software that monitors and measures drivers' efficiency and productivity. They also feature on-demand automatic vehicle location (AVL) for real-time reporting of vehicle stops and locations, and provide tracking and routing data.

For more information contact 877/265-9559 or www.fleetboss.com / circle no. 293

What's the frequency?

Motorola Spirit XTN Series radios are available in both one-watt and two-watt models with one-channel operation and user-selectable frequencies (56 UHF and 27 VHF). Available in VHF radios for use in and around wooden structures and forested areas or the UHF models for use in and around concrete/steel buildings and structures. Each Spirit XTN-Series radio comes with coded squelch and digital coded squelch.

For more information contact Forestry Suppliers at 800/360-7788 or www.forestry-suppliers.com / circle no. 294

Something in the air

Airput Mobilizing Operations' Air Hours eliminates paper timesheets for field personnel in construction and other service-related industries. Exchange information between any Nextel Internet-ready phone and AirHours' Web site (www.airhours.com) using Nextel Online wireless Internet service. Collect timesheet and project information around the clock.

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The Garmin Rino 110 combines the navigational capabilities of a full-featured, WAAS-enabled, 12-channel parallel GPS receiver with the reliable communication power of a 22-channel FRS/GMRS radio. This combination allows for peer-to-peer position reporting using the FRS spectrum to transmit your exact location to another Rino 120 within a two-mile radius.

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Game over, grubs. MACH 2* specialty insecticide is *the* proven season-long force against grubs – not to mention cutworms, sod webworms and armyworms. And now, it's available with a standard 2-lb. per acre a.i. rate for all grub species. That's more power for the same cost. With its wide application window, you can control grubs clear through the second instar – without the need for immediate irrigation. The competition can't make that claim. Fact is, nobody's better at putting insects two inches below six feet under, baby.

Really know your pest enemies

Knowledge is the key to dramatically increasing your chances of controlling turf/ornamental pests

BY DR. R. CHRIS WILLIAMSON

Get to know — really know — the pests that commonly damage the turfgrass and ornamental plants under your care. You will dramatically increase your chances of controlling them.

It will take some training, but your customers, not to mention your company's bottom line, will benefit from your knowledge.

A limitless supply

The number of organisms that inhabit nearly all turfgrass and ornamental plants is almost limitless. These include disease pathogens, insects, weeds, micro-fauna and micro-flora, earthworms and vertebrate animals. Some cause no measurable damage and require no control. Some are beneficial because they help aerify the soil, decompose thatch or control other pest species.

Surprisingly, compared to the millions of insect species on earth, less than 100 plant-feeding species cause measurable damage to turfgrass and ornamental plants. In many instances (and to the untrained eye), pest and non-pest insects, including beneficials, look the same. That's why you must be able to accurately distinguish between them. In other words, before you can control a pest, you have to recognize what kind of pest it is and learn as much as you can about its biology. That knowledge must encompass behavior and habits, life cycle, plant-damaging life stages, and the life stage when it's most vulnerable to Integrated Pest Management (IPM) control.

You have to get down and look carefully if you want to make an accurate pest ID.

Control with IPM

The concept or idea of understanding a pest's biology is fundamental to the concept of IPM, which is a synthesis of all possible control options available to you. IPM is a management approach and, contrary to what some people think, it is not exclusively biological or "organic."

IPM provides you with a variety of pest control options, strategies and techniques. As its title suggests, it specifically targets the pest(s) causing the damage. Therefore, any information related to the pest in question is critical to successfully managing the pest.

Essentially, there are four steps for successful pest management:

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Introducing QuickSilver.™ Fast control of broadleaf weeds.

Introducing the most advanced chemistry in herbicides—QuickSilver, for extremely fast control of post-emergent broadleaf weeds, including tough-to-control weeds such as clover and thistle. But even though QuickSilver is tough on broadleafs, it is soft on sensitive turf varieties, such as Bermuda and St. Augustine Grasses. Which makes QuickSilver the smart alternative to clopyralid.

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Circle No. 136

Late afternoon treatments offer best control for the black cutworm caterpillar.

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▶ **Precise pest ID.** Spiders, mites, nematodes and other animals inhabit turfgrass and ornamentals. You must be able to tell nonpests and beneficial species from the pests. Often, you've already developed good control strategies for a particular pest because of previous experience. If not, you'll have to rely on resources such as university fact sheets, bulletins, insect flash cards, Web sites or insect collections. Other valuable resources include county extension agents, colleagues, consultants and agricultural chemical technical managers.

▶ **Behavior and habits.** After conclusively identifying the target pest, study its behavior and habits. You have to know where, when and how the target pest functions. In a sense, you have to be like a football coach who reviews game films of the opponent before building his team's game plan.

For example, consider the biology of black cutworm caterpillars. Since these caterpillars feed on the foliage of turfgrass plants at night, the most effective control strategy is to apply an insecticide that's been proven effective in black cutworm caterpillar control in the late afternoon or early evening, and to withhold irrigation for 12 hours. This gives the caterpillars time to contact and consume the insecticide. If you apply the product in the morning, you may decrease its effectiveness due to factors such as photodegradation (breakdown by sunlight) as well as volatilization (natural dispersion into the atmosphere). All pest insects have different control strategies.

▶ **Life cycle.** Knowledge of an insect's life cycle allows you to sample and monitor target pests. Monitoring is key to anticipating subsequent damage and implementing timely controls. Some insect species only have one generation per year, while others have multiple generations per year. As a result, control strategies for respective insect pests with only one generation per year are often different than those for insect pests that have several generations per year.

Insects that have multiple generations per year typically require repeated control treatments. When the best IPM control strategy is the use of an insecticide, however, there's greater risk of promoting pest resistance, especially if similar insecticide chemistries (i.e. modes of action) are used. Technicians who understand the life cycles of insect pests are best prepared to develop control strategies that exploit the most susceptible or vulnerable life stages of the pests.

▶ **Damaging life stage.** You must be able recognize signs that point to pest damage before it reaches a certain threshold. Again, frequent sampling and monitoring of plant material reveals early signs of insects and the damage they cause. This knowledge also allows you to solve the insect pest problem when it's easiest to solve — when the pest is at its most vulnerable stage.

Insects are more vulnerable to control measures or strategies at certain life stages. Typically, it's easier to control younger and smaller insect pests. For example, Japanese beetle grubs are considerably more vulnerable to certain insecticide treatments when they're young (newly hatched through first-instar grubs) compared to older or more mature (late-second and third-instar grubs).

This information enables you to time their treatments. Applying a curative insecticide treatment of a grub control product in the spring when the grubs are nearly fully mature would likely not be a good idea. This grub control treatment would be more effective if it was done in August when Japanese beetle grubs are younger and more vulnerable. (Because dates vary due to geography and climate, check with your local extension service for best dates in your area.)

Be smart for a sound plan

Establishing an IPM program requires a sound understanding of growth habits and cultural requirements of your turf and ornamentals. You also need to understand any insect pests that threaten the turf and ornamentals you maintain. This includes knowledge of their behavior, life cycle, damaging life stages and vulnerable life stages.

Remember, there are three critical steps in successfully managing an insect pest. First, accurately identify the specific pest you're attempting to manage or control. Next, gain a comprehensive understanding of the organism's biology including but not limited to behavior and habits, life cycle, damaging life stage and vulnerable life stage. Finally, implement an IPM control strategy that provides the most effect control while taking into consideration the economic cost, potential environmental impact, and public perception. LM

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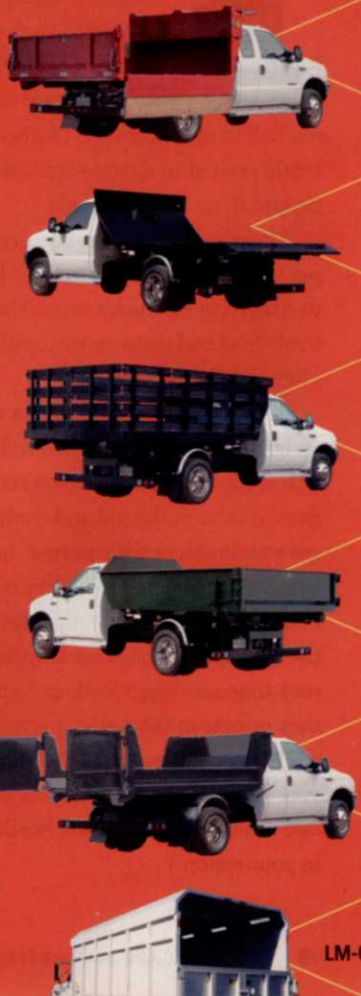

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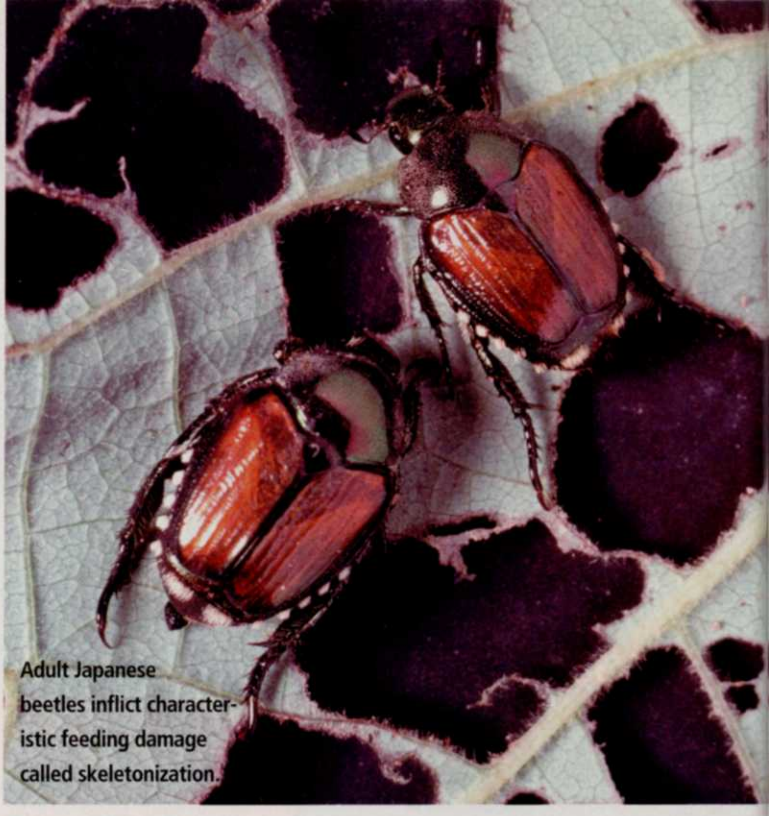

Adult Japanese beetles inflict characteristic feeding damage called skeletonization.

Research and careful observation dispel some long-standing beliefs regarding Japanese beetles and their control

BY DAVID HELD

The Japanese beetle is a destructive urban landscape pest in the eastern United States. This metallic colored beetle was accidentally introduced to a nursery in Riverton, NJ in 1916. It's likely that the beetle larvae (white grubs) arrived in the soil ball of nursery stock. The beetle is currently present in all states east of the Mississippi River except Florida.

Japanese beetles have one generation per year. The adults are present from June to August in Kentucky, when they'll actively feed and mate on susceptible plants, often defoliating them.

The females leave the plants to seek out turfgrass and lay eggs, which will hatch into grubs. The grubs feed on roots and organic matter in the soil and continue to grow throughout the summer. In the fall, as soil temperatures cool, they move down in the soil below the frostline for winter. In the spring, they move back up into the root zone and begin feeding. During May, they pupate in the soil in preparation for adult emergence in June. (Check with your local extension service for a more precise timing of the Japanese beetle life cycle in your region.)

The damage Japanese beetles cause to trees, ornamentals and turfgrass is extensive. More than a half billion dollars a year is spent trying to control them. Since its introduction into the United States, the problem of managing this beetle has resulted in an array of management recommendations such as companion planting and host plant resistance. Let's take a careful look at some of the folklore surrounding Japanese beetles and try to balance those anecdotes with recommendations based on field research.

Trapping folklore

The Japanese beetle is strongly attracted to blends of plant odors, particularly those that are floral and fruity. Based on this, commercial traps were developed and proposed as a possible management tool for the adults and larvae. The use of traps in commercial and residential landscapes has been touted for reducing or eliminating defoliation by the adults and reducing the presence of grubs in the local turf. When evaluated in replicated experiments, however, the presence of traps didn't reduce the amount of damage to nearby plants. In fact, traps increased defoliation of nearby plants while having no effect on grub populations in surrounding turf.

Milky disease

Milky disease is a bacterial infection of grubs that results after it ingests spores of *paenibacillus popilliae* while it feeds. An infected grub has a distinctive milky-white appearance relative to a healthy grub. In the field, this disease is often present when grub populations are high. Milky disease is considered one of many natural buffers in the soil that suppress heavy populations of grubs.

Commercial products containing the bacterial spores have been developed for use as a microbial insecticide for Japanese beetles. Users apply powders containing lit-

erally millions of bacterial spores to infested turf for grub control. These products, however, didn't fulfill the claim as a "natural" insecticide. Also, the application of commercial powders to turf didn't increase the occurrence of the disease or result in reduced grub numbers. A contributing factor to the products' failure was their purity. Analysis showed significant contamination of milky disease powders with other non-infective bacterial spores.

Companion planting

Companion planting is a horticultural synergism between a crop plant and one or more plant species that results in the protection of the crop plant from pests. These garden companions are commonly aromatic herbs or other fragrant plants grown to mask the smell of a favorite garden ornamental or vegetable plant.

There are several recommendations regarding Japanese beetles and roses, one of their favorite foods, in organic gardening books and magazines. For example, interplanting members of the onion family, *allium sp.*, anise or fennel *foeniculum vulgare*, and rue, *ruta graveolens*, with roses are said to protect the plants from Japanese beetles attacks. Likewise, certain plants like four o'clocks, mirabilis jalapa, and zonal geranium, *pelargonium x hortorum*, are considered effective trap crops because they may intercept beetles as they're flying to roses to feed.

When tested in replicated small garden plots, however, there was no reduction in the number of beetles on roses interplanted with rue, garlic chives or zonal geranium. Roses interplanted with geraniums generally had more beetles than roses planted alone.

A milky disease infected grub on the left, compared with a healthy grub on the right. Milky disease is common among concentrated infestations in the field but has been shown to be ineffective as a commercial microbial insecticide.

Plant selection

Japanese beetle adults feed on over 300 species of plants in 79 plant families, but there are plants that are truly resistant to feeding. This resistance occurs across species and among cultivars of the same species. In field trials with different cultivars, resistance is quite evident when one cultivar is completely defoliated and the other cultivar next to it is untouched by the beetles. While no apparent resistance to beetle feeding has been shown among rose cultivars, there's considerable variation among the crabapples, lindens, elms and birch.

This infestation of grubs has completely consumed the roots of this turf. Turf damaged by white grubs like Japanese beetles is easy to diagnose. It will roll back like a loose carpet.

Selection of a resistant species or cultivar can be an important strategy for managing beetle feeding damage. Some of the information regarding resistant and susceptible woody plants can be found at: **http://www.uky.edu/Agriculture/PAT/recs/crop/pdf/entfa409.pdf.**

Japanese beetle adults feed on over 300 species of plants in 79 plant families.

The flowers of certain ornamental plants such as cannas, hibiscus, hollyhock, dahlias and roses are like candy to Japanese beetles. If these plants are in bloom, beetles will land on the flowers and begin feeding, almost ignoring the leaves. Among roses, cultivars with white or yellow flowers are more attractive to Japanese beetles.

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Beetles become paralyzed after feeding on the petals of zonal geraniums.

Tantalizing but toxic

Along with the anecdotes about trap crops, some plants are believed to be toxic to the Japanese beetle. It was even suggested that extensive planting of these alleged toxic species would slow or eliminate the spread of the beetles across the eastern United States. Leaves of the castor bean, *ricinus communis*, and leaves and flowers of the garden larkspur, *delphinium sp.*, and bottlebrush buckeye, *aesculus parviflora*, are said to kill the beetle if consumed. The toxicity of castor bean leaves to the beetles was disproved in a series of experiments published in scientific papers during the 1930s and 1940s. Likewise, experiments with larkspur and bottlebrush buckeye failed to show any negative effects to Japanese beetles that feed on the flowers or leaves.

The zonal geranium, *pelargonium x hortorum*, is one plant that has fulfilled the claims of toxicity to the beetle. Zonal geraniums are a preferred food plant for Japanese beetles, which proves to be a fatal attraction. In 1920, a USDA entomologist noticed large numbers of dead beetles under zonal geraniums growing in the full sun. Beetles can eat just half a petal and become temporarily paralyzed. The paralysis occurs only when beetles feed on the flowers and not the leaves, although paralyzed beetles falling from the flowers are often seen on the foliage.

Paralysis from feeding also occurs with other ornamental geraniums such as ivy geraniums, *pelargonium peltatum*. Beetles that become paralyzed on the plants in the landscape lose about 30% of their body weight in just a few hours. This likely explains why beetles die on plants growing in the full sun but may recover on plants growing in the shade. If beetles do recover, they typically shake off their buzz and feed again on the flowers that just intoxicated them.

— DH