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TULIPTREE APHID HONEYDEW MANAGEMENT

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Abstract. Aphids are important pests in the urban forest because of the honeydew which they produce. A method for field monitoring honeydew has been developed to assist in the management of the aphid *Illinoia liriodendri* on tuliptrees, *Liriodendron tulipifera.* Monitoring can assist in timing the application of aphid control tactics and may provide for more effective honeydew management. However, the most economical long-term solution to pest prone street trees may be to replace them.

Résumé. Les pucerons représentent des insectes nuisibles importants pour la forêt urbaine dû à la substance mielleuse qu'ils produisent. Une méthode de terrain pour évaluer et contrôler ce problème a été développée pour aider au contrôle du puceron Illinoia liriodendri sur le tulipier, Liriodendron tulipifera. La méthode de surveillance permet de mieux synchroniser les mesures de contrôle et peut améliorer la gestion de ce problème. Cependant, la solution la plus économique à long terme serait de remplacer les arbres de rues plus susceptibles aux insectes et aux maladies.

Aphids are a major pest problem in our urban forests. Aphid honeydew and associated black sooty mold produces a sticky, unsightly mess on sidewalks and parked automobiles. A national survey of over 1,500 cities found that aphids were considered to be the most important group of street tree insect pests in the United States (4).

The tuliptree, *Liriodendron tulipifera,* is often host to an abundant aphid species, *Illinoia liriodendri,* which apparently occurs wherever tuliptree is grown. This study was undertaken to develop an ecological or integrated pest management program for tuliptree aphid honeydew.

Pest prevention planning. Proper plant selection is an important first step in minimizing pest problems. In addition to the aphid honeydew problem, the tuliptree's eventual very tall height and large canopy create maintenance problems in commercial areas where buildings are set back only a short distance from the street. This tree's high moisture demands combined with the compacted soils around intense developments make tuliptrees prone to root displacement of sidewalks resulting in costly repairs and potential liability. A more appropriate tuliptree planting location is in lawn or park areas where these trees have adequate moisture, room for growth, and where honeydew will be less bothersome than in pavement areas.

Tuliptree aphids and honeydew. Tuliptree aphids overwinter as tiny eggs laid in the fall, primarily in bark crevices near buds. In the spring the aphid eggs hatch when the leaves begin flushing. Aphids' predominantly parthenogenic (without mating) reproduction combined with a short generation time can lead to rapid buildups in their populations during the spring and summer. Male and egg laying female aphids are produced in the late fall.

Monitoring is an important component of all integrated pest management programs, yet most tree managers respond to complaints or spray prophylatically prior to any actual problem. Responding only to complaints has disadvantages because the foliage and sidewalks are already fouled with honeydew and sooty mold. Two separate responses may then be required, aphid suppression and cleaning up the honeydew.

Treatment on a "preventative" basis may be wasteful as tuliptree aphids may not be a problem every year. This appears due at least partly to natural controls such as beneficial insects, temperatures unfavorable to aphids, or periodic rains which may cleanse away honeydew before it

accumulates to bothersome levels. Insecticides applied prophylactically can result in excess environmental contamination and may lead to future aphid outbreaks by negatively impacting the beneficial natural enemies of aphids. Some aphids have become resistant to common insecticides and may become more difficult to control on trees with a history of frequent pesticide use.

Aphids can be monitored beginning each spring by counting and recording the number of insects found each week on the foliage of 4 to 8 one-foot-long branch terminals on each of several trees in each location where aphid honeydew has been a problem in previous years. However, monitoring honeydew, rather than counting aphids, has the advantage of directly measuring the actual problem (falling honeydew, not aphids on foliage). Monitoring honeydew takes less time than counting aphids, particularly when the insects become numerous (1).

Honeydew Monitoring

Honeydew can be efficiently monitored using yellow water-sensitive insecticide spray droplet monitoring cards on which honeydew produces distinct blue dots.[1] The cards were placed on plastic petri dishes (about 4" in diameter) and suspended from the tree canopy using a bent wire coat hanger. The hangers should position the honeydew-monitoring cards about 18" beneath, and 6-12" from the terminal of, the branch. Select lower outer branches with little or no overhanging canopy above them other than the sample branch. Position the monitoring devices using a ladder or a terminally hooked pole (we used the upturned hook of a coat hanger bent around the end of a pole pruner to deploy and retrieve our devices).

Conduct your monitoring during rainless days of relatively normal temperatures. Deploy the devices for approximately 4 hours from about 11am to 3pm. Four per tree should be used, one in approximately each cardinal direction. At least four trees in each area where honeydew has been a problem should be sampled at about 7-10 day intervals. Select sample trees which represent a variety of "microhabitats" such as those on opposite sides of the streets and on both corners and midblock. Sampling should commence several weeks before the honeydew problem season typically begins, which in northern California means sampling starting in late April or early May. The most important consideration in monitoring is to be consistent in your methods so that you can safely assume that any change in your data reflects corresponding change in aphid honeydew abundance.

The average number of honeydew drops per cm^2 of card surface should be determined for the 4 hour period and recorded. This can be done in one of three ways: A) Count and record all drops on all cards and then calculate the average of these values. This method is most exact, but most time consuming. B) Estimate the average number of drops per card by counting the droplets in three randomly chosen 1 cm^2 portions of each card and using the average of these "subsamples" as the value for that card. C) Visually compare the droplet density on your monitoring cards to standards prepared from cards with known droplet densities as determined above in option A (Fig. 1). Table 1 contains more detailed instructions on each method.

Once you have calculated the average honeydew density for that date, you can make your decision whether to spray as discussed in the following section on "Establishing Treatment Thresholds." Honeydew monitoring before and soon after treatments can also be used to evaluate the effectiveness of your control tactics.

Establishing Treatment Thresholds

No aesthetic injury levels have been established to determine at precisely what level honeydew becomes bothersome. Tolerance for honeydew will vary among individuals and neighborhoods and according to the extent of sooty mold growth. Honeydew tolerances can also change. When the public learns that aphids rarely if ever kill trees, they may tolerate more of it. Conversely, when they expect or become used to its control, for ex-

1Water sensitive cards are available from several distrubutors and in many sizes. We used 76mm x 52mm cards manufactured by Ciba-Geigy and distributed by Spraying Systems Co., North Ave. & Schmale Rd., Wheaton, Illinois 60187. The cards should be handled wearing gloves or using a forceps as they will change color from contact with the moisture in your skin.

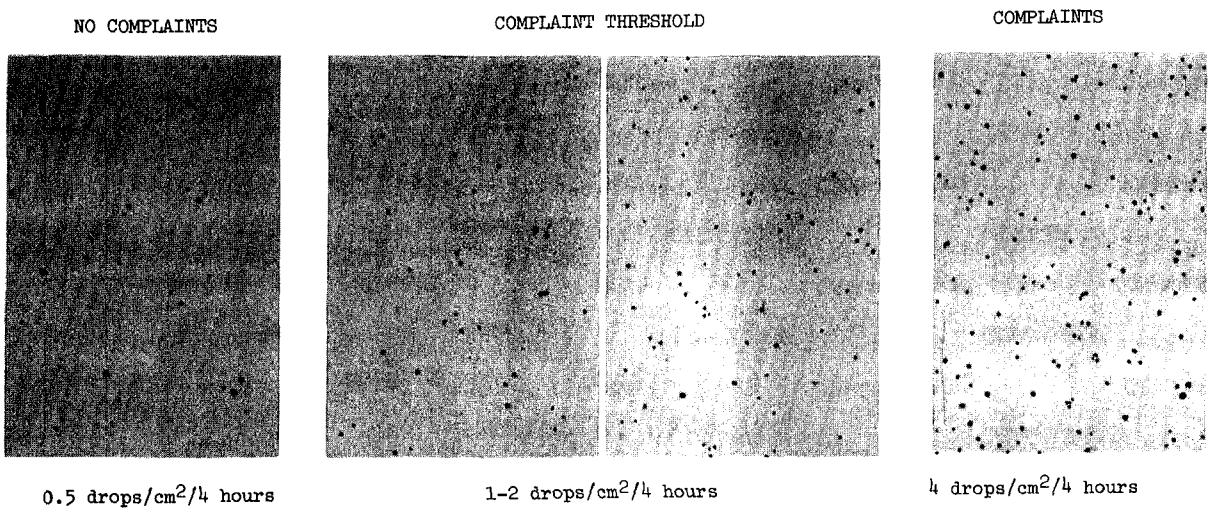

Fig 1. Tuliptree aphid honeydew droplet density monitored (using 7.6 × 5.2 cm cards) along a commercial street (University Avenue) in Berkeley, California, during 1985. "Complaint Threshold" represents the droplet density (1 to 2 drops/cm^2 from 11am to 3pm) which began to prompt complaints to the city.

Table 1. Directions for calculating average tuliptree aphid honeydew density

Select one of the three honeydew density calculation methods below. Below is an example from the first lines of a form which can be used to record and calculate the honey dew data from each card according to the method selected:

A. Count all the drops on the card and record this in box II (box I is not used). Calculate the area of the monitoring card by multiplying its length times width (in centimeters). Put this area number in box III (it should be the same for all cards). Divide the number in box II by the number in III and place this in the "Average"box.

B. Estimate the average number of drops per card through "subsampling". Do this by cutting a hole 1x1 centimeters in size in an index card. Place this cut-out at random on your monitoring card and count the number of whole drops appearing through this "window." Record that number in box I. Repeat this process two times and place those values in boxes II and III. Add the numbers in boxes I through III, divide their sum by 3, and place that number in the "Average" box.

C. Estimate the droplet density on each card by visually comparing it to prepared standards (Fig. 1). Record this visual estimate for each card in the "Average" box. Prepare your visual comparison standards by labeling and preserving a range of cards, each of known droplet density, as calculated above in method A.

FOR ALL METHODS add up all of the "Average" values for each card. Divide this sum by the total number of cards (which should be the same as the total number of "Average" values). Record this overall average as the "Grand Mean." Use this grand mean to make your treatment decision as discussed in the text section "Establishing Treatment Thresholds."

TULIPTREE APHID HONEYDEW MONITORING DATA FORM

Card	*Monitoring*		*Honeydew droplet density/calculations*			
No.	*Date*	*Tree location*	*Box 1*	*2*	*3*	*Average*
1.						
2.						
3.						
etc.						

Grand mean _____

ample because a city has had a street tree pest management program, the public may come to expect prompt action and tolerate less honeydew.

We found that in the main commercial district of Berkeley, California, the City began to receive complaints when honeydew excretion measured as the average of all monitoring devices exceeded about 1 to 2 drops/cm^2 over a four hour period (Figs. 1 & 2).

Pest managers can establish thresholds for their communities by regularly monitoring and keeping record of honeydew levels, and using the level measured just prior to most complaints as the threshold for treatment during subsequent seasons. First distribute a one-page flyer which provides a brief background on pest biology. Mention that tuliptree aphids are small green insects with tiny straw-like mouthparts that are typically abundant on foliage in the late spring and summer. The aphid found on tuliptrees feeds only on tuliptrees and will not spread to other plant species which may also have aphids but of a different kind. The clear sticky liquid falling from trees they infest is "honeydew" which is mostly dilute sugar and other excess nutrients excreted by the aphids. Unlike pine pitch, honeydew can be washed away with water and regular hosing of cars and sidewalks is recommended. Describe your monitoring program and the type of treatment planned if monitoring reveals excessive honeydew. Include a name and telephone number for complaints and further information.

Keep a written log of the date, number, and location of complaints. In subsequent seasons,

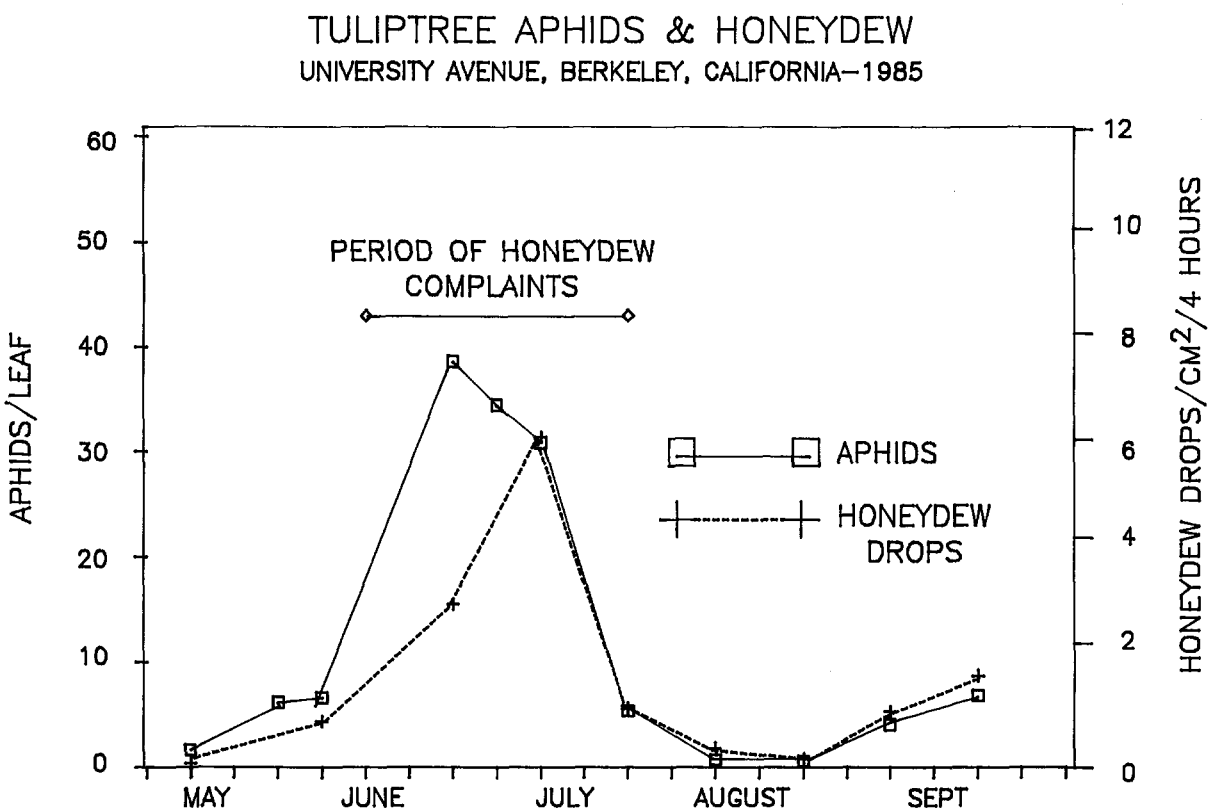

Fig. 2. Example of the type of graph which can be used to display your sample data and assist in decision-making. Illustrated here is the seasonal abundance of tuliptree aphids and their honeydew monitored along a commercial street (University Avenue) in Berkeley, California, during 1985. "Period of Complaints" refers to when complaints about honeydew were received by the City of Berkeley.

treat when your monitored honeydew droplet density approaches the level which previously prompted the bulk of your complaints. It may help you to graph your honeydew density data by date as we've shown for the Berkeley example (Fig. 2) and to indicate on your graph the number of complaints received each week.

Adjust your treatment threshold as necessary according to your budget and workforce and as you become more experienced with the program. Once you have established your thresholds, you could experiment with reducing your monitoring costs (labor) by enlisting volunteers from a community organization or from among willing residents or business people solicited through your annual spring informational flyer. Each trained volunteer would adopt, and regularly monitor, one or two street trees near their home or business. They would regularly tabulate their monitoring data and forward it to a staff coordinator who would make the treatment decisions.

Aphid Honeydew Management

Many beneficial insects feed on aphids. These include ladybird beetles and the maggot-like larvae of syrphid flies (also known as hover flies or flower flies). Tiny wasps which do not sting people and are specific to aphids may also be important. These parasites insert their eggs into aphids and the immature parasite feeds within killing its host. The dead aphid's outer integument turns brown or black and is called a "mummy." Another aphid killing parasite then emerges.

However, these natural enemies, many of which are attracted to and feed on aphid honeydew, do not always suppress aphids enough to satisfy us. To supplement these beneficial insects, we investigated periodic releases of the common green lacewing, *Chrysoperla carnea* (3). Green lacewing eggs can be mail ordered from several commercial insectaries. The eggs hatch into small alligator-like predacious larvae which have been shown in releases in certain greenhouse and row crops to provide effective pest control.

We encountered several problems, that until resolved will not allow for effective release of green lacewings for tuliptree aphid control. In nature, female lacewings lay their eggs on the end of a silken thread, commonly attached to the lower surface of leaves. Commercially produced eggs are packaged after harvesting them by cutting the stalks attached to artificial egg laying surfaces. These loose eggs are diffiicult to efficiently distribute in trees. Because the eggs lack their natural stalk attachment to foliage they are readily found and consumed by foraging ants. Clumped egg distribution also leads to high cannibalism by hatched lacewing larvae. There can also be deficiencies in the quality of commercially produced green lacewing eggs. We found in our study that many lacewing eggs failed to hatch resulting in no effective aphid control even on trees from which ants were excluded through the use of sticky bands.

The University of California recommends acephate (Orthene®), diazinon, or insecticidal soap for tuliptree aphid control (5). Insecticidal soaps (such as Safer AgroChem's or ACCO Highway Spray) are widely used. Although not as long lasting as other sprays, they have the advantage of both killing aphids and washing away their honeydew. Insecticidal soap is of very low toxicity to humans and pets and is readily accepted by the public concerned about pesticide hazards.

Systemic insecticides implanted in trunks or injected into the root zone can also be used. These have the disadvantage of encouraging "preventative" application because they can take days to be fully absorbed and transported through the tree foliage. Repeated trunk implantation may cause tree damage and Metasystox® , which is applied by soil injection, has recently been restricted in its uses in California because of laboratory animal studies indicating that it may cause adverse human reproductive effects.

Maintenance vs. replacement of problem prone tuliptrees. Pest management and other maintenance concerns can be burdensome for trees poorly adapted to the local environment. Tuliptrees planted in pavement wells in California's Mediterranean climate without summer rains become particularly bothersome as they mature. Based on our survey of San Francisco Bay Area street tree managers, tuliptree honeydew management costs can range from $9-38 per tree per year (2).

Besides the honeydew problem, street tree managers in Palo Alto and San Jose, California,

estimate that about 1/4th of their 35-40 year-old tuliptrees have caused sidewalk damage averaging about $400 in repair costs per tree. The longterm costs of aphid honeydew management, pruning, and sidewalk repairs compared to the costs of tuliptree removal and replacement with a better adapted species indicate that gradual replacement of problem tuliptrees can be a more economical alternative. The temporary loss in aesthetic value from the replacement of mature (but problem prone) street trees must be weighted against the long-term benefits of a more attractive and less bothersome species.

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Literature Cited

1. Dreistadt, S.H. 1987. *Monitoring of honeydew excretion in the field as a method of sampling Illinoia liriodendri (Homoptera: Aphididae) infesting Liriodendron tulipifera.* J. Econ. Entomol. 80:380-383.
2. Dreistadt, S.H. and D.L. Dahlsten. 1986. *Replacing a problem prone street tree saves money; a case study of the tuliptree in Berkeley, California.* J. Arboric. 12(6): 146-149.
3. Dreistadt, S.H., K.S. Hagen and D.L. Dahlsten. 1986. *Predation by Iridomyrmex humilis (Hym.: Formicidae) on eggs of Chrysoperla carnea (Neu.: Chrysopidae) released for inundative control of Illinoia liriodendri (Hom.: Aphididae) infesting Liriodendron tulipifera.* Entomophaga 31(4): 397-400.
4. Kielbaso, J.J. and M.K. Kennedy. 1983. Urban forestry and entomology: a current appraisal. pp. 423-440 **In** Urban Entomology: Interdisciplinary Perspectives, G.W. Frankie and C.S. Koehler (eds.). Praeger, New York.
5. Koehler, C.S. 1987. Insect pest management guidelines for California landscape ornamentals. Cooperative Extension. University of California. Division of Agricultural and Natural Resources. 6701 San Pablo Ave. Oakland, CA. 94608 Publication 3317 ($10.00) 82 pp.

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Abstract

BYFORD, J.L. 1987. **Combat wildlife damage with common sense control methods.** Am. Nurseryman 165(8): 91-94, 96, 98, 100.

Wildlife damage control is the opposite of wildlife management. If you have unwanted animals around your nursery, it's a sure bet that there is already enough food, water and cover for them. The solution is to remove at least one of these elements—and if you can remove two, it's better. First, is there some way you can keep the animals from getting to the problem site. If you can't build them out, can you repel them from the problem site? If you can't put up an effective barrier or repel the animals from the problem site, the last step is to remove the animals that are causing your problems. However, when considering this alternative, you should check with your county wildlife officer to get approval—unless the animals are unprotected. Deer probably cause nursery managers more headaches than any other wildlife species. Rabbits are valuable from a recreational and food standpoint, but they can cause severe nursery damage. If your trees are suffering from girdled bark, the damage is probably caused by beavers, muskrats, rabbits or voles. Woodchucks, commonly called groundhogs, cause no harm at all in many cases. But they can sometimes forage on nursery crops and dig dens that pose a menace to machinery.