

Laboratory Evaluation of Efficacy of Orange Oil (XT-2000) for Control of Drywood Termites in Naturally-Infested Boards

Orange oil, d-limonene oil extracted from orange fruit peels, is currently available as XT-2000 for localized treatment of drywood termites. The efficacy of orange oil (XT-2000) for control of western drywood termites, *Incisitermes minor*, was evaluated in a laboratory study of infested wood boards¹. Prior to treatment, the wood boards were confirmed to be infested with live drywood termite colonies using non-destructive detection methods: X-rays, and sensors that detect termites moving or chewing wood.

Completely exposed boards were drilled and treated by an experienced pest control operator. Three boards were tested per treatment; including XT-2000 (92% orange oil), water only, and untreated control (see figure 1).

Holes were drilled using a "W" pattern and were spaced about 2 inches apart² along the entire length and width of each board. Each hole was injected with the treatment. The maximum volume of orange oil that could be absorbed by the wood was injected (see figure 2).

Three months after the treatment, all boards were cut into small fragments to extract and count live and dead drywood termites. Live termites were found in all treatment boards. Termite survival was high in both control treatments, while an average of 19% of the termites survived the orange oil treatment (see table below).

Figure 1



Figure 2



Treatment	Total No. Drywood Termites (Three Boards/ Treatment)				Average Survival ^b
	Live	Dead	Casualties ^a	Total	
Orange Oil (XT-2000)	336	1,105	9	1,450	18.7%
Water Control	1,090	35	1	1,126	94.2%
Untreated Control	961	38	30	1,029	96.4%

^aCasualties include termites destroyed in the extraction process, and were not included in the % Survival calculations.

^b% Survival = Sum of % survival [# Live / (# Live + # Dead)] for each board divided by 3 (number of boards tested)

These results demonstrated that even in a best case scenario with complete access to infested wood and thorough coverage at the maximum application rate, orange oil (XT-2000), obtained only 81% control of drywood termites. Whole structure fumigation is the most effective method documented to provide complete control of drywood termites in structures, including colonies in areas inaccessible for localized treatment.³

¹Dr. Vernard Lewis, University of California, Berkeley, CA. 2008

²XT-2000 label suggests wider intervals (3-5 inches) for drilling injection holes

³Scheffrahn et al. 1997. J. Econ. Entomol. 90: 492-502; Lewis Haverty. 1996. J. Econ. Entomol. 89: 922-934.

VIKANE® VS ORANGE OIL

Methodology

Vikane

Whole-structure treatment: The entire structure is tarped and thoroughly fumigated with Vikane, killing all detected and undetected termites, including those inaccessible for spot treatment.

Orange Oil (d-limonene, citrus oil)

Spot treatment: Only accessible colonies can be treated by drilling small holes at about 5 inch intervals into which orange oil is injected.

Third-party Validation of Efficacy

Vikane

Fumigation with Vikane is the most thorough, consistent and efficacious treatment of infested structures evaluated in more than 20 years of university research and over 50 years of commercial use^{1,2,3}. Researchers and pest control operators acknowledge that whole-structure fumigation, compared to spot treatments, penetrates better into concealed locations and large volumes of wood are treated more efficiently.⁴

Orange Oil (d-limonene, citrus oil)

Recent laboratory research at the University of California Berkeley demonstrated in a best case scenario with complete access to infested wood, orange oil (trade name XT-2000) injected to saturation at 2 inch intervals obtained an average of only 81% control of the drywood termites with up to 100's of termites documented surviving treatment. This termite survival is important because previous research at the University of California Riverside (UCR) showed that drywood termite colonies can reproduce and increase with as few as 20 worker termites.⁵ Recent laboratory research at UCR has also demonstrated orange oil does not have residual activity; drywood termites with continuous exposure to wood topically treated with orange oil and aged 30 days did not have greater mortality than termites on untreated wood.⁵

Limitation on Treatment Application by Termite Location in Structure

Vikane

There are no limitations: Vikane penetrates all airspace in termite galleries within the tarped structure to kill termites.^{1,2}

Orange Oil (d-limonene, citrus oil)

Termite colonies must be accessible to the applicator.

Limitation on Efficacy by Applicator Ability to Detect Termites

Vikane

There are no limitations: Vikane penetrates all airspace in termite galleries within the tarped structure to kill termites.^{1,2}

Orange Oil (d-limonene, citrus oil)

Detecting live termite infestation is critical for treatment efficacy of spot treatment with orange oil: Undetected colonies will not be treated or controlled. Besides visual inspection, other detection methods include dogs, odor detectors, fiber optics, movement-sensitive devices and feeding-sensitive devices. These devices are infrequently used and, except for feeding-sensitive devices, adequate research has not been conducted to confirm their reliability to detect drywood termites. With the uncertainty of current detection methods, the secretive behavior of drywood termites and building construction (drywall or other wall coverings) concealing infestations, there is always doubt as to the location and extent of all drywood termite colonies in buildings that restrict accessibility and limit treatment.⁷

Possibility of Damage by Treatment Application

Vikane

The possibility of damage is low when Vikane is used according to the label. Improper tarping may cause damage.

Orange Oil (d-limonene, citrus oil)

Many injection holes in wood and walls may need to be repaired. Orange oil is an oily liquid which is used as a solvent and a degreaser. Its effect on paint and surface finishes is unknown.

Flammability

Vikane

Vikane is non-flammable.

Orange Oil (d-limonene, citrus oil)

Orange oil is flammable with a flash point of 115°F.

Indoor Air Quality

Vikane

Applicator must follow specific aeration procedures followed by air testing using sensitive detection equipment to confirm airborne concentrations comply with federal label requirements. Aeration procedures and detection equipment have been extensively researched to validate their performance.

Orange Oil (d-limonene, citrus oil)

Orange oil has a pungent citrus odor. No air testing is conducted after application.

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Vikane is a federally Restricted Use Pesticide
Always read and follow label directions

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¹Lewis, V.R. and M.I. Haverly. 1996. Evaluation of six techniques for control of the Western drywood termite (Isoptera: Kalotermitidae) in structures. *Journal of Economic Entomology* 89(4): 922-934.

²Scheffrahn, R.H., N.-Y. Su, and P. Busey. 1997. Laboratory and field evaluations of selected chemical treatments for control of drywood termites (Isoptera: Kalotermitidae). *Journal of Economic Entomology* 90(2): 492-502.

³Su, N.-Y. and R.H. Scheffrahn. 1986. Field comparison of sulfury fluoride susceptibility among three termite species (Isoptera: Kalotermitidae, Rhinotermitidae), during structural fumigation. *Journal of Economic Entomology* 79(4): 903-908.

⁴Lewis, V.R. 2003. IMP for Drywood Termites (Isoptera: Kalotermitidae). *Journal of Entomological Science* 38(2): 181-199.

⁵Lewis, V.R. and M. Rust. 2009. Drywood termite control — Preliminary laboratory evaluation of chemical local treatments for drywood termites. *PCOC*. Spring vol. 14-15, 17.

⁶Unpublished data, T. Atkinson, formerly University of California, Riverside (personal communication).

⁷Lewis, V.R. 2002. Drywood Termites, Pest Notes, University of California Agriculture and Natural Resources. Publication 7440.