A vexing problem along University Avenue in Berkeley in early summer is the rain of sticky tuliptree aphid honeydew. Biological control attempts have failed. Gradual replacement of the tuliptree may be the least expensive solution.

Integrated pest management of tuliptree aphids

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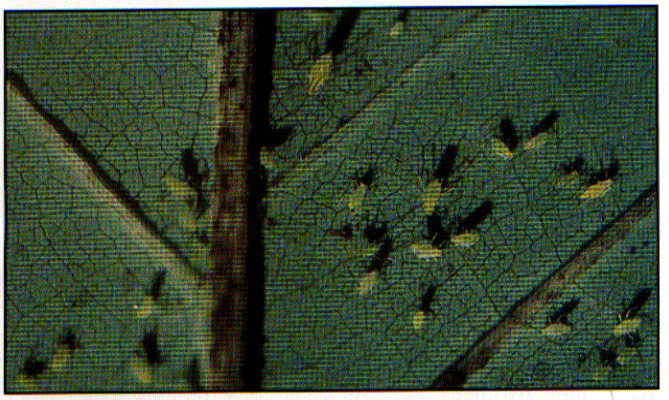
Municipal streets in America are lined with about 57 million trees, with a value conservatively estimated at $15 billion. While trees greatly enhance the quality of our urban environment, they also have some disadvantages, including the cost of maintenance. Pest management is among the major costs, but research on economical and ecological solutions to urban tree pests has lagged far behind investigations of pests attacking commercial forests or agriculture.

One pest-prone street tree in the San Francisco Bay area is the tuliptree, *Liriodendron tulipifera* L. Tuliptrees are native to the moist temperate zone hardwood forests of the eastern United States; they are adapted to deep, rich, well-drained soils and plenty of summer moisture. In the late 1960s, approximately 400 tuliptrees were planted along University Avenue in Berkeley, California. Unfortunately, tuliptrees are not well suited for the summer drought of a Mediterranean climate, are sensitive to air pollution, and in Berkeley are stressed from being planted in poorly drained clay soils covered with pavement.

A source of complaints

The most vexing problem of University Avenue's tuliptrees has been the summer "rain" of aphid honeydew.

Tuliptree foliage glittering with aphid honeydew.



Heavy populations of tuliptree aphids (above) produce a copious supply of sticky honeydew. Efforts to suppress the aphid by releasing eggs of the predaceous common green lacewing (below) failed because of predation of the eggs by the Argentine ant.

Aphids are considered to be the foremost street tree pest problem in the western United States. Their honeydew, and an associated black sooty mold, makes a sticky mess on parked cars and sidewalks. Tuliptree aphid honeydew along University Avenue has been the City of Berkeley's primary source of street tree pest complaints. To assist street tree pest managers with the aphid honeydew problem, a two-year integrated pest management research project was funded by the Elvenia J. Slosson Endowment Fund for Ornamental Horticulture.

A suitable pest monitoring method is the prerequisite of any successful integrated pest management program. Honeydew excreted by the tuliptree aphid, *Illinoia liriodendri* (Monell), was efficiently monitored in the field using commercially available, yellow water-sensitive papers, on which honeydew produces distinct blue drops.

Along University and Piedmont avenues in Berkeley, highly significant correlations were found between aphids (per leaf) and honeydew (droplets per square centimeter per hour) except at relatively low densities (less than about four aphids per leaf). The honeydew excretion rate was positively correlated with temperature. The highest rate (drops per square centimeter per hour) was from 11:00 a.m. to 3:00 p.m. and the lowest from 7:00 p.m. to 7:00 a.m. Monitoring honeydew required 30 percent less time than taking the same number of aphid samples. In contrast to counting insects, honeydew monitoring provides a direct measure of damage and could be adapted for efficiently field-monitoring other honeydew-producing insects.

In an effort to suppress the tuliptree aphid, approximately 2,000 eggs of the predaceous common green lacewing, *Chrysoperla carnea* (Stephens), were released four times on each of eight University Avenue tuliptrees during the spring of 1984.

Biological control fails

On trees foraged by the Argentine ant, *Iridomyrmex humilis* (Mayr), the ants removed 98 percent of the green lacewing eggs from the egg release tapes. A total of about 1,250 larvae per tree emerged from the 8,000 eggs released on each tree without ants. Of the larvae that did emerge, 50 percent died as a result of cannibalism or entrapment in the sticky egg release tapes, and approximately 625 first-stage lacewing larvae on each tree were free to forage for aphids.

Inundative lacewing releases of *C. carnea* did not suppress tuliptree aphid populations because of the ant predation, the low viability of commercial eggs used for the releases (0 to 73 percent emergence), cannibalism by emerged larvae, and inadequate release technology. The poor quality of commercial lacewing eggs is particularly disturbing, since lacewings are probably the predaceous insect most widely available from, and promoted by, commercial insectaries. Inundative releases of insectary-reared lacewings have been demonstrated to suppress mealybugs in pears, Lepidoptera larvae in cotton, and aphids in the greenhouse and on row crops. A poor-quality commercial product, however, will preclude the effective use of lacewing releases in operational pest management programs.

Wheast (yeast cultured on cheese whey, then sterilized) combined with sucrose has been successfully used in row crops to increase predator density. Beneficial insect-attracting food sprays that simulate insect honeydew were evaluated along University Avenue in 1985 as a method of increasing aphid predators. No significant differences were found in the density of tuliptree aphids or their predators on food-sprayed trees compared with untreated controls. This may be because of a lack of synchrony between high aphid populations and sufficiently warm evening temperatures for adult lacewings to be active. University Avenue tuliptree aphid populations were highest in late spring and early summer, an often cool, foggy season in Berkeley. Adult lacewings were more active in late summer, when weather around the San Francisco Bay is generally more clear and warm.

No residential complaints

While tuliptree aphid honeydew along commercially developed University Avenue has been a continuing source of street tree pest complaints, no aphid honeydew complaints have been received regarding tuliptrees planted along Berkeley's residential streets. Natural enemies, tree vigor, or local environment have been suggested as possible explanations for the presumed lower aphid density in residential tuliptrees. To test these hypotheses, aphid and honeydew density along University Avenue during 1985 was compared with that of tuliptrees along Piedmont Avenue in a residential neighborhood.

The Berkeley Parks and Marina Department, receiving tuliptree aphid honeydew complaints along University Avenue during June and July, applied Safer Agro-Chem insecticidal soap. No complaints were received from Piedmont Avenue residents, and no treatments were done there. However, 1985 aphid and honeydew densities along Piedmont Avenue were found in this study to be as high as and, during July and early August, significantly higher than those along University Avenue.

The difference between citizen responses to honeydew in these two locations was probably due to the fact that merchants, whose livelihood depends on customers who must park and walk under the messy trees, were more readily annoyed than were homeowners.

No aesthetic injury levels have been established for street tree aphid honeydew. Damaging levels of tuliptree aphid honeydew result from a combination of honeydew production (excretion per aphid times the number of aphids) and the length of time during which honeydew has been accumulating. The differences in citizen response to University and Piedmont Avenue conditions demonstrates that aesthetic injury levels can be difficult to determine quantitatively, because pest tolerance varies among locations and individuals.

Maintenance vs. replacement

Trees require maintenance beyond pest control to function satisfactorily along city streets. Because University Avenue's tuliptrees have been particularly demanding of Berkeley's street tree management budget, the projected costs of maintaining these problem-plagued ornamentals was compared with the costs of tree removal, replacement, and maintenance of the better adapted London plane, *Platinus acerifolia*.

Excluding the costs of pest management and repair of sidewalks that have been damaged by the roots of the moisture-seeking tuliptrees, 20-year maintenance costs of 400 University Avenue tuliptrees ($222,000) were found to nearly equal the costs of tuliptree removal, replacement, and maintenance of 400 less-problem-prone plane trees ($223,000). The projected costs of sidewalk repair and the least expensive method of aphid honeydew management (systemic insecticides) could increase the 20-year costs for tuliptrees by more than $100,000. A temporary loss in aesthetic value would, of course, occur from replacing mature (but problem-prone) street trees. The long-term benefits of gradually replacing these tuliptrees would be a substantial cost savings, less bother, and greater eventual attractiveness.

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Insect pest management manual

Support of the Slosson Endowment Fund contributed to the compilation of a landscape insect pest management manual by Carl Koehler, University of California Cooperative Extension Urban Entomology Specialist, in Berkeley.

The manual is designed for arborists, public- and private-sector grounds maintenance personnel, nursery growers, landscape architects, consultants, homeowners, and students.

It includes discussion of the theory and practice of landscape insect pest management for 80 plants or plant groupings, and describes symptoms of attack of approximately 400 common pests.

The manual identifies the different ways in which pests might be managed, allowing the user to decide the best course of action.

To assist the manual user in the identification of less common pests, a system for classifying the probable pest type is offered, based on plant symptoms and illustrated with color photographs. The bulk of the manual, consisting of tables, is not illustrated; the reader is referred, however, to the profusely color-illustrated Cornell University publication *Insects That Feed on Trees and Shrubs*, to which the manual's author also contributed.

The manual will be available from the Publications unit of the UC Division of Agriculture and Natural Resources early in 1987.