were incubated in the soil for 2 years. The stakes without boots were then washed free of soil, and all stakes were again air-dried and weighed. The difference between the initial and final weights was the measure of wood weight lost by decay.

Results

Apparently, the decay fungi were distributed nonuniformly in the soil bins; this situation was unexpected, but can help explain the stake weight losses, which were either very large or relatively small. Because of these extremes, the weight losses are reported in two distinct populations: < 25 percent and > 25 percent (**Table 1**). Weight losses in stakes with boots were markedly lower than those in stakes without boots, regardless of the treament. The losses in stakes with boots were very small, with values ≤ 2 percent (**Table 1**). The uniformly low weight losses suggest they might be attributable to more extractive leaching than to decay.

In contrast, weight losses in the stakes without boots were as high as 42 percent and approximately one quarter of the stakes incurred losses of 30 percent or more. If one considers only the below-ground portion of the stakes, the losses were, or course, much greater. Shrinkage and deformation were greater in stakes without boots (**Fig. 2**). It seems valid to consider the merits of the boots in the light of much larger amounts of decay, since the evidence suggests that larger amounts of decay would have occurred in all the stakes without the boots had the attacking decay fungus been uniformaly distributed in the soil.

There was no indication that the boots enhanced the effectiveness of the chemical treatments; decay was virtually prevented in all the booted stakes, treated and untreated. Likewise, there was no indication that the sawkerfs, simulating deep seasoning checks, reduced the protection by the boots.

At least one basidiomycete was isolated from the stakes (5), but the species is yet to be determined. The extreme deformation of affected stakes (**Fig. 2**) and the crosschecking indicate that the decay fungus was primarily of the brown-rot type. There was no evidence that the plastic boots themselves had degraded; however, the permanence of plastic could be a consideration in practice. Polyethylene is generally considered to be very durable underground, where it is not subjected to ultraviolet light.

Discussion

These results clearly show that decay did not occur in stakes encased in a 2-mil polyethylene boot, even without supplemental chemical protection, whereas decay sufficient to cause extreme loss of strength occurred in stakes without the boot protection. Field testing of boots on posts of a conventional size would be an appropriate follow-up study. This approach to post protection would be of considerable interest to farmers and homeowners, particularly if the boots could be used with simple preservative treatments, such as dipping. Polyethylene products suitable for post boots are commercially available at a reasonable cost. A film thickness of 3 or 4 mil might be appropriate for the larger materials.

SUMMARY

A 2-year test to ascertain the effectiveness of a polyethylene film covering in preventing decay was conducted on small ponderosa pine sapwood stakes set in forest soil contained in a greenhouse. The belowground portion of half the stakes was prevented from soil contact by a 2-mil polyethylene boot. Decay during the 2 years of exposure differed greatly between the stakes with and without boots. Booted stakes had little evidence of decay, whereas those without boots experienced large weight loss and extreme shrinkage and deformation. From these results, we conclude that comparable trials using polyethylene barriers on posts of conventional size are warranted.

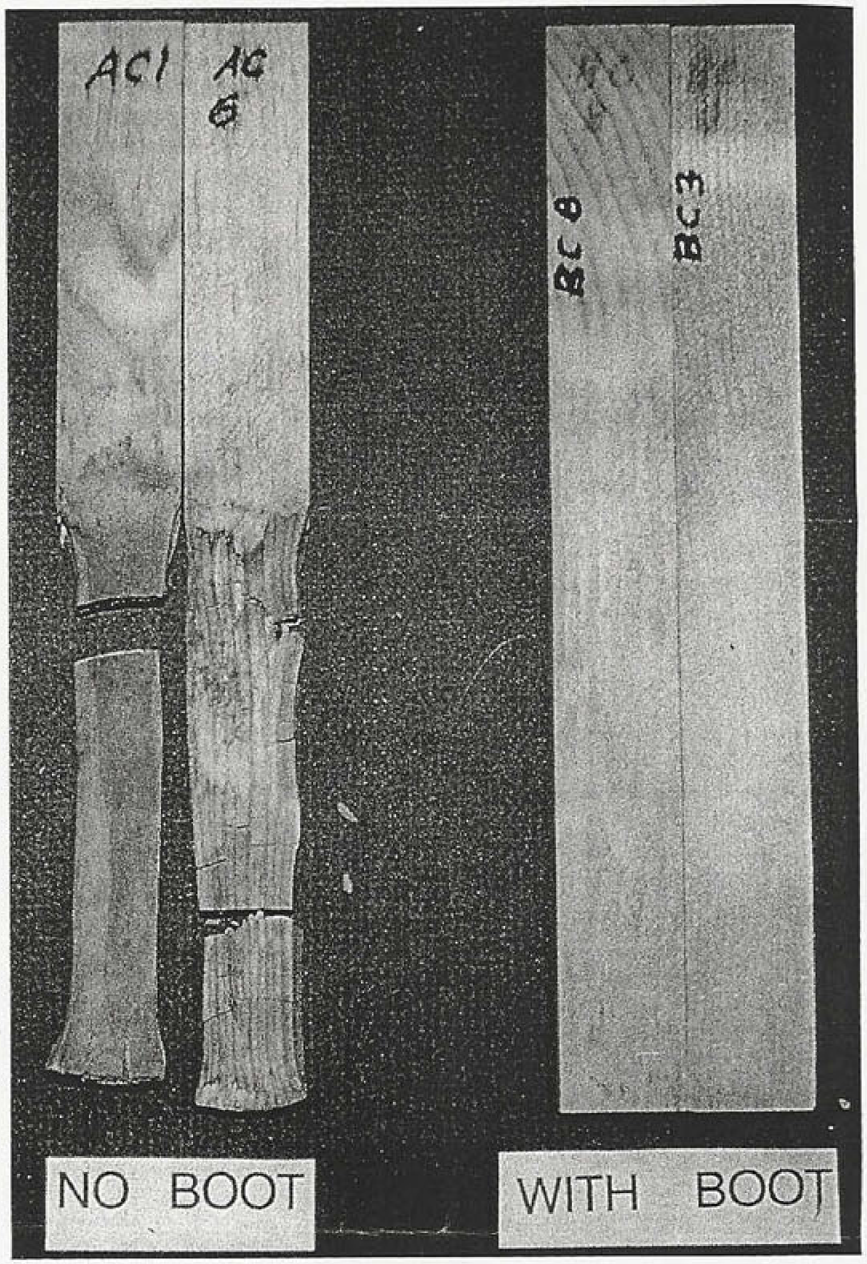

Figure 2. — Examples of copper-naphthenate-dipped stakes, with and without polyethylene boots. Weight losses: stakes without boots, 34 percent and 31 percent; stakes with boots, 3 percent and 3 percent.

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