

ned outages.

The last row of data in Table 1 confirms the minimal impact of tree-related outages upon our customers, by summing the products of the number of customers affected by each outage and the duration of each outage.

Summary

Murray City Power has successfully incor-

porated its utility line clearance program into a broader context of urban forest management. By doing so, we have more satisfied customers, healthier trees, a more reliable and cost effective electrical system, and a more beautiful community. We are energized about professional arboriculture, and look forward to new innovations and technologies that will perpetuate our success.

TREATMENT OF PITCH CANKER ON MONTEREY PINE WITH FUNGISOL INJECTION

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Abstract. Fungisol injections into mature Monterey pines with pitch canker, caused by *Fusarium subglutinans*, failed to eradicate pre-existing branch infections and did not prevent disease when trees were artificially inoculated or infected naturally.

Résumé. Des pins de Monterey (*Pinus radiata*) à maturité infectés d'un chancre causé par *Fusarium subglutinans* furent traités avec DEBC (Fungisol) par des injections de type Maujet. Le traitement n'a pas permis d'éliminer les infections présentes sur les branches et de prévenir la maladie lorsque les arbres furent inoculés artificiellement ou naturellement par le champignon.

Pitch canker, a disease of pines, was found in the summer of 1986 to affect several thousand Monterey pines throughout Santa Cruz county, California. Although Monterey pine (*Pinus radiata*) was the principal species infected, allepo pine (*Pinus halepensis*), Bishop pine (*Pinus muricata*), and Italian Stone pine (*Pinus pinea*) were infected as well. Several hundred infected trees were found in nearby counties.

Pitch canker is caused by the fungus *Fusarium subglutinans*. It primarily causes branch dieback

and cankers on the trunks. All infected tissue is resin-soaked and stained an amber color. Often copious pitch exudes from infected tissue. Many pitch canker-infected trees are dying. Whether tree death is caused primarily by the disease or by the insects that are attracted to the unhealthy trees is under investigation.

Several control strategies have been proposed. One strategy is doing essentially nothing because it is thought that the fungus will not kill trees and infected trees will recover. Another strategy proposes removal of moderately to severely infected trees to reduce the fungus (inoculum) levels and therefore reduce disease incidence. A third strategy proposes injecting the trees with the fungicide DEBC 2-(2-ethoxyethoxy) ethyl-2-benzimidazole carbamate (Fungisol). The J.J. Mauget Co. has a registration for Fungisol in California for pine pitch canker control and apparently had efficacy data to support its registration. This paper reports the results of injecting mature Monterey pines with Fungisol.

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Materials and Methods

Ten Monterey pines were selected for the experiment. They were approximately 35 feet high, 18" in diameter, and spaced an average of 12 feet apart in a row. Each tree had numerous branches apparently infected with pitch canker. To confirm that pitch canker was present, a sample from a diseased branch was randomly selected and removed from each tree. The plant pathology laboratory at U.C. Berkeley confirmed the presence of *F. subglutinans* in each sample.

Fungisol was applied March 30, 1987 using Mauget injectors spaced every 5 to 6 inches at the base of every other tree. Five trees were injected and five were untreated. Each treated tree received approximately 10 injections by a tree service professional who had substantial experience using the Mauget system. The trees had not absorbed the entire dosage of Fungisol (4 ml per injection) by the end of the day so the injectors were removed for safety reasons. On April 4 the same trees were injected as before and most of the Fungisol was absorbed. Conservatively, with both applications, each tree received at least a full dosage as recommended on the label.

To test the prophylactic effectiveness of Fungisol to prevent pitch canker infections, two healthy branches of each tree were inoculated approximately 1, 2, 3 and 4 months following Fungisol injection. An inoculation was made by pricking a branch through the soft bark about 1 inch below its tip with a dissecting needle covered with *F. subglutinans*. The trees were observed once a month for disease symptoms.

To test the therapeutic effectiveness of Fungisol to eradicate the fungus from pre-existing infection, a naturally infected branch was removed from each tree 4 months after the last Fungisol injection. The samples were sent to the U.C. Berkeley pathology lab to confirm presence or absence of the fungus.

Results and Discussions

The experiment was concluded approximately 6 months after Fungisol injection on September 30. Pitch canker was present on every inoculated stem of injected and noninjected trees. (Table 1).

Symptoms first appeared approximately 6 weeks after inoculation and by 8 weeks were fully

TABLE 1. Incidence of Pitch canker symptoms on inoculated stems in untreated and treated trees.

Date of Inoculation	Incidence of Pitch canker*			
	July 1	July 30	Aug 22	Sept. 30
April 30	+	+	+	+
June 3	-	+	+	+
July 1		-	+	+
July 30			-	+

* (+) Each of the two inoculated branches on both untreated and treated trees showing characteristic dieback caused by pitch canker.

(-) No symptoms.

manifested. Clearly the Fungisol treatments did not prevent development of disease in inoculated branches. In addition, by the end of the experiment there were new naturally-infected branches in both untreated and treated trees.

A previously infested branch from each tree was sampled 4 months after the last Fungisol injection. Isolations in culture demonstrated that every branch contained *F. subglutinans*. Clearly Fungisol treatments did not eradicate the fungus from diseased branches.

Laboratory tests at U.C. Berkeley demonstrated that DEBC inhibited growth of *F. subglutinans* in culture, however, since disease developed in spite of injections it is suspected that DEBC did not accumulate in sufficient concentration in susceptible tissues to limit development of the fungus.

DEBC moves passively in the water-conducting tissues of pines and would be expected to accumulate in needles, where the water is transpired. It seems unlikely that DEBC could accumulate in diseased branches where the fungus has undoubtedly cut off water movement into it. Apparently even in healthy inoculated tissue, where you would expect good water/chemical movement, the DEBC concentration was not sufficient to prevent infection. Based on this study, Fungisol injection is not effective in controlling pitch canker in Monterey pine.

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