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CHEMICAL DETERRENTS TO GIRDLING OF YOUNG CITRUS BY SUBTERRANEAN TERMITES

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Abstract. **The Eastern subterranean termite, *Reticulitermes flavipes* (Kollar), was observed in association with girdling lesions of citrus trees in newly planted groves in southwest Florida. *Phytophthora* sp. was also detected in root tissue and surrounding soil of girdled trees. Two replicated field trials conducted in a commercial grove tested the ability of the insecticide chlorpyrifos (Lorsban 4E or 15G) and the fungicide metalaxyl (Ridomil 2E), either alone or in combination, to protect resets and established trees from termite girdling. Statistically significant reduction was obtained from all treatments, especially the reset trial, although there were no significant differences between chemical treatments. Lorsban 4E added to planting water caused severe phytotoxicity resulting in some tree loss although no phytotoxicity was observed with Lorsban 15G granules. The effectiveness of either metalaxyl or chlorpyrifos in protecting young trees from termite-associated lesions indicated a possible interaction between termites and *Phytophthora* in causing this type of damage.**

Introduction

Newly planted citrus in southwest Florida may often be subject to attack by subterranean termites. The termites remove bark from the tree crown below the soil line to the point of root branching (Fig. 1), and may also extend their activities above the soil line, sheltered by bark, trunk wraps, or galleries they construct.

Girdling from subterranean termites, especially after winter barking of young trees, was reported by Watson (1926). Dean (1954) showed that chlordane placed around the root zone of young citrus prevented attacks from desert damp-wood termites *Paraneotermes simplicicornis* (Banks) prevalent on newly cleared land. In the southwest Florida production area, damage from the subterranean termite *Reticulitermes flavipes* (Kollar) is associated with groves established on virgin pine and palmetto flatlands, a plant community typically harboring termite colonies. Attacks have been observed on Carrizo, Cleopatra and Swingle rootstocks. However, the most extensive tree loss occurred in a block of 'Valencia' sweet orange (*Citrus sinensis* L. Osbeck) on Ridge pineapple (*C. sinensis*) rootstock with a high incidence of both termites and foot rot, causing us to suspect some interaction between termites and *Phytophthora*.

The objective of the present study was to determine if an insecticide active against termites and/or a fungicide active against *Phytophthora* would protect young citrus from girdling by termites.

Materials and Methods

Two experiments were initiated in Fall of 1990 in a solid block planting of 6-month old 'Valencia' orange trees on Carrizo citrange (*C. sinensis* X *Poncirus trifoliata*) rootstock near Immokalee. The block was newly cleared pine and palmetto flatwoods, adjacent to an uncleared area of the same vegetative complex. Trees were planted in Immokalee fine sand at a spacing of 12 ft X 24 ft in two-row beds and received standard cultural practices. Polyfoam trunk wraps were applied at planting in Apr. and removed the following spring.

Treatments. All trees in the block were first examined for girdling by scraping away the top two inches of soil from around the crown. Trees exhibiting termite damage were removed, and two experimental procedures were carried out. One procedure was designed to protect rests where damaged trees had been removed, and the other to protect the remaining uninjured trees. On Oct. 9, 'Valencia' resets on Carrizo rootstock were planted with the following treatments and 3 gal of planting water; 3 lb a.i./acre chlorpyrifos (Lorsban 4E at 0.6 oz/tree), 0.72 lb a.i./acre metalaxyl (Ridomil 2E at 0.3 oz/tree), a combination of Ridomil 2E and Lorsban 4E at same rate, and an untreated check (N = 30 for each treatment). An additional 15 trees received an application of granular chlorpyrifos at the same per acre rate a.i. (Lorsban 15G at 2 oz./tree) scattered in the planting hole. The experimental design was completely randomized. The same materials and rates with the exception of the granular chlorpyrifos were applied to established trees on 5 Nov. for the second experiment. Applications were made as a soil drench in 8 alternate rows by pouring the solution into a 4 ft. diameter water ring around the tree. In the remaining 7 rows the solution was injected at about 35 psi to a depth of 12 inches and 6 inches from the crown at 3 points around each tree. The injector was adapted from a hand gun powered by a 12 volt Flowjet pump by replacing the nozzle with a 3 ft long

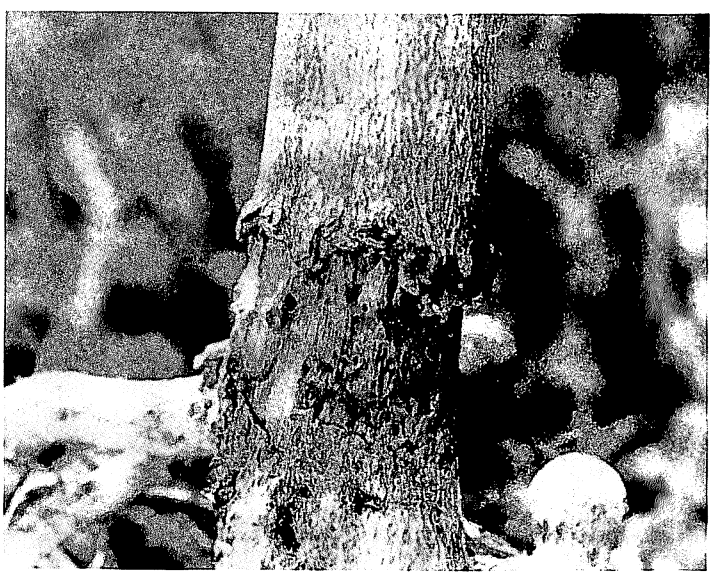

Figure 1. Termite damage on tree crown between roots and soil line.

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hollow brass wand with a hole drilled on each of 2 opposing sides of a pointed tip. The experimental design was a completely randomized block with 75 replications.

Evaluation. All trees were evaluated every 3 to 4 weeks to determine if new girdling had occurred or if termites were present, either on the tree or on a 2 in. X 4 in. aged pine "bait" block placed 3 in. below the soil surface and 8 in from the tree trunk. Samples of soil and feeder roots were collected within the dripline at a depth of about 5 in. of newly girdled and randomly selected ungirdled trees from all treatments to test for the presence of *Phytophthora* spp. using the method of Timmer et al. (1988). Initially (Nov.-Feb.), any tree with 1 propagule or more was considered positive whereas from Mar. through termination of the experiment, only propagule counts over 5 were considered positive. Analysis of variance was used to test for differences in length of the interval or "protection time" between treatment application and the occurrence of girdling. The relationship between the frequency of *Phytophthora* and the presence of girdling was tested using a chi-squared analysis.

Results

Termite activity. Termite activity and associated girdling of resets and established trees were observed through Dec., after which there was a lull until May, followed by a dramatic increase which continued over the summer as seen in control treatments (Figures 2 and 3). Where there were termites there was damage and where there was damage there were termites. Termites were observed on bait blocks in areas where damage occurred and there was a clear association between termites and girdling. Of 130 observations of termites on trees, all but 3 (2.3%) were found present in girdling wounds. Of a total 183 girdled trees, termites were found in the wounds of 127 (69%). Fecal spotting and galleries were seen where termites were not actually observed on girdled trees. Termite girdling was also characterized by clean removal of bark through the cambium layer, and by its confinement to the crown region above the roots. These characteristics clearly distinguished termite girdling from sloughing lesions caused by *Phytophthora*. Most affected trees were completely girdled one or two months after termite attack.

Treatment effects. All chemical treatments reduced termite attack compared untreated checks early in the trial with deterrent activity of chlorpyrifos extending to 6 months (Fig. 2 and 3). Treatments were more effective for resets than established trees, (Fig. 4 and 5) although there were significant differences in "protection time" between treated and untreated trees in both experiments (Table 1). Analysis showed no significant differences among chemical treatments, although a two-factor analysis of variance showed significant interaction between chlorpyrifos and metalaxyl ($df = 1,124$, $F = 3.67$, $P < 0.05$ for resets; $df = 1,295$, $F = 8.02$, $P < 0.005$ for established trees). Chemicals injected or applied as a soil drench gave comparable results. Lorsban 4E at the rate used in planting water caused severe phytotoxicity including wilting, foliar desiccation, and in 5 of 60 resets treated (8.3%), tree death.

Phytophthora. Although *Phytophthora*-like lesions were not observed on girdled trees, there was a significantly

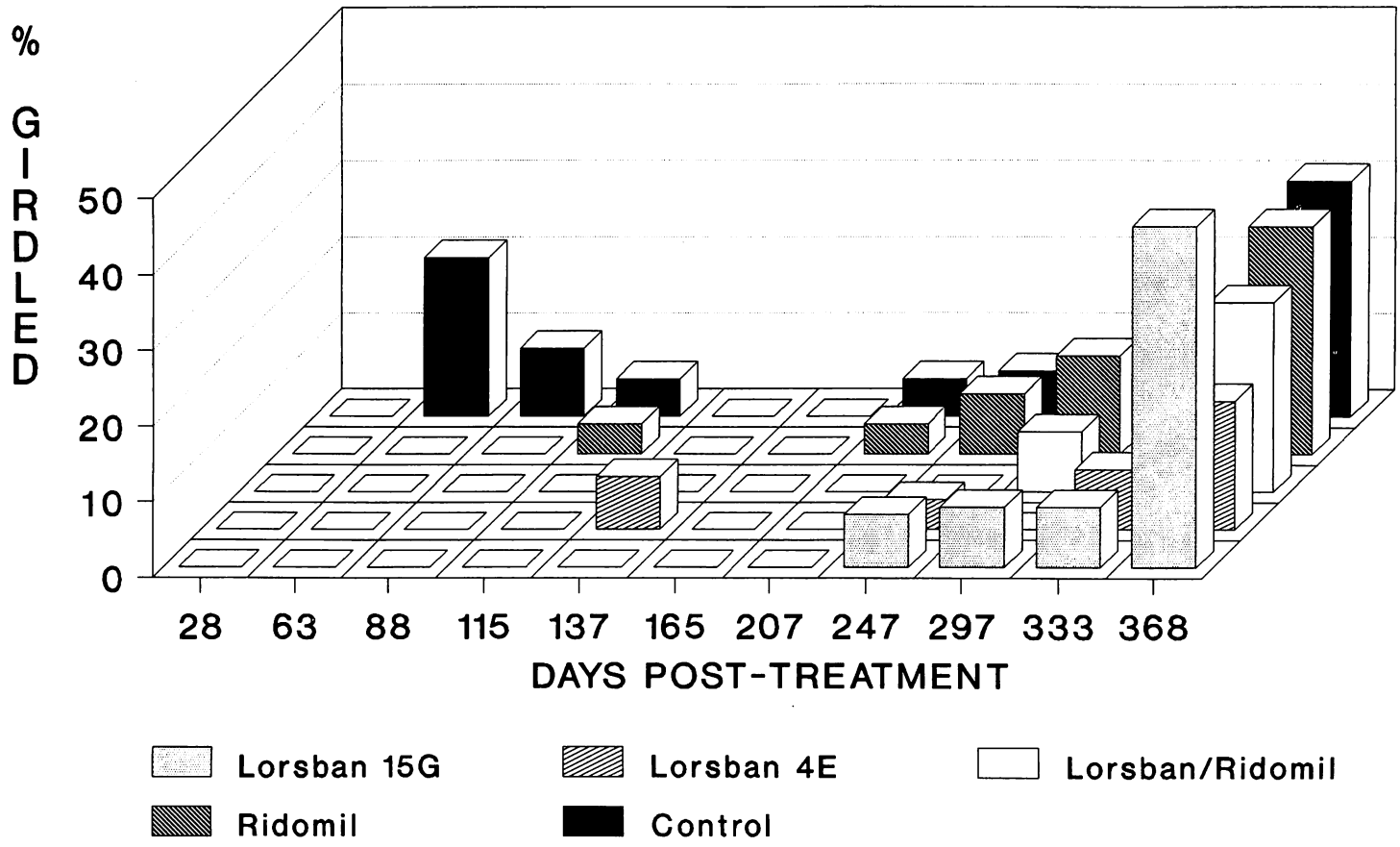

Figure 2. New occurrences of girdling by subterranean termites in resets.

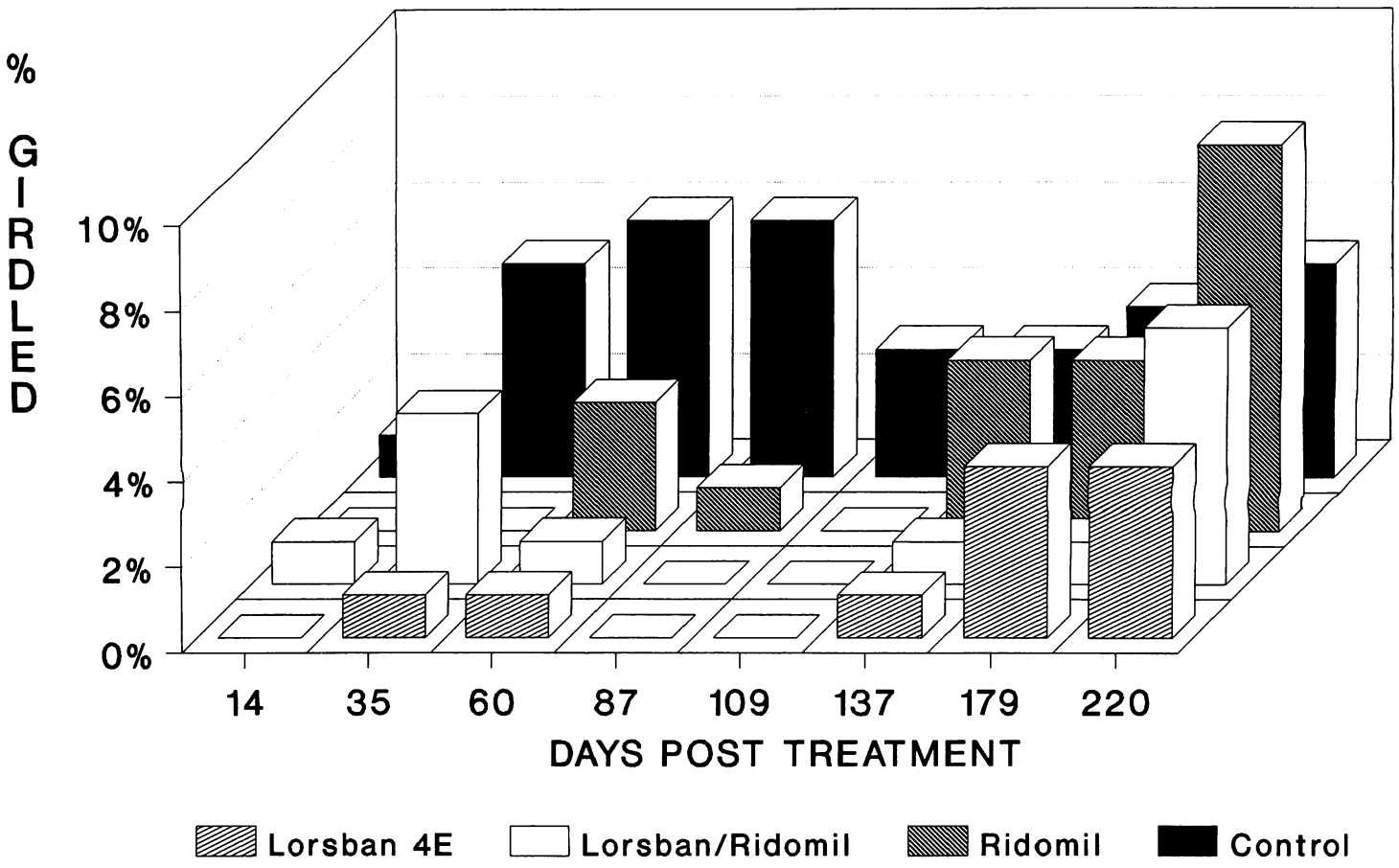

Figure 3. New occurrences of girdling by subterranean termites on established trees.

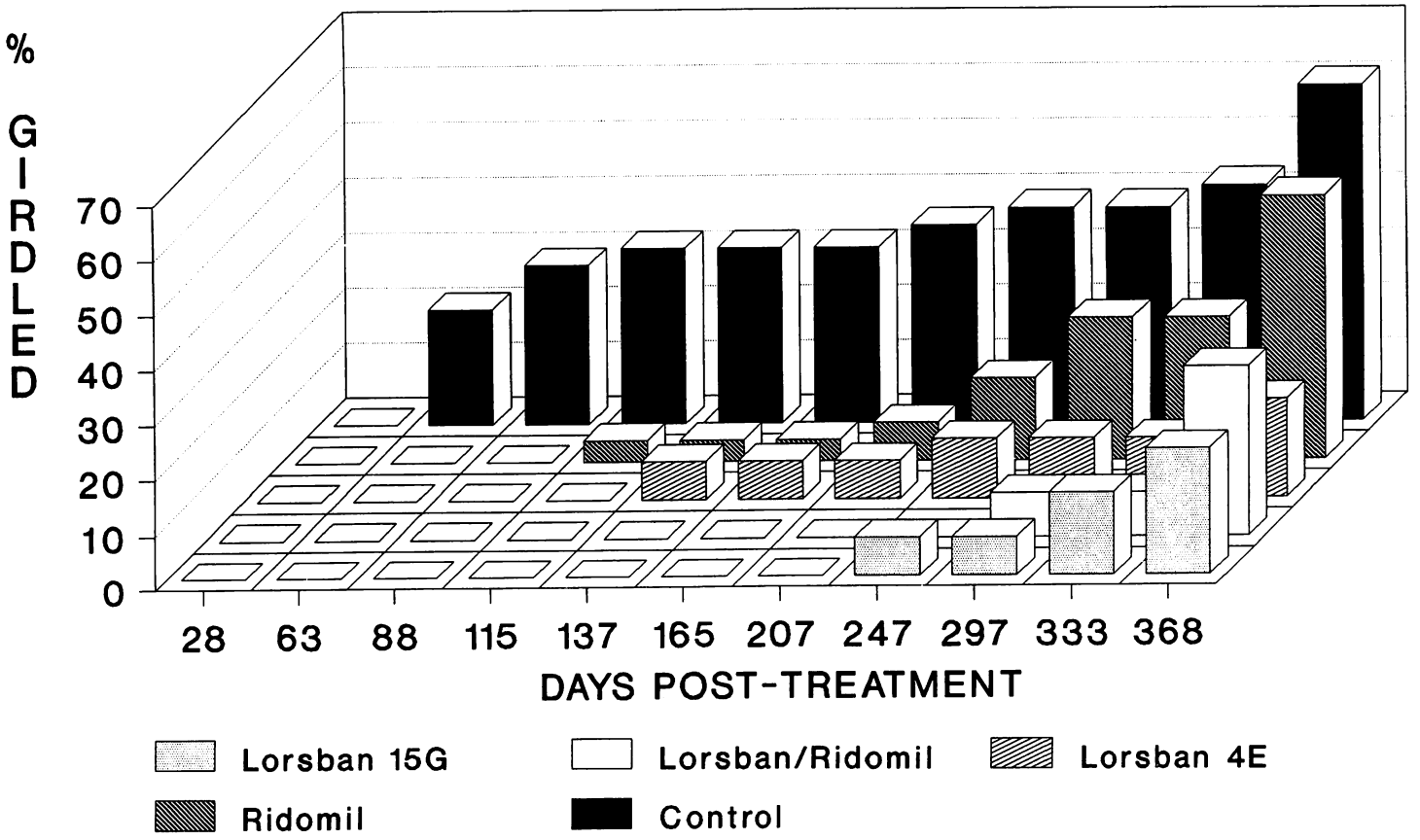

Figure 4. Cumulative incidence of girdling by subterranean termites on resets.

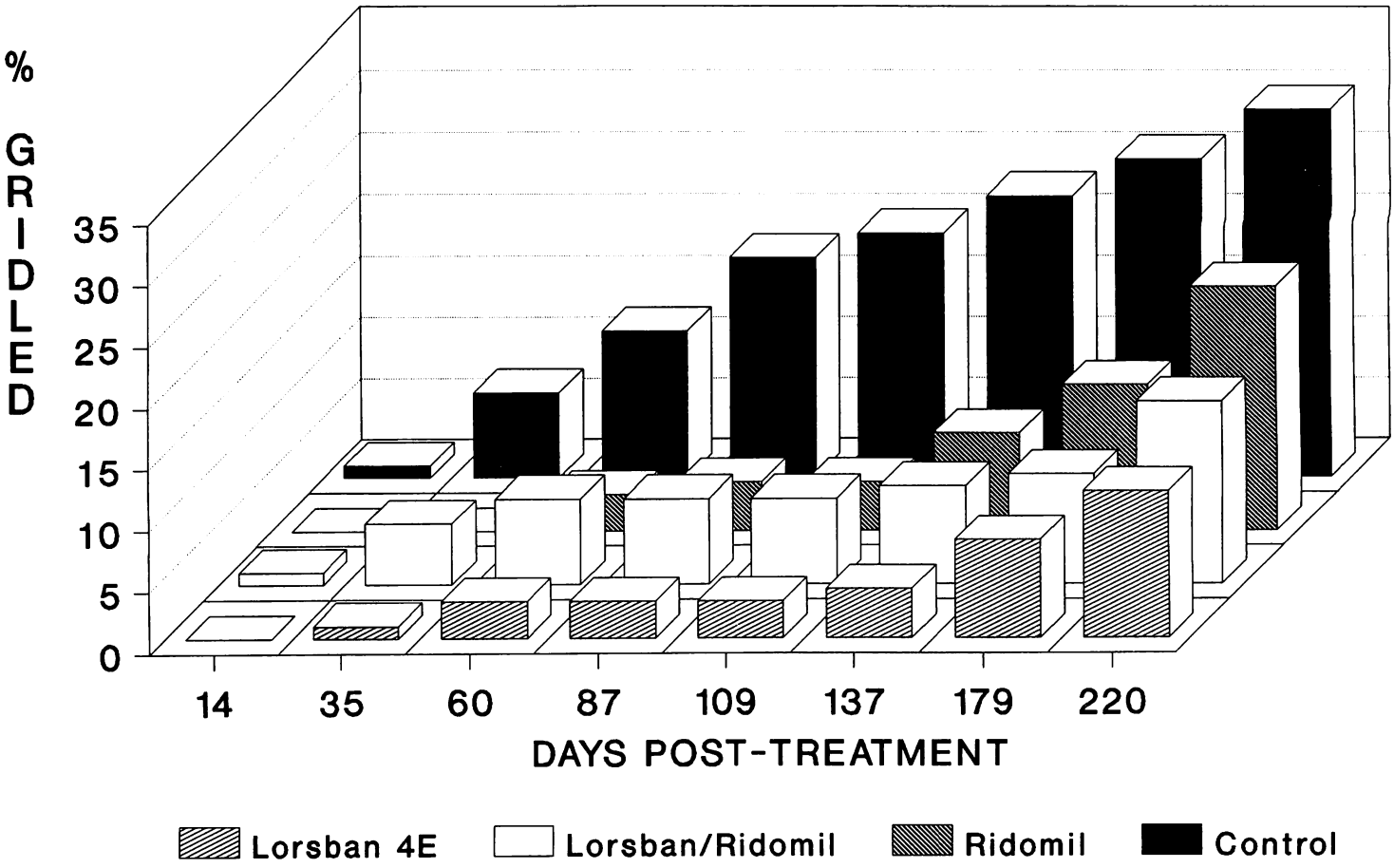

Figure 5. Cumulative incidence of girdling by subterranean termites on established trees.

higher incidence of *Phytophthora* propagules detected in samples from girdled trees (49%, N = 35) compared to ungirdled trees (19%, N = 68; X^2 = 9.7, df = 1, P < 0.002).

Discussion

Our observations clearly showed that subterranean termites attack young living citrus, and that the attack seems to be localized in the crown area of the trunk, resulting in girdling leading to tree death. We have yet to determine what attacts the termites or induces their attack. We did observe that no gum accumulated in the girdled area leading us to believe the termites were removing sap. Chlorpyrifos is known to inhibit tunneling by *R. flavipes* at concentrations of 40-100 ppm, although many pyrethroid termiticides are known to be more effective repellents (Su & Scheffrahn 1990). The repellant or toxic effect of chlorpyrifos concentrated around the crown appeared to be the most effective treatment used for preventing termite attack, and we are now experimenting with the application of granules in a ring around the trunk of established trees. The mode of action of metalaxyl was less clear. Possibly termites were attracted to infected trees so that uninfected trees were relatively unattractive. Watson (1926) stated that banking soil around young trees or setting them too deep were causes of termite attack, the same practices that increase the incidence of infection from *Phytophthora* (Whiteside 1971).

Table 1. Mean time interval ("protection time") between initiation of treatment and attack by termites, expressed as a percentage of the total duration of experiment = 368 days for the reset experiment or 220 for the established tree experiment.

Treatment	Protection Time (%) -Resets	-Established Trees
Lorsban 4E + Ridomil	97.1 a[z]	92.6 a
Lorsban 15G	94.4 a	
Lorsban 4E	93.1 a	95.6 a
Ridomil 2E	88.7 a	93.5 a
Control	68.6 b	81.7 b

[z]Means in the same column followed by the same letter are not significantly different (LSD P < 0.05).

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