

INTEGRATED CONTROL STRATEGIES ESTABLISHED FOR TREE INSECTS

by David G. Nielsen, Ph.D., Project Leader, Woody Ornamentals Laboratory, Department of Entomology, Ohio Agricultural Research and Development Center, Wooster, Ohio.

Integrated Pest Management (IPM) is a current and popular approach utilizing pest control techniques that optimize production or maintenance efficiency while minimizing adverse environmental side effects.

Insect Pest Management is the segment of Integrated Pest Management dealing only with insects and related organisms.

During the past two years President Carter has endorsed and encouraged pest management techniques that emphasize use of parasites and predators, disease organisms of pests, resistant varieties, and so-called third generation pesticides, including insect sex attractants, insect hormones, and other novel chemical compounds. Agriculture Secretary Bergland has stressed the importance of replacing conventional organic pesticides with more ecologically acceptable tactics.

The U. S. Environmental Protection Agency is encouraging research designed to discover and develop alternative pest control strategies. They are doing this in two ways: (1) funding research dealing with novel approaches to insect control; (2) minimizing registrations of conventional pesticides.

IPM is not new but was abandoned by many producers and landscape managers with the advent of petroleum based synthetic organic pesticides in the 1940's. IPM was once a necessity for minimizing losses due to pests. Today, IPM is an approach to improve efficient use of all available tactics, including conventional pesticides only when necessary. Most of us agree that conventional pesticides will be critical components of IPM programs in the foreseeable future.

In order to implement IPM on most commodities, certain thresholds must be established. The economic threshold is the population level that will cause economic damage if it is allowed to increase. The economic injury level is the population that will cause more dollar loss than that incurred by applying a control measure. Sampling procedures must be developed to economically determine when these thresholds are reached. Finally, an attempt is made to predict future pest populations and coincidental dollar or esthetic loss based on past and present information (a process called modelling). With all of this background, we then attempt to implement the most cost-effective tactics with minimum adverse impact on ecosystem stability and environmental quality.

Few programs have been developed to optimize control efficiency against pests of trees and shrubs. However, Insect Pest Management can be implemented against some of the most common and destructive pests of woody ornamentals in the landscape and the nursery. A few examples are

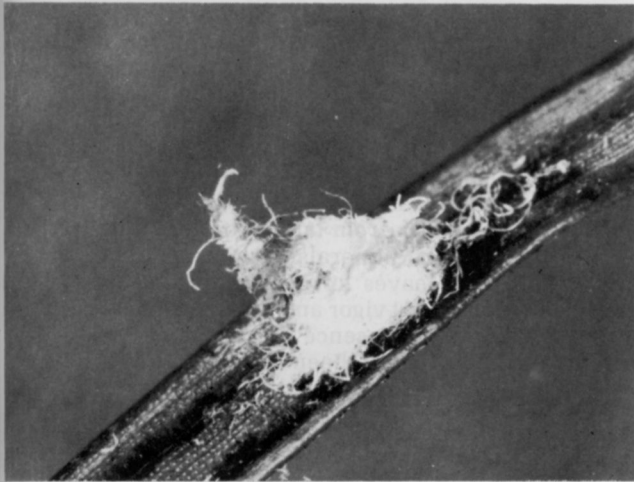


presented here to illustrate how these strategies are formulated based on thorough knowledge of the pests involved and tactics available for combating them.

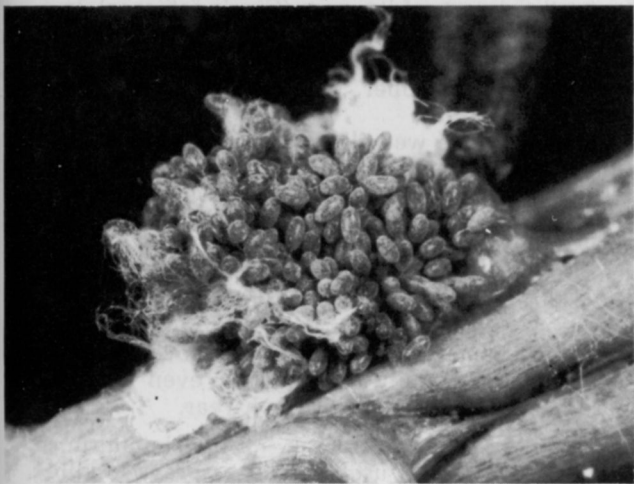
Spruce Gall Adelgids

In the March 1975 issue of *Weeds Trees & Turf*, Dr. R. L. Campbell, WWREC, Puyallup, WA, proposed to change the common names of insects in the subfamily Adelginae from aphids to adelgids. His recommendation was recently approved by the Committee on Common Names of the Entomological Society of America. Consequently, the new name for spruce gall aphids is spruce gall *adelgids*. Adelgids are more closely related to grape and hickory phylloxera than they are to aphids. The old common names led many people to use aphicides in an effort to control adelgids. However, control was rarely satisfactory because many aphicides are relatively non-toxic to phylloxerans, including spruce gall adelgids.

Eastern Spruce Gall Adelgid. The eastern spruce gall adelgid, *Adelges abietis* (L.), attacks primarily Norway and white spruce and causes pineapple-like swellings or galls to form at the base of new



Norway spruce (left) with Eastern spruce galls. Egg mass (below) of Eastern spruce gall. Waxy filaments of Cooley spruce gall (above) repel spray droplets.



twigs. This adelgid was imported from Europe during the 19th century and subsequently has spread throughout North America wherever hosts are planted. It overwinters as a dormant stem mother with its mouthparts inserted into the twig at the base of a bud. The following spring, overwintering adelgids mature and lay eggs just prior to budbreak. Adelgid crawlers hatch and begin feeding at the base of bursting buds. As the new shoot and needles grow, they are stimulated by the adelgids to produce a basal swelling that eventually forms a closed gall with many chambers. Feeding by both the stem mothers and their progeny is required for normal gall formation. In late summer the succulent green galls begin to dry out and turn brown. Soon the chambers split open, and the nymphs migrate to needles where they molt to the winged adult stage. All of the individuals are females that produce viable eggs without mating. Crawlers that hatch from these eggs are the overwintering stem mothers that produce the next, annual generation. This scenario, including galling, occurs each year on Norway and white spruce.

Cooley Spruce Gall Adelgid. The Cooley spruce gall adelgid, *Adelges cooleyi* (Gillette), causes pineapple-like swellings at the apical ends of twigs

on Colorado blue, Engelmann, and white spruce. This pest produces life forms that migrate to the alternate host, Douglas-fir. On Douglas-fir the adelgids feed on the undersides of leaves where they cause chlorosis and leaf distortion and sometimes premature needle drop. Galling does not occur on the alternate host. Most authors who have studied Cooley spruce gall adelgid have indicated that galls are not formed year after year on spruce unless migrants immigrate from Douglas-fir.

Choosing Suitable Tactics. Although galling caused by spruce gall adelgids is not a threat to tree survival, heavily infested trees are unsightly and often more of an esthetic liability than an asset in the landscape. Nurserymen must minimize galling because infested trees cannot be shipped in interstate commerce.

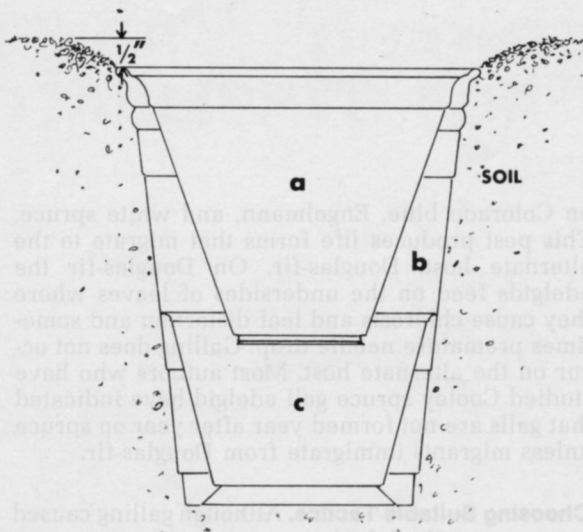
Several tactics can be employed to minimize galling on spruce trees. Individual landscape managers can choose those tactics which best fit their management practices and goals.

An obvious tactic to minimize terminal galling on Colorado blue, Engelmann, and white spruce is to not plant Douglas-fir nearby. Although we do not know how far migrants can disperse and still survive, crawlers have been trapped more than a mile away from the closest conifer planting. Consequently, if spruce are used on a golf course or cemetery, Douglas-fir should not be planted. The same logic applies to nurserymen and Christmas tree growers. If you plan to grow both Douglas-fir and susceptible spruce, expect annual galling on spruce and increased production costs.

The most common direct control method for spruce gall adelgids is a thorough application of hydraulic, insecticidal spray, after stem mothers are established in late summer and before they begin egg production the following spring. Spraying should be accomplished when temperatures are warmer than 60°F (15°C) and cooler than 80°F (27°C). The level of control achieved is directly related to how thoroughly you wet the twigs where stem mothers are feeding.

Nurserymen and Christmas tree growers who sell live spruce can reduce adelgid populations and eliminate new, unopened galls by pruning them during the shearing operation. This procedure is unnecessary in the landscape, providing trees are inspected annually and an insecticidal spray is applied before galling threatens to reduce aesthetic quality. Fall and spring inspections are effective since galls remain on the trees. Low-level infestations in the landscape neither constitute a pest situation nor justify use of an insecticidal spray, because tree vigor and appearance are not significantly reduced.

Cooley spruce gall adelgid on Douglas-fir can be controlled with a thorough-coverage spray in spring when buds begin to shed their scales. They are also vulnerable throughout the summer whenever they are in a nymphal stage. Adults are often



Pit-fall trap enables detection of first emergence of adult black vine weevil for optimum control.

more difficult to control because they are covered with a white, waxy material.

Another tactic that may be employed in a spruce gall adelgid control strategy is use of systemic insecticides. The insecticide, formulated in a slow-release granule, is applied to the soil surface at the drip line of a tree and cultivated into the top several inches (8-12 cm) of soil. An alternative application technique would be to place the granules in holes or a shallow trench at the drip line. The treated area is watered immediately after application and again in 2 weeks unless there is about one inch (2.54 cm) of rainfall. This tactic, employed in mid-April in northeastern Ohio, has precluded formation of new galls on trees that were heavily galled in previous years.

Union Carbide Corporation is currently pursuing a special local needs, 24C, registration for Temik 10 G (aldicarb) for this usage in Ohio. I believe it is an excellent alternative to foliar sprays because it (1) eliminates drift of toxic materials, minimizing contact with non-target organisms, including man, and (2) it eliminates galling. If used on an area-wide basis, annual application would not be required. Indeed, once an infestation is eliminated, galling will not recur until an infested tree is moved to the area.

In the future, spruce trees resistant to adelgids may be available. Dr. D. B. Houston, OARDC, is developing resistant Norway and white spruce and investigating the basis for resistance and a technique capable of detecting resistant trees when they are still small. Availability of trees resistant to spruce gall adelgids will dramatically reduce production and maintenance costs associated with spruce.

Black Vine Weevil

The black vine weevil, *Otiorhynchus sulcatus* F., was imported accidentally to the United States from Europe more than 100 years ago. It has established itself as one of the most common and damaging insect pests of woody ornamentals and small fruits throughout the northern portions of this

country and southern Canada. During the past 10 years its status as a pest has been increasing at an alarming rate.

Damage — Although adults consume foliage, they rarely eat enough to reduce plant health. Instead, the grub or larval stage causes the significant damage. Young larvae consume small feeder roots while becoming established and large larvae eventually strip bark from larger roots, cutting off supply of water and minerals to stems and foliage and sugars from leaves to roots. Extensive larval feeding reduces plant vigor and may cause death of the plant. Weevil presence is commonly overlooked until plants have been seriously damaged.

Life Cycle and Seasonal History — Black vine weevil overwinters in the larval stage near the root zone of host plants. Larvae resume feeding in spring and pupate in the top 4-6 inches (10-15 cm) of soil during May, June, and July. Adults usually begin emerging at the end of May in northern latitudes (Cleveland area); about 3 weeks earlier in the southern parts of its range (Cincinnati area). In the north, they continue to emerge through early August; egg laying begins in early July and continues through October. Only large larvae overwinter successfully.

All black vine weevils are females that reproduce without mating, a phenomenon called parthenogenicity. Newly emerged weevils must feed about 4 weeks before their eggs develop. Since they are flightless, they feed and lay eggs near their emergence site, and oviposition continues throughout the summer. One female may lay 1000 eggs during her life time. Consequently, a dense and damaging population can develop in a localized area in only a few years, even though there is only one generation each year.

Developing a Control Strategy — Dieldrin, aldrin, and chlordane were used as foliar sprays to kill adults and as soil treatments in an attempt to kill larvae until the early 1970's. Although some pest control operators reported good results with soil treatments, established larval infestations have always been difficult to control. Since these insecticides have been banned², and other soil insecticides have not proven effective against black vine weevil larvae, we must rely on foliar sprays and drenches to kill adults before they begin production.

Detecting Adult Emergence. The first step in implementing a black vine weevil pest management strategy is determining when adults begin to emerge in spring. Although we know emergence begins about June 1 in northern Ohio, accurate local information can optimize the strategy. If a dense infestation has been located, pit-fall traps³ can be installed to detect first emergence. Traps should be inserted in the ground so their upper lip is just beneath the soil surface in a location near infested plants and convenient for frequent inspection. Traps should be installed at least 2-3 weeks before emergence is expected and checked at least weekly. RECORD FIRST TRAP CAPTURE ON YOUR CALENDAR.

Timing First Spray. The first insecticidal spray should be applied 3 weeks after the first weevil is

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detected. Remember, weevils must feed about 4 weeks before they can produce eggs. Consequently, effectiveness of a single spray can be maximized and the number of sprays required to achieve excellent control can be reduced by allowing emergence to continue for 3 weeks before application. Some leaf notching will occur, but the weevils will be killed before they can reproduce.

If you are unable to determine when emergence begins in your area, you may be forced to make the first application based on calendar date. Emergence begins about the first of June in the northern half of New York, Ohio, and Illinois, and 3 weeks earlier in Philadelphia, Cincinnati, and St. Louis. In northern localities, first application should be made about June 20; in more southern areas about June 1.

Repeat Application Required. The second application should be applied 3 weeks after the first spray has lost its effectiveness. Some insecticides have been surprisingly persistent in our studies of black vine weevil control. However, this persistence may be associated with use of taxus, a plant with a thick waxy leaf surface. Consequently, until we know that a material persists more than a few days re-application should occur 3 weeks after first treatment (= 6 weeks after first adult emergence). If this spray interval is followed, a third application will be required 9-10 weeks after first application, because adults sometimes continue to emerge through early August.

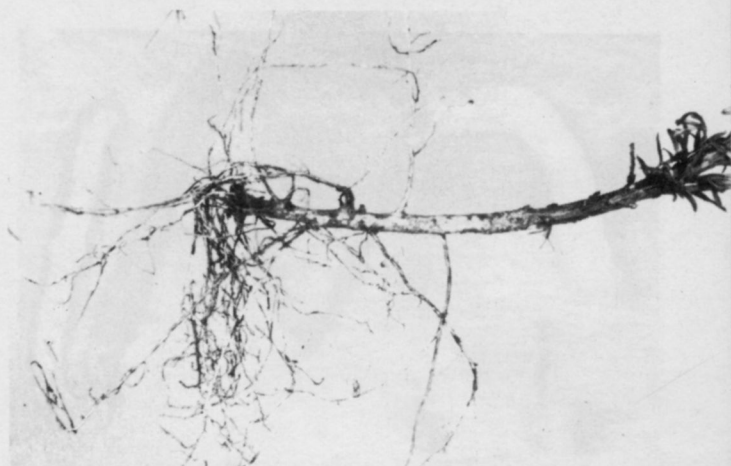
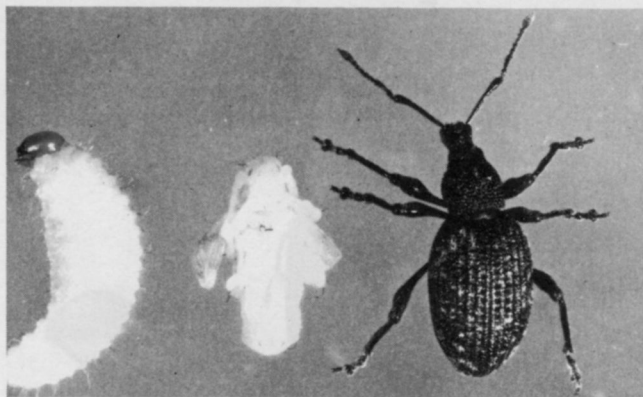
State Registration. Growers and pest control operators in Ohio are taking advantage of a state registration for use of Guthion 50 WP at 0.5 pounds of active ingredient per 100 gallons of water to control black vine weevil adults. Guthion persists at least one week, so re-application is not required until 4 weeks after first application.

Ortho Division of Chevron Chemical Company is in the process of receiving a national label for Orthene Tree and Ornamental Spray for black vine weevil control. Orthene is as toxic as Guthion to black vine weevil adults, but must be used at 3 week intervals, because it persists for only 2-3 days. Orthene's short persistence and low toxicity to man and other mammals enables its usage in the landscape by both pest control operators and homeowners.

An adult strategy, based on detection of first adult emergence and application of an appropriate insecticide at specified intervals can be used to prevent black vine weevil infestation and/or reinfestation. This approach is critical to black vine weevil pest management, because established larval infestations are impossible to control with insecticides at this time. Remember, success of a black vine weevil adulticide program is directly related to proper timing and thoroughness of coverage.

Borers

Borers comprise another damaging group of insect pests on trees and shrubs. Larvae destroy tissues in which food and water move, and they construct galleries that weaken trunks and branches. Furthermore, larvae operate beneath



Black vine weevil life stages (top), left to right; larva, pupa, adult. **Root damage** by black vine weevil larvae (above). Larvae consume small feeder roots and strip bark from larger roots.

bark where they are invulnerable to insecticidal sprays. Consequently, borer control strategies must rely upon preventing larval establishment beneath bark.

Most borers are beetles or moths in the adult stage. Common beetle borers include, bronze birch borer, flatheaded appletree borer, red oak borer, and locust borer. Carpenterworm, lilac/ash borer, lesser peachtree and peachtree borers, and dogwood borer are moths when adults. Most authors who have studied borers have reported that trees in poor vigor are most susceptible to borer attack and damage.

Life Cycle and Seasonal History — Borers overwinter as larvae in galleries beneath tree bark. The following spring or summer they complete development, pupate, and emerge as adults, if there is one generation per year. Some borers require more than one year to complete development. Mating occurs soon after emergence, followed by egg laying on or in bark or on plants growing near host trees. Larvae hatch within 2-3 weeks and chew their way beneath the bark where they remain until mature.

Developing a Control Strategy — The most important and effective approach to minimizing borer infestation is to maintain vigorous trees. Consequently, cultural practices including watering, fertilization and pruning should be used to promote tree health. Furthermore, aphids, leafminers and similar pests should be controlled on trees like white birch that are prone to borer attack.



Bronze birch borer adult (top) and D-shaped emergence hole. **Larva and gallery** (above) of the bronze birch borer.

Bronze birch borer, *Agrilus anxius* Gory, attacks apparently healthy white birches and annually kills thousands of trees in the northern United States and southern Canada. This native insect attacks only unhealthy trees in the forest, but is apparently a primary pest of birch in nurseries and landscape plantings. There has been an unconfirmed report that Monarch birch is resistant to this pest; river birch is not attacked.

Lindane is the only insecticide registered for use against bronze birch borer. It should be applied when adults first begin emerging (about June 1 in northeastern Ohio) and repeated at least twice at 2 week intervals. All branches should be thoroughly covered, especially tree tops where bronze birch borer attacks first.

Birches should be irrigated every 10-14 days with about 1 inch (2.54 cm) of water during the summer when rainfall is low. They should also be fertilized annually with a lawn-type, high nitrogen fertilizer. Additionally, birch leafminer and birch aphids should be controlled to reduce chances of trees becoming predisposed to borer attack. Although these procedures may seem overwhelming and costly, the relative costs associated with maintaining healthy trees is low compared to replacing trees killed by borers.

If bronze birch borer is detected when only top branches are infested, corrective pruning and insecticidal sprays may be used to save the tree. All limbs distal to D-shaped emergence holes and sinuate larval galleries should be removed in May before adults emerge. Lindane should be applied

in the aforementioned manner, beginning in late May or early June. Although heavily pruned birch will look unsightly for about 2 years, new branches will grow quickly and fill-in the canopy. This procedure has been accomplished with excellent results in Wooster, Ohio.

Clearwing Moth Borers. Last year I wrote an article for WTT explaining how sex pheromone traps⁴ can be used to detect presence of clearwing moth borers. When these traps are used according to directions, pest control operators, landscape managers, and others can determine which clearwing borers are present in your local area, when adults begin to emerge, and how long adults continue to emerge. This information can be used to plan ahead regarding need for borer sprays, pinpoint the time when the first spray should be applied, and determine if additional applications are necessary.

Chlorpyrifos (Dursban®) has provided excellent control of all clearwings against which it has been evaluated, including lilac/ash borer, peach-tree borer, and lesser peachtree borer. It is probably equally effective against other clearwings, including dogwood borer, rhododendron borer, banded ash borer, and sequoia pitch moth. Although Dursban® is not labeled for use against these borers, I will be asking the U. S. Environmental Protection Agency to approve a general clearwing moth label for it on woody trees and shrubs. If EPA grants this request, the combination of clearwing borer traps and Dursban® should provide a pest management strategy useful for dramatically reducing damage by clearwing moth borers.

Developing Control Strategies — Landscape managers interested in developing Insect Pest Management strategies to optimize control of particular pests or groups of pests should consult their extension entomologist or appropriate publications. Make an effort to learn all you can about the pest's life cycle and seasonal history and the stage(s) most vulnerable to manipulation or control. Determine how tree management practices influence susceptibility or resistance to attack and damage. Learn how to detect presence of the stage that will key your chemical control efforts. Perhaps scouts will be employed in the future to monitor tree health and make prescriptions regarding the what, when, and how of tree management. After all, IPM and Insect Pest Management efforts are designed to improve overall tree health while reducing production, management, and environmental costs.

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Footnotes

- ¹ Consult your local county agent regarding insecticides registered for specific uses.
- ² Chlordane may be used for control of black vine weevil until January 1, 1980.
- ³ Pit-fall traps are available from Carolina Biological Supply, Burlington, NC 27215.
- ⁴ Clearwing borer traps are available from CONREL, 110 A Street, Needham Heights, MA 02194