
Borates for the Control of Termites

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An article in the March 1998 issue of *The IPM Practitioner* featured the use of borates to protect wood against termites, wood-boring beetles, carpenter ants and decay fungi. "Boric acid and its salts, the borates, have been used for wood protection in Australia and other countries since the 1940s," states the author. Because boric acid is widely available and relatively inexpensive, this information should be relevant to many in our network.

Borates are salts with chemical structures closely resembling boric acid. For example, borax is a sodium salt [in Fort Myers, Florida, borax sells for approximately US\$0.63/lb or US\$1.39/kg]. Other formulations will be less available in developing countries, but you may want to be aware of them; they include disodium octaborate tetrahydrate (DOT) and zinc borate. DOT is highly soluble and has been used by the lumber industry in conjunction with the dip-diffusion method for lumber protection. Zinc borate is much less soluble and therefore is less likely to enter ground water when used as an insecticide (i.e. uses other than wood treatment).

Borates can be used against termites in several ways: (1) as insecticides (killing termites on contact), (2) as antifeedants (making treated material unappealing for insects to eat), (3) as a digestive poison, and (4) as repellants. Borate treatments kill termites by direct contact when concentrations are at least 0.5% w/w (where "w" equals weight, i.e. 5 grams of borate per kg of material being protected). They act as antifeedants when concentrations are greater than 0.25% w/w. Concentrations of borates that are too small to act as antifeedants are able to poison the termite digestive process over an extended period of time.

(This paragraph is for those who want more detail and who know some chemistry). Different borate compounds have different molecular weights. Unless you happen to be using boric acid, a good portion of the weight of the molecule will come from the part of the molecule other than borate. All borate compounds will contain the same amount of borate if expressed as "borate equivalent weights." Multiply the grams per kilogram in the previous paragraph by the molecular weight of the borate compound and divide by the weight of the borate anion. For example, the molecular weight of zinc borate (ZnB_2O_4) is 250.9. The weight of the borate anion ($B_2O_4^{2-}$) is 85.6. A concentration of 0.5% w/w would contain 14.66 g of zinc borate ($5 \text{ g/kg} \times 250.9 / 85.6 = 14.66 \text{ g/kg}$).

Treated wood possesses repellent properties. When structural lumber used in new house construction is pretreated with borates, houses are termite resistant. "In Australia, where termites seem to be found everywhere, this treatment is required by

the building codes for Eucalyptus timbers in the states of New South Wales and Queensland." Even older houses can be made more termite resistant by remedial treatment with borate sprays. In this case, termites already existing in timber are hesitant to "tube over" treated areas. Effectiveness of spray treatments is dependent in part on how well the spray penetrates wood. Borates that are readily soluble in water, like borax or DOT, rapidly penetrate when applied to bare wood. This eliminates right after fresh boards are produced can protect wood for a lifetime. One easy treatment method is dip-diffusion. No elaborate equipment is needed... Since borates penetrate wet wood better than dry, freshly cut wood averaging about 70% moisture is easy to protect... Boards are dipped for about a minute in a 130°F (50°C) solution of 25% DOT, then are stored from 2 to 8 weeks to allow borate diffusion into the wet wood." ates active infestations of termites near the surface of the timber.

Freshly cut wood for new construction also can be treated. According to the IPM Practitioner article, "Borates applied right after fresh boards are produced can protect wood for a lifetime. One easy treatment method is dip-diffusion. No elaborate equipment is needed... Since borates penetrate wet wood better than dry, freshly cut wood averaging about 70% moisture is easy to protect... Boards are dipped for about a minute in a 130°F (50°C) solution of 25% DOT, then are stored from 2 to 8 weeks to allow borate diffusion into the wet wood."

Very small doses of borates can poison termites. Borates inhibit many enzymes. The enzyme cellulase is particularly important for termites, because it allows them to digest wood cellulose. Termites either secrete cellulase themselves or have access to a ready supply through intestinal protozoa that produce cellulase. Small doses of borates cause termites to starve, because they no longer are able to digest cellulose. In one study, all eastern termites were killed within two weeks and all Formosan termites within three weeks of being fed a diet of cellulose with 0.0625% boric acid equivalent by weight. At this lower dose, termites still ate wood and therefore benefits were not seen immediately.

Borates can act as rather long-lasting "antifeedants" when used at a higher dose. An antifeedant is a chemical that deters feeding. Many of the studies listed in the article reported antifeedant properties when doses were within the range of 0.25% to 1.0% boric acid equivalent by weight [that is, a solution of 0.25% to 1.0% boric acid by weight]. In one test, "about 1% boric acid concentration kept the amount of pine eaten by the termites *Coptotermes lacteus* and *C. acinaciformis* to 5% or less, while 80% or more of untreated wood was consumed."

Although borate-treated wood possesses repellent properties, borates in general should not be considered repellents. For example, tunneling by termites in treated sand (0.5% to 1.5% boric acid) was not inhibited. In contrast, borates are contact insecticides. In another study, "all eastern subterranean termites exposed for one minute to boric acid died within 8 days ... Though boric acid dust is an effective termiticide upon direct contact, a large proportion of a termite colony has to be exposed to achieve acceptable control levels."

Strategies devised to take advantage of the various termite control properties of borates include dusting galleries. "One possible method of control for both subterranean and drywood termites involves injection of finely powdered poisonous [borate] dust into their galleries with a dust gun. Since termite biology involves extensive social grooming, if a small percentage of a gallery can be dusted,

potentially the whole nest can be destroyed." Field tests of this method against subterranean termites were not very successful, especially when the wood was damp. Other researchers believe that injection of insecticidal dust into galleries is unlikely to result in contamination of a sufficient number of individuals to control ground-nesting species of termites. This difficulty can be avoided by using the "Trojan termite" approach. "Small colonies of subterranean termites can be destroyed by presenting poisoned termites as gifts to the termite colony. The poisoned termites are welcomed and groomed, and the poison on one termite kills at least 10 others. If a persistent poison such as a borate is used, it can be spread further through cannibalism. Theoretically, if 25,000 termites were caught in traps, dusted with borates, then released back into their shelter tubes, a nest of 250,000 subterranean termites could be destroyed. Zinc borate may be more useful for this purpose, as it is less water soluble." Successful bait must be both non-repellant to promote feeding and slow acting so the poison can be distributed throughout the termite colony. In addition, bait formulations must be attractive if they are to be effective. One such bait is composed of sawdust (cellulose) and boric acid mixed with honey and molasses. The honey and molasses may act as a "sticker," increasing the adhesion of boric acid to the termite.

There are a few cautions. Water-soluble borates should not be used as a ground treatment because they are moderately toxic and persistent, and can pollute groundwater. High doses of borates are poisonous to humans when ingested or inhaled. Therefore adequate care, including use of goggles and gloves, is recommended when a borate dust or solution is applied. Absorption through the skin is negligible unless there are abrasions or other breaks in the skin. Masks for respiratory protection should be used in confined spaces where ventilation is poor.