NEW METHODS FOR CONTROL OF LEAFY MISTLETOE (*PHORADENDRON* SPP.) ON LANDSCAPE TREES

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Leafy mistletoes in the genus *Phoradendron* parasitize many trees common in amenity and natural landscapes in the United States from coast to coast, where winter temperatures are moderate (Fig. 1). These parasitic angiosperms reduce the vigor of host trees such as *Fraxinus, Juglans, Quercus, Gleditsia, Alnus,* and others (5), by tapping the host tree xylem for water and mineral nutrients. Branches infected with mistletoe may die (7) and if the whole tree is exposed to other stresses, such as drought, the mistletoe may contribute to its death (8).

Current recommendations for control of this pest include not planting susceptible species; removing mistletoe-infected branches at least 12 inches below the site of infection; or pruning the mistletoe cluster flush to the host branch and wrapping the infected area with black plastic, tar paper or aluminum foil (1). Mistletoe can also be pruned to a stub and treated with a formulation of (2, 4-dichlorophenoxy) acetic acid (2, 4-D) applied in a foam (1, 2, 8). While these control methods are effective, they are time consuming, expensive and potentially damaging to plants and humans. The City of Sacramento spent $1.4 million for mistletoe control in 1978-79, including some remedial treatment (5), and now Sacramento spends approximately $350,000 annually.

Ethephon[1] ([2-chloroethyl] phosphonic acid) is readily absorbed by plant tissues and then releases ethylene, a plant growth regulator affecting many physiological plant processes (6). When sprayed on intact clusters of leafy mistletoe, ethephon at 2% a.i. can cause complete abscission of the aerial parts of the parasite (3). Stress on the host is thus reduced, and mistletoe seed production is eliminated or delayed. We have observed, however, that regrowth of the mistletoe from buds or from the endophytic system can occur in the same season following such a treatment. In the present study, therefore, we tested for control of mistletoe regrowth by applying ethephon to cut stubs of *Phoradendron,* rather than to the whole aerial cluster. In our experiments, we tested the effects of ethephon on two species of *Phoradendron* parasitizing three host tree species. In the same experiments, we compared ethephon treatment to other materials, including the currently-recommended control, black plastic wrap. Black plastic works because it blocks light from penetrating to the host branch, so that the mistletoe cannot carry out the photosynthesis necessary to survive. We tested an aerosol pruning paint[2] because it blocked out 97% of incident light, and might have an effect similar to black plastic. In addition, we tested glyphosate[3] (N-[phosphonomethyl] glycine). Mistletoes reportedly do not translocate substances back to the host branches through the phloem (4), so we decided to test whether this systemic herbicide could kill the parasite without harming the host.

Materials and Methods

Three experiments were conducted during the 1989 dormant season. Heavily-infested mature trees of a single species and approximately the same age were selected, and treatments were carried out using aerial platforms. Mistletoe plants

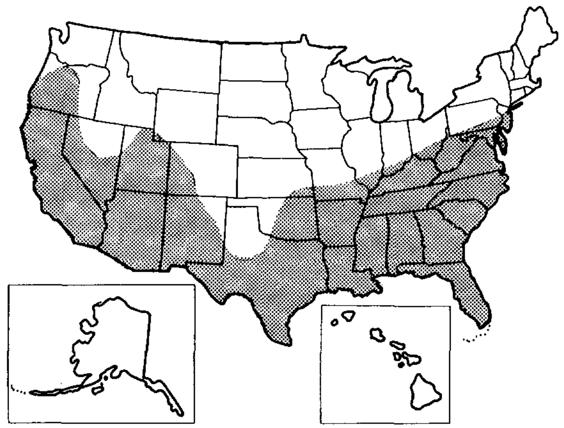

Figure 1. Distribution of *Phoradendron* on both hardwoods and conifers in the United States (2, 7).

8" to 40" in diameter were pruned to stubs 2" long and treated. Ethephon treatments were applied with a hand-held sprayer and stubs were sprayed to runoff. Glyphosate was applied with a paint brush. In each experiment some mistletoe clusters were pruned to stubs and left untreated as controls. The threated and control mistletoe stubs were marked with flagging tape. Regrowth was monitored during the growing season with field glasses, but final counts were carried out from aerial platforms or ladders. Regrowth was scored as mistletoe shoots arising from stubs or from the haustorial (root) system of the parasite. Percent regrowth was calculated as the percentage of mistletoe stubs in a treatment that had started to regenerate when followup observations were made. Damage to treated host branches was examined at the end of the first growing season. Details of individual experiments are given below.

Modesto ash (Fraxinus velutina var. *glabra* 'Modesto'). Clusters of *Phoradendron macrophyllum* on Modesto ash street trees in the city of Sacramento, CA were cut to stubs and treated with 2% or 10% ethephon (+ 1% surfactant[4]) on April 1, 1989, just before bud break. Controls consisted of pruning the mistletoe clusters to a stub without ethephon treatment (pruned only). Treatments including untreated controls were replicated 25 times. Regrowth was determined by direct observation of the cut stubs, 9 and 15 months after treatment (January 11 and June 24, 1990). (Fig. 2)

Blue oak (Quercus douglasii). Clusters of *Phoradendron villosum* on blue oak trees in Oroville, CA were cut to stubs and the stubs were treated with 10% ethephon or 5% glyphosate on February 24, 1989, during the dormant season. Controls consisted of pruning mistletoe clusters to a stub without further treatment (pruned only). Regrowth was determined 12 and 17 months after treatment (January 8 and June 25, 1990). Treatments including untreated controls were replicated 10 times. (Fig. 3)

Honeylocust (Gleditsia triacanthos f. *inermis).* Clusters of *Phoradendron macrophyllum* on honeylocust trees in Davis, CA were cut to stubs and stubs were treated on January 22, 1989, during the dormant season, with 10% ethephon

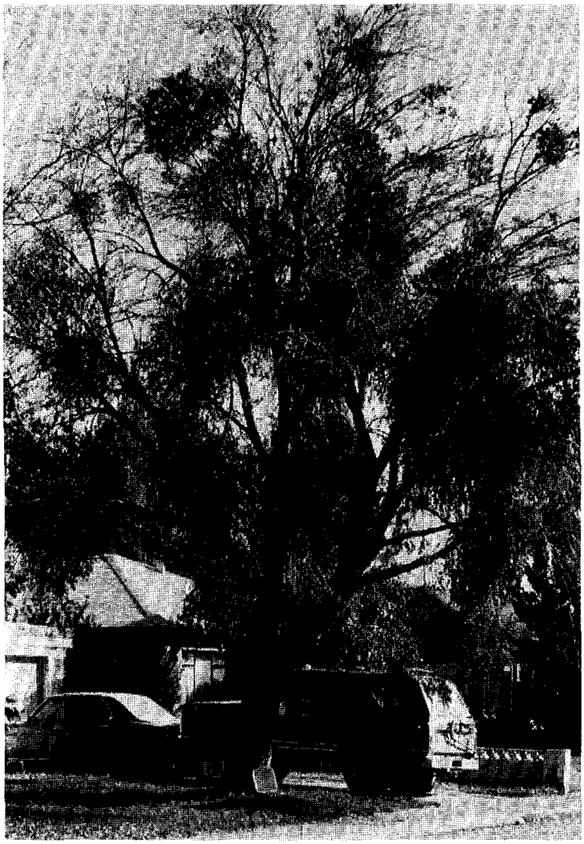

Figure 2. Fraxinus (Modesto ash) heavily infected with *Phoradendron macrophyllum* (leafy mistletoe) in Sacramento, California, Photo credit: Linda L. Dodge.

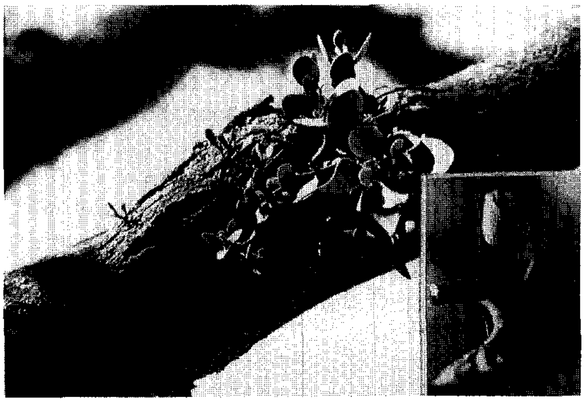

Figure 3. Characteristic regrowth of mistletoe shoots from buds formed at the site of infection. Mistletoe regrowth can occur within the first growing season. This photograph was taken two years after pruning the original cluster to a stub. *INSET.* Stub of mistletoe cluster treated with 10% ethephon shows no regrowth.

+ 0.05% surfactant, with 5% glyphosate, with pruning paint, or by wrapping in black plastic. Controls consisted of pruning mistletoe clusters to stubs without further treatment (pruned only). Regrowth was scored 12 months after treatment (January 6, 1990). Treatments were replicated 4 times.

Results

Modesto ash. When *P. macrophyllum* stubs on *Fraxinus* branches were treated with 10% ethephon, regrowth was completely prevented within 9 months after treatment (Table 1). By 15 months after treatment, few mistletoe stubs had regrown (6% regrowth). Treatment with 2% ethephon was less effective at controlling regrowth (36% regrowth after 15 months). When mistletoe stubs were pruned only (control), 85% of the stubs regrew by 9 months after treatment, and 73% had regrown by the second observation. No visible difference in damage to host leaves or branches was observed on ethephon-treated branches compared with untreated controls.

Blue oak. When cut stubs of *P. villosum* on *Q. douglasii* were treated with 10% ethephon, the pattern of regrowth was similar to that reported in Experiment 1, with 0 regrowth at 12 months, and 8% regrowth observed at 17 months (Table 2). No differences in host branch damage were observed due to the ethephon treatment. Good control of regrowth was achieved by treatment of mistletoe stubs with glyphosate (8% regrowth after 17 months, Table 2). However, extreme host leaf deformity was observed following treatment on all treated branches. When mistletoe stubs were left untreated (pruned only), 40% regrew by 12 months after pruning. Only 20% of the untreated stubs were growing by 17 months after pruning, indicating that some of the initial regrowth had died back.

Honeylocust. As with the other experiments, 10% ethephon completely controlled regrowth of mistletoe stubs as observed at 12 months following treatment (Table 3). Glyphosate treatment was completely ineffective at controlling regrowth (100% regrowth). In addition, host leaf deformity was observed in all glyphosate-treated branches. Treatment with pruning paint eliminated regrowth (0 regrowth), and no host branch damage related to treatment was observed. Wrapping mistletoe stubs with black plastic also effectively controlled regrowth of mistletoe after 12 months. However, ants, scale and mealy bugs were observed to accumulate under the black plastic. No significant differences in host branch damage were observed when ethephon-treated branches were compared with untreated controls.

Discussion

Ethephon. In all the experiments, treatment of cut stubs with 10% Ethephon prevented regrowth completely after the first growing season. Treatment of mistletoe stubs with a 2% formulation of ethephon also inhibited regrowth, but to a lesser extent (32% regrowth on ash). There was no visible difference in damage to host leaves or branches measured on ethephon treated branches compared with untreated controls.

Pruning only. In general, pruning mistletoe clusters to stubs slowed the spread of mistletoe, but did not give longterm control on *Fraxinus* or

Table 1. Mistletoe regrowth: *P. macrophyllum* on *Fraxinus*

Treatment	*Date*	*Percent Regrowth*
2% Ethephon	1/90	32
	6/90	36
10% Ethephon	1/90	0
	6/90	6
Pruned only	1/90	85
	6/90	73

Table 2. Mistletoe regrowth: *P. villosum* on *Quercus*

Treatment	*Date*	*Percent regrowth*
10% Ethephon	*1/90*	*0*
	6/90	*8*
Pruned only	*1/90*	*40*
	6/90	*20*

Table 3. Mistletoe Regrowth: *P. macrophyllum* on *Gleditsia*

Treatment	*Date*	*Percent regrowth*
10% Ethephon	1/90	0
Pruning paint	1/90	0
Black plastic	1/90	0
Pruned only	1/90	100

Gleditsia trees infested with *P. macrophyllum.* In contrast, mistletoe regrowth from the pruned-only stubs of *P. villosum* on blue oak was very low, only 20% by the second season. The lack of regrowth of *P. villosum* on oaks even without ethephon treatment could indicate a difference in response based on mistletoe or host species. Alternatively, environmental differences between treatment sites may have accounted for the difference in response. Interestingly, regrowth of mistletoe actually decreased between measurements in two experiments (Tables 1, 3). It appears that some of the new mistletoe shoots may died back in the second season.

Glyphosate. Glyphosate was extremely variable in its control of mistletoe after the first growing season (0-85% regrowth). Host leaf deformity was observed on all branches treated with glyphosate in the first growing season. In contrast to previous reports, the damage to host leaves we observed suggests that translocation might occur between the mistletoe and the host tissue. Because of these problems, the use of glyphosate cannot be recommended for treatment of mistletoe.

Pruning paint. Treatment of mistletoe stubs with pruning paint prevented the regrowth of *P. macrophyllum* on *Gleditsia,* after one growing season. Treatment with this compound was quick and easy. Further studies with pruning paint are warranted.

Black plastic wrap. Black plastic wrapping controlled mistletoe regrowth after one growing season on *Gleditsia.* However, ants, scale and mealy bugs were observed to accumulate under the black plastic. Thus the microenvironment created under the plastic is cause for concern. Plastic may cause heat damage to the bark, and it is not aesthetically pleasing.

Conclusion

In conclusion, we found that 10% ethephon applied to mistletoe stubs can be used effectively for mistletoe control in landscape trees. Ethephon appears to be a cost effective, environmentally safe, easy to use and inconspicuous method for mistletoe control. The 10% ethephon treatment would be appropriate on high value landscape trees, or on large scaffolds in combination with pruning of smaller limbs. Black plastic wrapping, while effective, has some possible drawbacks in terms of bark health. Apparently the effectiveness of pruning paint was similar to that of black plastic wrap. More research is needed to confirm the promising preliminary results with pruning paint.

[1]Florel Pro[R], Rhone Poulenc AG Company, Research Triangle Park, North Carolina.
[2]Tree Sealer[R], Morrison's Orchard Supply, Yuba City, California.
[3]Roundup[R], Monsanto, St. Louis, Missouri.
[4]Surfel[R], Rhone Poulenc AG Company, Research Triangle Park, North Carolina.

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