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Challenges *from page 20*

of course, timing of the application is correct.

Eastern spruce gall can be found on Norway spruce and the Cooley spruce gall on blue spruce.

Overwintering stem mothers lay their eggs and start the process of gall development. Swelling at the base of needles starts very early, The gall can begin to develop before the bud cap is off. The aphids are protected in pockets inside the Cooley gall; here they feed and reproduce.

Woolly Oak aphid - Although the injury caused by the woolly oak aphid could be confused with leaf scorch, it actually is caused by masses of the aphids. This can be very injurious to leaves.

Pine bark aphid - Normally when pine bark aphid is mentioned, one thinks of aphids covering the main trunk and lower limbs. Control is more difficult when they feed on the base of the needles and are observed only as minute bits of cotton sticking out of the fascicle. I have seen Scotch pines that have been killed by the pine bark aphid.

Leaf miners

Leaf miners range from arborvitae leaf miner, which can wipe out a planting, to the birch leaf miner. Although I have not seen it kill birch, its damage may increase the possibility of attack by the bronze birch borer. The larvae feed between the leaf surfaces. The mining takes place in birch rapidly, making the timing of sprays critical.

Leaf chewing insects

Eastern or apple tent caterpillar and fall webworm are two pests that are present to some degree each year. They can completely defoliate a tree.

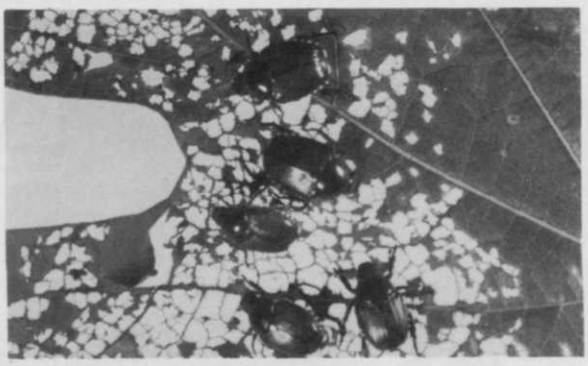
These pests are not so difficult to control, but their unsightly webs remain on trees long after they are gone.

Eggs of the fall webworm are laid over a four- to six-week period, making control difficult with the short residual insecticides, especially if the home owner expects 100 percent control with a single application.

Japanese beetle

The Japanese beetle seems to be on the increase. You are no doubt familiar with its life cycle. Linden is one of its favorite hosts, and sycamore is another.

Control of Japanese beetle is difficult, primarily because a sprayed tree can be reinfested over such a long period of time — at least two months. To prevent feeding damage, sprays would have to be applied weekly.



Japanese beetle is increasing its damage to many trees, especially linden and sycamore.

Pin oak sawfly

The pin oak sawfly skeletonizes the leaves, causing them to turn brown. The slug-like larva causes the injury. Usually an infested tree will "brown-up" before the home owner is even aware that a problem exists. This pest has been reported on the rise in the New Jersey area.

Research and extension needs

More information is needed on timing spray applications especially for those pests that hatch over a prolonged period or where adults lay eggs or feed over a four- to six-week period.

Phenological studies should be continued to help relate plant developmental stages with insect activity.

Long-range programs should include the effect of varying insect populations on the vigor of trees and shrubs. This type of study is being done on gypsy moth defoliation; hopefully, it can be done for other pests.

Weather has always been a problem. New application techniques are needed to provide the desired pest control and to reduce the chances of pesticide pollution to the environment.

How can we get coverage of the tall trees? How can we protect trees near the swimming pool or pond without the danger of polluting with drifting or dripping spray? How can we accomplish desirable results during adverse weather? Weather certainly influences the length of residual of an applied insecticide. How can we lengthen this period in order to provide better control with fewer sprays?

There is a need for studies on soil injections with systemics as well as injections directly into the tree. California has recently secured a special need label using Orthene injected into elms for elm bark beetle control.

If we are going to inject trees, we need teamwork from the plant physiologists on how to inject, where to inject, and the long-range effect of these wounds.

Last year we looked at the chemical distribution in elms injected with Arbotect. Bioassay of branch discs showed only 60 percent of the branches contained sufficient chemical to inhibit the test organism. What must be done to obtain 95 percent to 100 percent coverage?

It is well known that systemics move up in a tree, but rarely, if ever, down. Is there some way systemics could be tied into the phloem tissue where they might aid in the control of borers, twig scales, and other pests feeding in that area?

Help is needed from the arborist, municipal forester, and home owner to know when there is going to be an invasion of a certain pest. Is it practical to expect some assistance in predicting or forecasting outbreaks?

We are aware of the effect of insect defoliators on tree decline and mortality. Therefore, it would be very beneficial for all to know the likelihood of this defoliation occurring so that protective measures can be taken. **WTT**

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ASH, HACKBERRY AND KATSURATREE OFFER ELM'S URBAN ADAPTABILITY

By Douglas Chapman, Horticulturist, Dow Gardens, Midland, MI

Ash (*Fraxinus*), Hackberry (*Celtis*), and Japanese Katsuratree (*Cercediphyllum*) are three trees which offer adaption to many urban conditions (as did elm), be it park or landscape tree.

White Ash *(Fraxinus americana)* is a rapid growing tree which is easy to transplant. When young, it is a rather upright, oval tree that when reaching maturity (between 70 and 90 feet) becomes somewhat open and round. It often increases 3 to 5 feet in height per year when young. The summer foliage is somewhat bright green with fall color being quite exciting, ranging from a good clear yellow to purple. The insect problems include ash flower gall, scale, and, more significantly, ash and lilac borer. But it must be stressed that ash and lilac borer are only problems on trees which are not in good vigor. White Ash presently is showing some susceptibility to sulfur dioxide and ozone. 'Autumn Purple' White Ash, a male, thus seedless form, develops deep purple or magenta fall color. With increasing frequency, this plant has been showing problems of graft incompatibility or incongeniality, manifested by longitudinal cracking at or near the graft. Species White Ash not only has potential as a park tree, but also integrates well in lowland soils, fitting many urban landscapes as a specimen or border tree.

Green Ash *(F. pensylvanica lanceolata)* is a 50- to 60-foot tree with dense foliage. It displays a round habit of growth when old, yet pyramidal through early maturation. The fall color is a good clear yellow which can be a major addition to any landscape. Green Ash will grow in almost any soil, tolerating wet soils extremely well, while showing good tolerance to high pH and sodium or calcium chloride concentrations. Further, Green Ash is very sensitive to fluorides, slightly sensitive to ozone, and extremely tolerant of sulfur dioxide, making it an exceptional urban tree. Scale and borer can be a problem but somewhat less than we normally see on White Ash. 'Marshall's Seedless' Green Ash, a male green ash, has dark green foliage in the summer with outstanding clear yellow fall color. This seedless form again shows little problem with borers. Its habit is somewhat pyramidal when young, showing great potential as a street or border tree. 'Summit' Green Ash, with a strong central leader, has a somewhat symmetrical habit of growth. The plant is female, thus producing many seedlings, but is almost an ideal street tree. It has no problems with graft incompatibility.

"These trees add diversity and help fill the niche opening by the death or decreased use of American Elm

Blue Ash *(F. quadrangulata)* has a somewhat irregular crown, reaching 50 to 75 feet in height. Although slower growing than the other ashes, it adapts well to wet-heavy clay, high pH soils. Ash borer can be a problem spring or fall, but, more significantly, oystershell scale and plant bug have caused major problems which should limit the wholesale use of this particular native species. The tree is outstanding for its dark blue-green summer foliage, but usually has very pale or no fall color. 'Kimberly' Blue Ash, a somewhat recent introduction, has a more uniform rounded habit of growth. The cultivar grows more rapidly, being landscape effective in street or park conditions as a specimen or mass plantings.

European Ash *(F. excelsior)* is a rounded tree, reaching 70 to 80 feet in height. It is extremely tolerant of urban conditions. It has good rich foliage in the summer, which remains late in the fall, thus developing little or no fall color. European Ash thrives on moist, loamy, alkaline soils found throughout much of the midwest. The main drawback in using European Ash is its extreme susceptibility to borer. In fact, even under ideal conditions, pest-free plants are rarely found. 'Hessei' European Ash, a vigorous grower with dark green summer foliage and a somewhat upright, oval habit, has been reported to show good resistance to borers, but our experience in central Michigan shows it is not much more resistant than species of European Ash.

Of the four ash species normally used in the landscape, Green Ash (*F. pensylvanica lanceolata*) is by far the best selection. It is a rapid grower that tolerates urban conditions, e.g. air pollutants, salt, etc., is less susceptible to borers, and grows well in wet, high pH soils, rarely showing ill effects from calcium or sodium chloride, applied for snow removal. Its cultivar, 'Marshall's Seedless' Green Ash, is an exciting street or park tree, not used to its full extent. Although ash fills an important niche in our landscape, certainly their wholesale use should be limited to plants showing best adaption to urban conditions. If there is such a thing as ranking from top to least desirable, Green Ash, White Ash, Blue Ash, and European Ash would be the order. Although borers have been reported to be a problem with all ash types, European Ash is certainly the most susceptible, with the other ash showing decreased susceptibility, in fact, almost immunity, if plants are kept in a healthy-vigorous state. Oystershell and other scales have caused some problems in the past, but the simple application of dormant oil in the spring, integrated into the maintenance program, can effectively control this problem. In working with flood plains, golf courses, or recreation sites, subject to flooding, ash should be considered an effective alternative, being a

Continues on page 27

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Common Hackberry (left) tolerates heavy urban soils, grows to a height of 40 feet, and has black corky bark.
Japanese Katsuratree (immediately below) is fast growing, requires little pruning after reaching 15 feet, and makes a good specimen tree for parks, golf courses, institutional grounds and streets.
Clear yellow foliage of 'Marshall's Seedless' Green Ash in the fall (below left).
Purple foliage is the benefit of 'Autumn Purple' White Ash (below right) a seedless, male form.

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Ash *from page 24*

plant that not only tolerates but thrives on wet soil conditions. This genera can add tree canopy rapidly while being very effective for fall color.

Common Hackberry *(Celtis occidentalis)* is a native throughout the midwest. It tolerates heavy, urban soil conditions well. Its upright, spreading habit, often reaching 40 feet in height, with black corky bark, can be an exciting addition to the winter landscape. The plant normally has good, wide-angle crotches, responds well to pruning, while being relatively resistant to wind and ice storm problems. In the southern part of its range (southern Michigan and Ohio) witches broom can be a problem, but further north this problem is rarely significant. Nipple gall does cause objectionable galls on the foliage but is certainly not an insect problem that will kill the plant. Hackberry is one plant that grows in most urban areas where elm thrives. It seems to tolerate urban conditions well and should be used more extensively as a park or street tree on these heavy soil sites. The fall color, although not exceptional, can certainly add variation and light yellow tinges to the landscape. Ash and hackberry are good companion plants that grow well in areas where many plants decline.

Japanese Katsuratree *(Cerediphyllum japonica)* is a medium-sized oval tree effectively reaching 50 to 70 feet in height. The heart-shaped leaves with the dual terminal make this a unique plant. The summer foliar color is blue-green with fall color ranging from scarlet to a clear brilliant yellow. This medium to large size tree is an outstanding specimen plant for use in parks, golf courses, institutional grounds, or as a street tree. It is fast growing, requiring little pruning, after reaching 15 feet in height. The largest tree in the midwest, in fact, the country, is on the Michigan State University campus. During the past 18 years, I have not noted a major insect or disease problem. Katsuratree is a plant found rarely in the trade, but one which should be grown with increasing frequency.

Katsuratree, hackberry, and ash all grow well in moist, fertile soils. They are fast growing, respond well to fertilizer, and, if pruned actively when young, form a good structure. When considering maintenance, they would rank Katsuratree, hackberry, and ash, with ash being the most maintenance intensive by virtue of insect-related problems. Most of these trees withstand urban conditions well and would not only add diversity but certainly effectively fill the niche rapidly opening by the death or decreased use of American Elm.

WTT

KNOWLEDGE OF SPRAY EQUIPMENT CONTRIBUTES TO APPLICATOR EFFICIENCY

By John Kerr, Assistant Editor

Knowing how spray equipment functions not only makes someone a better applicator, but can save valuable time during work or back at the shop. A basic understanding of the spray system can provide, at the least, an intelligent and time-saving report of a malfunction, should one occur.

Since Green Industry operations often expand into new arenas, a sprayer used on lawns may also have to spray trees. "It makes no sense to have a system for each application," says Ed Gray, sales engineering manager of Spraying Systems Co. Also, many new and improved pesticides have recently become available and costs have risen sharply. Consequently many users have had to replace or modify their sprayers or spraying methods to meet changing requirements or to improve efficiency.

Once you've decided on what chemical to spray, you need to know how to spray it. "The chemical does the work; it just has to be applied at the proper rate and time, according to the manufacturer's specifications," says Gray. "If you have the right equipment, you're halfway there."

The right equipment on a spray system, according to the Weed Science laboratory manual written by Dr. William Meggitt and Jack Dekker of Michigan State University, consists of five basic components. These are the tank, nozzles, agitator, pump, and regulating devices. Much of the authors' research follows.

All possible uses for a spray system should be considered before purchasing a unit.

Tanks

Tanks for large scale spray systems are non-pressurized. These can be large (generally the bigger the greater the soil compaction problems) without being prohibitively expensive. In this system, a pump produces liquid pressure at the nozzle. Pressure exists in the system only from the pump to the nozzles. There is usually a suction from the tank to the pump. Non-pressurized tanks should be mounted so that the bottom of the tank is above the pump.

Tanks should be made of, or coated with, a corrosion-resistant material, such as stainless steel, aluminum, plastic, fiber glass, and steel with or without coatings. Chemicals may be corrosive to certain materials and care should be taken to avoid using incompatible equipment.

Keep tanks clean and free of rust, scale, dirt, and other contaminants. Solid particles from a tank can quickly wear out a pump and nozzle tips. Dirt may collect in the nozzle and restrict the flow of chemical resulting in improper rates of application. Debris from the tank can clog strainers and restrict flow of spray through the system.

Flush the tank with clean water after spraying is completed. A tank with a drain hole near one end permits tilting the tank to allow for complete drainage. An opening in the top large enough for internal inspection, cleaning, and service is desirable.

A volume sight gauge on the tank aids in efficient spraying. On metal tanks a clear plastic tube mounted on the end, marked off in gallons, works well. On clear plastic or fiber glass tanks, place marks on the side of the tank to indicate gallons.

If you are applying a chemical that requires agitation, keep the agitator running at all times when the chemical is in the tank. It is recommended to agitate the mixture in the tank before spraying. If the equipment is shut off and the chemical settles out, it may be very difficult to get the chemical into suspension.

Nozzles

Sprayer design and modification starts with the selection of the proper nozzles for the type of spraying to be done. It is the nozzles that break the liquid into droplets of optimum size, form the spray pattern and propel the droplets in the proper direction. The nozzles also determine the rate of chemical distribution at a particular pressure, forward speed, and nozzle spacing. Only after the nozzles have been selected and their total volume and pressure requirements measured (or computed) can the other elements of the sprayer be chosen or properly adjusted.

People involved in several different operations, such as spraying herbicides or insecticides, usually need to change their nozzles and orifice tips. Basically the same nozzles work well for landscape and turf care that work for agricultural purposes. A boom can have one nozzle or 20 depending on how wide of a swath you want. To a sprayer's pump-tank package, you can attach a boom to spray the lawn, a boom or gun to spray one side of a right-of-way or ditch, and a heavy-duty spray gun to hit the tops of trees. "The bottom line is the proper application rate, which is controlled by the spray tips," says Ed Gray. "Tips and nozzles are a minor investment compared to the whole rig, but since they control the rate of application, they are very important in terms of calibration, performance, and choice."

Continues on page 30

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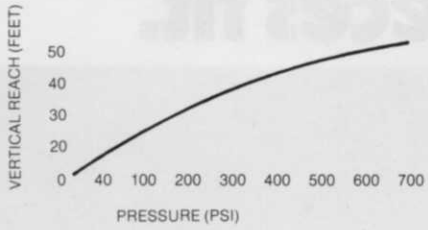

Height limitations of spray systems and nozzles should reduce wasteful and ineffective spraying over certain heights.

Table 1. Wear Comparison of Common Nozzles

Nozzle Material	Life Compared to Brass
Plastic or Nylon	Same
Aluminum	Same
Stainless Steel	3.5 times
Hardened Stainless	10 to 15 times
Tungsten Carbide	150 to 200 times

Table 2. Summary of Nozzle Types and Their Uses

Nozzle Type	Distribution of Droplets	Main Use
Flat Fan	Uniform when the boom is at the proper height. Best for broadcast spraying.	Herbicides or insecticides.
"Even" Spray	Not uniform for broadcast spraying. Good for band spraying.	Herbicides.
Full or Hollow Cone	Not uniform when used on a boom.	Insecticides.
Flooding Fan	Not uniform as flat fan nozzle.	Liquid Fertilizer and herbicides.
Boomless	Not uniform. Very poor in wind.	Herbicides in waste places.

Nozzle tips are made from several types of material. The most common types include brass, aluminum, nylon, stainless steel, and hardened stainless steel. Brass and aluminum tips are the cheapest, but the metal is softer and the tips wear faster. Nylon tips resist corrosion and abrasion, but some chemicals cause nylon to swell. Tips made from harder metals cost more, but wear longer. Tests have shown that 2,4-D may wear nozzles enough to increase the rate of chemical flow 8 percent in a period of 50 hours. A 10 percent increase may not be readily noticeable, but if 150 acres is sprayed with a chemical that costs $5 more per acre, a 10 percent increase in spray volume will cost $75 more.

Each nozzle on a spray rig should apply the same amount of chemical. Collect the discharge from each nozzle and compare the output. If the discharge from one nozzle varies more than 10 percent above or below the average of all the nozzles, replace it.

Do not mix nozzles of different materials, different discharge angles, or gallon capacity on the same sprayer. Any one of these will produce uneven spray patterns.

If spray nozzles become clogged from foreign matter or from contact with soil, care must be used in cleaning. It is best to disassemble the nozzle and blow out the dirt with compressed air. A soft bristled brush such as a toothbrush can also be used. Never use a nail or wire to clean the nozzle because they can easily damage it.

Nozzle spray patterns vary to accommodate a particular broadcast application. Table 2 summarizes the various nozzle types and their uses.

With a flat fan nozzle, the spray droplets arrange in a fan shape as they leave the spray nozzle. Less material applies along the edges of the spray pattern, so the patterns of adjoining nozzles must be overlapped to give a uniform spray across the length of the boom. Normal operating pressure is 30 to 40 psi which may cause drift. Lower pressures will reduce this. It can be used for most herbicides and some insecticides where penetration through the leaves is not required.

The "even" spray nozzle produces a fan-type pattern, but uniformly distributes the spray across a width. This pattern is ideal for band spraying where there is no overlap from other nozzles. Operating pressures of 40 psi will reduce the possibility of spray drift. Width of the band is dependent upon the nozzle placement above the ground.

A hollow cone nozzle produces a spray pattern with most of the liquid concentrated at the outer edge of a conical pattern. This nozzle is used mainly for applying insecticides, fungicides, and certain postemergent herbicides where complete coverage of the leaf surface is very important. Use the hollow cone pattern for low volume applications where a fine spray pattern is needed for thorough coverage. Use the solid cone spray pattern for high volume application where dense foliage requires a coarse spray for good penetration around plant leaves.

The flooding fan nozzle produces a wide, flat spray pattern that you can direct outward, down, or up. Use it for any application requiring wide coverage at low pressures with large droplets. The flooding nozzle works well for applying herbicides and mixtures of herbicides and fertilizers and it will operate at lower pressures than flat fan nozzles with less drifting.

A boomless nozzle consists of a cluster of nozzles capable of spraying widths of 30 to 60 feet. It suits spraying of roadsides, ditch banks, and right-of-ways. The spray is more susceptible to drift than nozzles mounted on a boom, and the distribution across the swath is not as uniform.

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