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Principles and History of Turfgrass Pest Management

By Frederick P. Baxendale and Jennifer A. Grant

The importance of developing efficient and environmentally sound methods for managing turfgrass pests has been reemphasized by recent concerns over environmental safety, the loss of long-term residual insecticides, and a growing awareness of the problems associated with the overuse of pesticides. Integrated pest management (IPM) addresses these concerns while maintaining the aesthetic and utilitarian qualities of the turf. IPM is an approach that utilizes all suitable methods and techniques in a compatible manner to maintain pest densities below levels causing unacceptable damage. Although insects and mites are discussed in this handbook, the same management principles apply to other turf problems such as diseases and weeds.

Inherent in the IPM philosophy is the recognition that, for most pests, population levels exist that can be tolerated without substantial plant injury. Eradication of pests is not attempted because moderate pest levels help maintain natural enemies, and chemical overuse can lead to pesticide resistance. The overall objective of IPM is to optimize and diversify, rather than maximize pest control. The selection of optimal management strategies will vary depending on site requirements and will change as new practices and products become available.

An important aspect of the IPM approach involves planning ahead to avoid or minimize future pest problems. Decisions made during the establishment and maintenance of a turf area can substantially influence pest development. Among these key decisions are selection of turfgrass species and cultivar, weed and disease control strategies, irrigation, fertilization, thatch management, and other cultural practices that affect the health and vigor of the turfgrass. As a general rule, stressed or poorly maintained turf exhibits pest damage sooner than healthy turf and is slower to recover after insect or mite injury.

Despite appropriate measures to avoid or reduce insect problems, pest populations may increase under certain conditions. When using an IPM approach, control measures including conventional pesticides are employed only when pest numbers reach or threaten to reach predetermined levels (treatment thresholds). These thresholds are flexible guidelines that are usually defined in terms of the level of insect abundance or damage that can be tolerated before taking action. They are typically based on a number of variables including pest species, abundance, and life stage; variety, vigor, and value of the turfgrass; relative effectiveness and cost of control measures; and time of year. Treatment thresholds are not hard rules that apply to every situation, but when used conscientiously they should help turfgrass managers make effective pest management decisions.

Implementing an IPM Program for Turfgrass Insects

Establishing a pest management program requires a sound understanding of the growth habits and cultural requirements of the turfgrass; knowledge of the biology, behavior, life history, and type of damage caused by potential pests; and information regarding the time of year, growth stage of the turfgrass, and environmental conditions under which pest damage is most likely to occur. Accurate pest identification is also essential. In addition, turfgrass managers must integrate insect control with disease, weed, and cultural management strategies.

Pest Identification. All turfgrasses are inhabited by a diverse array of organisms, including insects, spiders, mites, nematodes, and many other small animals. Most of these cause little or no damage and are generally considered nonpests. Others serve important beneficial roles as a food source for wildlife, in the breakdown of thatch, in aeration of the soil, or as natural enemies of various insect and mite pests. Only a few of the species present are actually plant-feeding pests. Because of the many similarities between pests and nonpests, it is essential that the turf manager be able to accurately distinguish incidental and beneficial species from target pests.

Pest Monitoring. Successful management of most turf insects depends on the early detection of pests before they reach damaging levels. This can best be accomplished through frequent turf inspections to detect early signs of insects and their damage. Monitoring (scouting) is a systematic method of inspecting turf for pests and cultural problems and should be the backbone of any

pest management program. Its primary goal is to detect, identify, delineate, and rank pest infestations and turfgrass abnormalities. All turf areas should be monitored on a regular basis during the growing season. The scouting interval may vary from 1 to 2 days to several months, depending on whether the turf is associated with a golf course, institution, home lawn, sod farm, or other area.

Among the more common symptoms of insect-damaged turf are a general thinning of the grass, spongy areas, irregular brown patches, or plants that easily break away at soil level. Substantiating the insect origin of the problem may be difficult, however, because many of the symptoms described above could also be caused by non-insect factors such as heat or drought stress, nutritional deficiencies, turf diseases, soil compaction, chemical burns from gasoline, fertilizers, herbicides or insecticides, scalping during mowing operations, or even excrement spots left by pets. If the problem is insect related, a close visual inspection of the damaged area should reveal either the presence of the pest or indirect evidence that an insect infestation has been present.

Bird and animal feeding activity often indicates potential insect problems. Starlings, robins, moles, skunks, and raccoons are well-known insectivores. However, confirmation of the insect origin of a problem requires close examination of the injured area. Look for signs of skeletonized leaves, clipped grass blades, fecal pellets, sawdustlike debris, stem tunneling, silken tubes, or webbing. Then, refer to individual sections of this handbook for a description of damage symptoms caused by specific insects. If no evidence of insects or their feeding is found, the condition is probably due to another cause, and use of insecticides or other insect control measures would be ineffective.

Insect Sampling Techniques. Insect sampling techniques provide an important complement to visual monitoring of turf. Sampling should be initiated when an insect infestation is suspected, at appropriate times in a pest's life cycle, in historically infested areas, or when a post-treatment analysis of pesticide efficacy or other control measures is desired. Because insect and mite pests rarely distribute themselves evenly throughout the turf, it is essential that the entire turfgrass area be sampled in a consistent, uniform pattern. Enough samples must be taken to assure a reasonably accurate estimate of pest numbers in the sampled area.

If turf damage is evident but no pests are detected, examine the turf for other causes of injury such as disease, excessive thatch, improper mowing, or heat or moisture stress. When examining turf, be on the lookout

for beneficial natural enemies that may be reducing pest populations such as lady beetles, bigeyed bugs, lacewings, ground beetles, spiders, and parasitic wasps. Sampling techniques for detecting surface- and soil-inhabiting insects are described below.

Disclosing (Irritant) Solution. Surface-active insects can be flushed from the turf with a disclosing solution. Mix two to four tablespoons (30–60 ml) of liquid dishwashing soap, or 1 tablespoon (15 ml) of 1% pyrethrins, into 2 gal (7.6 liters) of water and pour the mixture over a 1.2-yd² (1-m²) area of turf. Insects such as webworms, cutworms, armyworms, mole crickets, billbug adults, as well as earthworms, will come to the surface within 5–10 minutes. There they can easily be collected, identified, and counted. Treatment thresholds based on this sampling method are available for some insects and are described in their respective sections. Because detergents vary in their concentrations and components, they should always be tested to determine the soap-to-water ratio that will irritate the target insects, yet not be phytotoxic to the turfgrass.

Flotation. Many insects float to the surface when submerged in water. This phenomenon can be exploited by inserting a metal cylinder (preferably 8–9 in [20–23 cm] in diameter) about an inch (2.5 cm) into the ground. A large coffee can with both ends removed is suitable. Fill the can with water and replace any water that escapes until the turf has been underwater for 3–5 minutes. Insects will float to the water surface where they can be collected, identified, and counted. An alternative method is to remove a large soil core with a golf course cup cutter and place it in a bucket of water for the same amount of time. These techniques are ideal for detecting chinch bugs and many of their natural enemies. See the section on chinch bugs for further details regarding when to sample and threshold levels.

Soil Examination (Cup Cutting and Soil Diggings). Most soil-inhabiting insects, such as scarab grubs, cannot be sampled by the methods previously discussed. These insects must be sought in the root and thatch zones where they feed. One sampling method involves cutting three sides of a square turf area (0.25–1 ft² [0.02–0.09 m²]) with a shovel or knife and peeling back the sod layer to expose white grubs, billbug larvae, and other soil dwellers. It is important to examine the entire root zone, including both the sod cap and the upper 1–3 in (2.5–7.6 cm) of soil. Several samples should be taken to determine population levels throughout the area.

A second method for sampling soil-inhabiting insects utilizes a standard golf course cup-cutter, which removes

soil cores with diameters of 4.25 in (11 cm). Cores can be rapidly inspected for insects as the soil is discarded back into the original hole. If the sod cap is then replaced and the area irrigated, damage to the turf is minimal. Record the numbers of each insect species found and its predominant life stage (egg, larva [instar], nymph, adult), on a data sheet or map. Inspecting soil samples in a grid pattern across any turf area helps to delineate areas with insect infestations. Minimum intervals of 22–33 yd (20–30 m) between samples in large turf areas should be sufficient. Ultimately, the number of samples taken depends on the time and labor available. Studies in New York have shown that 20 samples can be examined per person per hour. Sampling time will also vary depending on insect density, soil type, thatch thickness, and other factors.

Traps. Insect activity can be monitored using a variety of trapping methods. Most traps utilize an attractant (lights, pheromones, food scents) that lures insects to the trap. Upon reaching the trap, insects are captured by mechanical means, such as sticky surfaces, or killed with insecticides. Typically, these traps are hung from trees or stakes in or near the turf area. Light traps collect a wide variety of flying insects, including scarab beetles and cutworm, webworm, and armyworm moths. The sheer abundance and diversity of insects collected can be a disadvantage to this approach because of the extensive sorting and identification time required. Pheromone traps are highly selective and usually capture only one sex (usually males) of a single species of insect. Pitfall traps are placed in the ground so that the top is flush with the turf surface. These traps capture insects as they move along the ground. Arthropods such as mole crickets, billbug adults, ground beetles, and the winter grain mite can be monitored using pitfall traps.

Insect traps are useful monitoring devices that provide important information confirming the presence and timing of a particular pest in an area. For example, peaks in adult activity can be tracked and used to predict when damaging larval activity will occur later in the season. Traps should not be relied on to reduce or eliminate pest infestations. It is important to understand fully the capabilities and limitations of any trapping method before use. Also remember that to be effective, traps must be checked on a regular basis - sometimes daily! Insect monitoring traps can be obtained from most pest management supply companies.

Visual Inspection. Certain insects are most easily detected by visual inspections. Billbug adults, for example, can be monitored as they stroll on paved areas and side-

walks in hot weather, and a treatment threshold is associated with this activity. The annual bluegrass weevil can be detected by inspecting the clippings in mowing boxes from close-cut turf, and chinch bugs can sometimes be found by separating grass plants with the thumb and forefinger and examining the base of the plant. Visual inspection can be used to detect most insects, but it is rarely as efficient as other sampling techniques.

Other Detection Methods. Standard insect sweeping nets are useful for collecting flying insects in turf areas. Mole crickets in flight have been monitored using sound-trapping stations that broadcast recordings of males. Their damage can be assessed by placing a square frame 30 by 30 in (76 by 76 cm), divided into nine equal sections, over damaged turf. Turf is then rated from 0 to 9 by the number of sections containing mounds or tunnels.

Record Keeping and Evaluation. Accurate records are essential for the success of a turfgrass pest management program. During the growing season, day-to-day pest management decisions are based on scouting information. Effective record keeping greatly increases the long-term value of this information by providing the turf manager with historical, site-specific knowledge of pest activity. This information can be used to predict when certain pest problems are most likely to occur later in the season and in subsequent seasons. In addition, records call attention to patterns and associations that may be overlooked during a pest event. Examples include particular turf areas or cultivars that are chronically infested or insect activity coinciding with drought or disease stress. Pest histories should be reviewed several times each season so that potential pest problems can be anticipated and initial monitoring efforts focused on historical “hot spots.”

Pest management records should be as complete as possible. Record the kinds and numbers of pests present, when and where they were found, and exact locations and extent of any turf damage or abnormalities observed. Information on the turf species and cultivar development, turf health, and current environmental conditions is also valuable. When recording scouting or other management information, be as quantitative as possible. Record the actual number of insects per unit area and assign damage ratings to injured turf (e.g., 1 = severe damage, 3 = moderate damage, 5 = no observable damage). Avoid vague designations such as high or low, or heavy or light. It is often useful to divide turf areas into pest management units (PMUs) that can be considered individually when making pest management deci-

sions. For example, each tee, green, and fairway on a golf course constitutes a PMU. Likewise, the front and back lawns of residential properties can often be placed in separate PMUs because homeowners typically have different aesthetic standards for these areas. When recording pest management information, be sure to specify both the PMU and the location within the PMU where the data were collected.

Assessing the effectiveness of cultural and pest control practices is an important yet often overlooked component of a turfgrass pest management program. In most cases, the same sampling techniques used to detect the original pest infestation can be used to ascertain the success or failure of a control strategy. However, when evaluating the efficacy of a control measure, sampling can be limited to only a few previously infested areas. The turfgrass manager can use the evaluation process to determine management approaches that were effective and those that need to be modified. At the end of the season, this information can be reviewed to plan and prioritize scouting and management activities for the future.

Pest Management Options

As previously discussed, IPM uses a combination of complementary strategies to manage pest populations. This section describes some of the pest management options currently available to the turfgrass manager.

Cultural Methods. Cultural methods involve manipulation of the environment to make it less suitable for pest survival. These measures are usually preventive in nature and must be implemented before the insect reaches pest status.

Turfgrass Selection. Select turfgrass species or cultivars that are well adapted to local soil and environmental conditions. Adapted turfgrass cultivars are better able to tolerate stress and are less likely to be damaged by insects than unadapted grasses. Further, a blend of improved adapted grasses will usually outperform a single cultivar. Information on locally adapted turfgrasses is available from local seed dealers, Cooperative Extension offices, as well as most nurseries and garden centers.

Insect-resistant turfgrasses provide another valuable IPM tool. Plant resistance to insect pests has been found in many turfgrasses, although the degree of resistance may vary considerably from one species or cultivar to another. Several cultivars of billbug-resistant Kentucky bluegrass are available commercially.

Endophyte-Infected Grasses. Endophytes are organisms, typically bacteria or fungi, growing within a plant.

Turfgrasses infected with endophytic fungi in the genus *Acremonium* have shown enhanced resistance to 14 species of insects including aphids, leafhoppers, chinch bugs, armyworms, webworms, and billbugs. Among the turfgrasses containing endophytes are certain cultivars of perennial ryegrass and tall and fine fescues. Useful endophytes have not been found in creeping bentgrass or Kentucky bluegrass.

Effective Maintenance. Many turfgrass insect pests are attracted to lush, overly maintained turf. Sound cultural practices that optimize plant health and vigor enable the turf to withstand higher pest infestation levels and recover more rapidly from insect and mite injury. Therefore, careful turfgrass management is one of the best insect prevention strategies available.

Biological Control. This important IPM strategy uses beneficial organisms including predators, parasites, or insect pathogens to reduce pest populations. Biological control can be implemented by releasing beneficial organisms into the turf area or by modifying cultural, chemical, and other control practices to conserve and enhance existing natural enemy populations. In general, effective use of this approach requires a detailed knowledge of the specific predator/prey or parasite/host relationship being manipulated. See the section on beneficial organisms for detailed information on various options for biological control of turfgrass insects.

Insecticides/Acaricides. Insecticides and acaricides are probably the most powerful tools available for insect and mite control in turf. In many cases, they afford the only practical method of reducing pest populations that have already reached damaging levels. Insecticides have rapid corrective action in preventing pest damage and offer a wide range of properties and methods of application. They are relatively low in cost, and their use often results in a substantial economic or aesthetic benefit. Some potential problems associated with insecticide use include the development of pest resistance; outbreaks of secondary pests; adverse effects on nontarget organisms including humans, pets, wildlife, and beneficial insects; hazardous residues in our food supply; and groundwater contamination.

Factors that can influence the effectiveness of an insecticide application include the insect species present, insecticide selection, timing of the application, irrigation before and after treatment, thatch and soil organic matter, water and soil pH, resistance of insects to pesticides, and soil microbial degradation. These factors should be considered carefully when making an insecticide treatment decision.

When insecticides are used in an IPM program, they should be carefully selected and their application timed with respect to the developmental stages of the target pest. Insect monitoring information can help pinpoint the optimal time for treatment. Proper selection and timing of pesticide applications are extremely important in obtaining the best possible control with the least adverse effect on the environment. Observe treatment threshold levels (i.e., treat only when necessary) and limit treatments to infested areas of the turf whenever possible. Ensure proper calibration of the application equipment and always read, understand, and follow all label directions.

Application Techniques. The following recommendations apply mainly to standard insecticide applications. Some biological control agents and new-chemistry insecticides require special handling and application techniques. Read the product label and discuss application procedures with the supplier before use.

For surface-active insects, the turf area should be mowed and the clippings removed before application to enhance insecticide penetration into the canopy. A thorough irrigation before application moves insects out of the thatch and soil and brings them to the surface. For night-feeding insects, apply the insecticide in the late afternoon or early evening. Light irrigation after spraying rinses the insecticide off grass blades and into turf where billbugs and other thatch-active insects reside. A heavier irrigation should follow granular applications to wash

granules off grass blades and activate the insecticide. For blade-feeding insects such as aphids, spider mites, and armyworms, do not irrigate for 24–48 hours after application.

In the case of soil-inhabiting insects, it is important that the insecticide move through the thatch layer and down to the root zone of the turf where the insects are feeding. Thatch layers of 0.5 in (1.2 cm) or more can greatly reduce the effectiveness of an insecticide by intercepting and chemically binding the active ingredient. Reduction of the thatch layer or aeration of the turf before application increases insecticide efficacy. For optimum control of soil-active insects, apply 0.5 in (1.2 cm) of water 24–48 hours before the chemical application to encourage the insects to move closer to the surface and to decrease the absorbency of the thatch. Irrigation before treatment is especially important if conditions have been hot and dry and insects are deep in the soil. Immediately after the insecticide treatment, a heavier irrigation of 0.75–1 in (1.9–2.5 cm) should be applied to ensure effective thatch/soil penetration.

Always follow label directions for reentry periods. Never allow sprays to puddle, because honey bees and wildlife may be injured. Remember that it may take several days after treatment to achieve control of surface-active insects and longer for soil inhabitants. Further information on pesticide safety, application methodology, and listings of registered turfgrass pesticides can be obtained from local Cooperative Extension offices.