

***Phytophthora ramorum* Infection in Coast Live Oaks and Shreve's Oaks Treated With Insecticide to Prevent Beetle Colonization¹**

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Abstract

As the name implies, sudden oak death, caused by *Phytophthora ramorum*, kills many, if not most of the coast live oaks, *Quercus agrifolia*, that become infected (McPherson and others, 2005). Several genera of ambrosia and bark beetles (Coleoptera: Scolytidae) colonize bleeding (infected) trees and are suspected to hasten tree death. Insecticide treatment is being offered to property owners to prevent the death of high value trees, although controlled studies of its efficacy are lacking. In this study, we are testing the efficacy of the synthetic pyrethroid insecticide permethrin in prolonging the life of infected coast live oaks and the closely related Shreve oaks, *Q. parvula* var. *shrevei*. This study was also designed to follow the progression of *P. ramorum* infection in the absence of beetle colonization. Asymptomatic coast live oaks (80 in each of two Marin County sites) were randomly assigned to three treatments in July 2002: inoculated (80), mock-inoculated (40, wounded but not inoculated), and control (40). Half of each group was randomly selected for spraying with permethrin twice each year, in August and February, prior to beetle flight periods, following recommended application levels. The study on Shreve oaks was started in March 2003 in one site in Henry Cowell State Park, Santa Cruz County. After one year, 72 percent of the inoculated coast live oaks were symptomatic (bleeding). Considerable variation was seen in the number of discrete bleeds on trees and in the total area affected per tree. Permethrin treatment prevented colonization through March and April 2003. However, by July, the mean number of beetle tunnels per tree did not differ as a function of permethrin treatment, indicating that efficacy decreased with time (*fig. 1*). Beetles colonized approximately half the infected, bleeding trees in both the insecticide-treated and untreated groups. However, although the number of beetle-colonized trees did not differ between groups, significantly fewer beetles tunneled into the

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permethrin-treated trees than the untreated trees. This difference was maintained through October 2004. Once insecticide-treated trees were colonized, significantly more beetles were trapped than on the trees that did not have any beetle attacks (*table 1*). This response demonstrates the production of aggregation pheromones by the colonizing beetles. This phenomenon is well documented in a number of ambrosia and bark beetles. The bark cankers produced by *P. ramorum* in coast live oaks often lead to cracking of the bark, with attendant fissures that disrupt any insecticide barrier on the surface. This damage to the bark may negate the effect of the insecticides. Ambrosia beetles, *Monarthrum scutellare* in particular, may tunnel to 10 cm and deeper in the sapwood (Svihra and Kelly, 2004). The attraction of beetles to trees in which colonizing beetles have established tunnels may overwhelm any natural resistance of the tree to *P. ramorum*. Ambrosia beetles have the capability to introduce microorganisms, including decay fungi, deep into the sapwood of trees (Hijii and others, 1991). Once the protection of the bark has been breached, a tree may have little resistance to introduction of fungi and bacteria into its conductive tissues. Of the five inoculated trees that had died by August 2004, one was in the permethrin-treated group. This study is continuing.

Bleeding developed in 45 percent of the inoculated Shreve oaks in one year. Very little is known about the course of *P. ramorum* infection in this species. Bleeding in inoculated trees tends to be more limited, and the association with beetles appears to be less consistent, than in coast live oaks. Through October 2004, no inoculated trees had died.

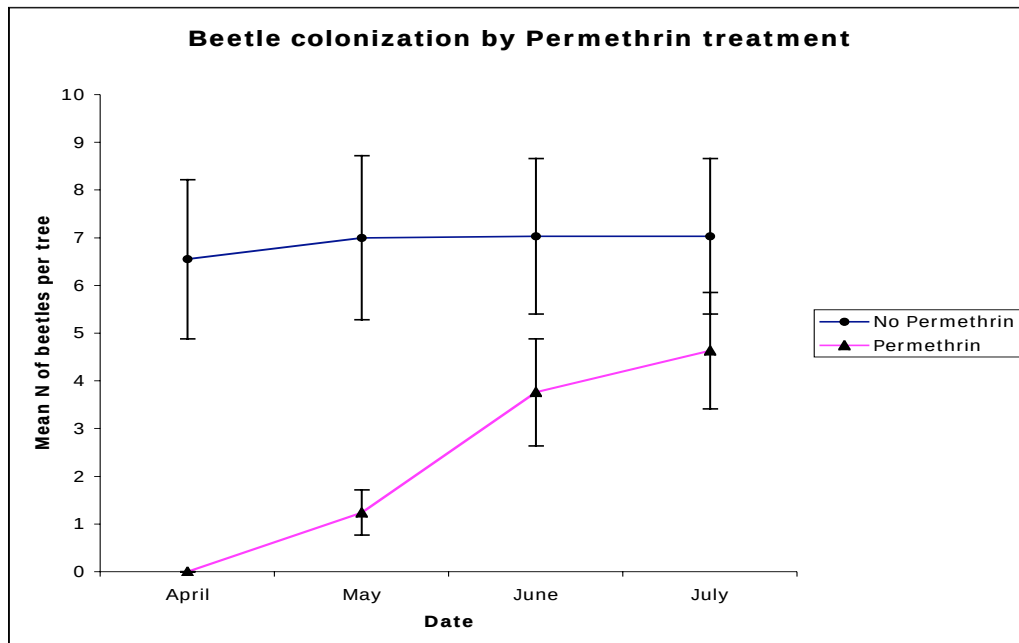


Figure 1—Numbers of beetle tunnels in inoculated bleeding coast live oaks sprayed with Dpermethrin (triangles) and unsprayed (circles), for April through July 2003 (mean $\pm$ SE)

Table 1—Trap catch on insecticide-treated bleeding coast live oaks as a function of prior beetle colonization during the 2003 season, mean $\pm$ SE; beetle trap counts were statistically different by t-tests. May, $p = 0.0016$; July, $p = 0.006$

Tree Status (Colonized, or not)	May	July
No Beetles	2.6 (1.2)	0.6 (0.2)
Beetles	9.0 (1.1)	14.0 (5.9)

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