# DIFFUSION OF DISODIUM OCTABORATE TETRAHYDRATE INTO SOUTHERN YELLOW PINE TO CONTROL WOOD-INFESTING BEETLES

WILLIAM H ROBINSON AND ROBERT A. BARLOW
Urban Pest Control Research Center, Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0319, USA

**Abstract**—Emulsions of chemicals applied to the surface of seasoned softwoods results in a residue 1-3 mm below the surface, and can provide control of wood-infesting beetles. Borate compounds can be delivered to wood surfaces in sufficient quantities for subsequent diffusion to depths below the surface. The penetration of boron depends on the presence of free water in the wood cells. Penetration at 24 h and 6 wk of a 10% (AI) dilution of disodium octaborate tetrahydrate (DOT) into southern yellow pine (*Pinus* sp.) blocks was investigated following one and two applications and exposure to 85% and 50% RH environments. DOT treated and untreated wood was sectioned (50 um per slice) with a microtome from the treated surface to five depths: 50, 950, 2000, 2500, and 3000 um, and analyzed for boron. The boron content of each wood slice (ppm) was performed by a dry ashing procedure using inductively coupled plasma spectrometer (ICP). Factors influencing penetration of DOT into the southern yellow pine blocks were maximum application volume, 16-19% initial WMC, and exposure to a 85% RH environment following treatment. Two applications of 10% DOT to wood with 16-18% WMC, followed by 6 wk in a 85% RH environment resulted in greater amounts of boron detected at the 3000 um depth than did other treatments. The results of the evaluations reported here indicate that the amount of boron detected on and below the wood surface, to the depth of approximately 2 mm, should provide protection from wood-infesting beetles.

## INTRODUCTION

The larvae of longhorn and powderpost beetles infesting structural timber can feed for an extended time, and at varying depths below the wood surface. While limited infestations of these pests cause only cosmetic damage, continued reinfestation and feeding can lead to severe structural damage. Strategies for the prevention or control of wood-infesting beetles include applying insecticides as a gas to the entire structure, or as a water- or solvent-based spray to exposed wood, or as a pressure-injected spray below the wood surface. The depth of penetration and duration of liquid insecticides used for wood protection depend on the wood species treated, the insecticide formulation, and the environment. In general, applying insecticides to seasoned softwoods results in a stable residue 1-3 mm below the treated surface (Berry and Orsler, 1983; Serment, 1986; Powell and Robinson, 1991). Emulsions of pentachlorophenol and lindane have been used successfully to control wood infesting beetles, such as the old house borer, anobiid, and lyctid powderpost beetles (Durr, 1954; Morgan and Purslow, 1973). Chlorpyrifos and the pyrethroids, permethrin and cypermethrin have also been used for wood protection (Powell and Robinson, 1992; Robinson, 1991).

There is considerable interest in the use of water-soluble polyborates, such as disodium octaborate tetrahydrate, to protect structural wood from wood-destroying insects (Williams and Mauldin, 1985; Williams and Amburgey, 1987; Grace and Yamamoto, 1992). Taylor (1967) summarized the toxicity of boron compounds for wood-infesting beetle larvae. She reported boric acid concentrations of 0.4-0.6 kg/$m^3$ to be lethal to *Hylotrupes bajulus* (L.) larvae (Taylor, 1967). Soumi and Akre (1992) reported on the control of the anobiid, *Hemicoelus gibbicollis* (LeConte) with borates.

Borate compounds can be delivered to the surface of wood in sufficient quantities for subsequent diffusion below the surface. Diffusion is the process by which boron is transported from a zone of high concentration to one of low concentration. The initial penetration of boron in the top layer of wood, and diffusion below the surface depends on the presence of free water in the wood cells (Smith and Williams, 1969). This prerequisite has usually limited the use of borate treatments to unseasoned lumber which has a high (30%) wood moisture content, or to pressure treatment of seasoned wood. Recently, borate formulations have been developed for treating seasoned wood by surface spraying (Becker, 1976; Creffield et al., 1983; Puettmann and Williams, 1992), or subsurface injection. The product label directions for treating seasoned timber with borates recommends to thoroughly wet exposed wood surfaces with two applications within 24 h (U. S. Borax Inc., Valencia, CA).

The diffusion of borates in seasoned wood is enhanced with increased wood moisture content (WMC) and surface loading (Smith and Williams, 1969). The moisture content of structural wood normally infested with beetles can range from 7-18% (Durr, 1954; Williams, 1983). The wood moisture content depends on the location within the structure, and seasonal differences in ambient relative humidity (RH) (Peck, 1932; Bois, 1951). Although there is data to show that borates can diffuse into green wood with high (35%) WMC, there is limited data on the diffusion of borates into structural wood, which has a WMC of 7-18%. The objectives of the research presented here are to evaluate the initial penetration into the outer layer and subsequent diffusion of a 10% water dilution of disodium octaborate tetrahydrate into southern yellow pine (Pinus sp.) with low (8-10%) and high (16-18%) WMC.

## MATERIALS AND METHODS

Penetration at 24 hours of a 10% (AI) dilution of disodium octaborate tetrahydrate (DOT) was investigated using southern yellow pine (*Pinus* sp.) sapwood. Wood used was free from knots and visible defects, and had a moisture content of 8-18%. It was cut into 4 x 5 x 1cm blocks for treatment. DOT was mixed with water to give a 10% finished dilution, and a pipette was used to deliver 204 ul to one 4cm x 5cm surface of each block. Applying this volume of liquid resulted in a thoroughly wet wood surface. One and two applications, approximately 24 h apart, were made to each block, and there were four replicates of each treatment. Following application, the blocks were maintained at 21°C, 50% RH, or at 26°C, 85% RH for 24 h or 6 wk. Then the center cubic centimeter of each block was removed and sectioned (ca. 50 um per slice) with a microtome from the treated surface to five depths: 50, 950, 2000, 2500, and 3000 um. Ten untreated blocks were sectioned at the same depths, and analyzed for boron. Each wood depth evaluated was represented by three replicates.

### Analysis

The boron content analysis of each wood slice was performed by a dry ashing procedure and using inductively coupled plasma spectrometer (ICP). Wood slices were ashed in a furnace (Model 186 Fisher Isotherm) at 460-480 C for 1 hour. The ash was dissolved in 2.5 ml of concentrated HCL, allowed to stand for 20 min, then 5 ml of deionized water was added. After 15 min, 17.5 ml of deionized water was added, to give a final volume of 25 ml and a 1.2 N HCL dilution. The dilution was filtered through ashless filter paper, then transferred to the ICP. Amounts of boron detected for each depth are presented in parts per million (ppm), based on the weight of the wood.

### Data analysis

Analysis of data was conducted using analysis of variance techniques (SAS Institute, 1985), means were separated with Tukey's Studentized Range Test. Differences were considered significant at the 0.05% level.

## RESULTS AND DISCUSSION

The factors influencing penetration and diffusion of DOT into the southern yellow pine blocks were maximum application volume, high initial WMC, and exposure of treated blocks to a high RH environment following treatment. Two applications of 10% DOT to southern pine blocks with 16-18% WMC, followed by 6 wk in a 85% RH environment resulted in more boron detected at the 3000 um depth than did single or double applications to blocks with 16-18% or 8-10% WMC wood, exposed for 24 h or 6 wk in 50% or 85% RH environments (Table 1, 2). In the untreated blocks there was a mean ($\pm$SEM) 56 + 19 ppm boron detected at all depths.