A PRACTICAL RESEARCH DIGEST FOR TURF MANAGERS

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Multiple Considerations in Turfgrass and Landscape Pest Management

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Lawns in the United States occupy an area estimated at between 25 million and 30 million acres (10.1 million and 12.2 million hectares), 50,000 sq. miles, or roughly the size of the five New England states. Approximately 50% of these properties receive pesticide applications by homeowners who the last time such data were gathered were estimated to be spending over $688 million on pesticides and fertilizers (Lawn Care Industry, 1985). Pesticides are also applied to approximately 10-20% of residential properties by the professional lawn care industry. Golf courses, athletic fields and parks planted to turfgrass are becoming an increasingly important part of American recreational activities.

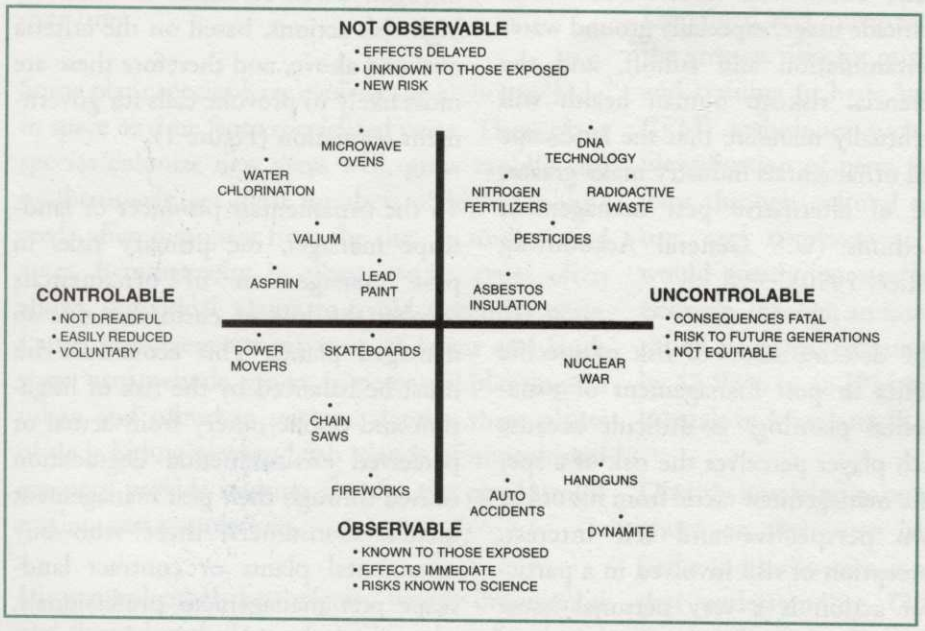

Figure 1 Adapted from Morgan 1993

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Golf courses are the most intensive users of turf pesticides on a per acre basis. Golf course superintendents are highly trained turfgrass managers, but rely heavily on pesticides to insure high quality playing surfaces. Between professional turfgrass management and homeowner lawn care, turf maintenance has become a $25,000,000,000 industry in the United States (Gibb & Buhler 1995).

Assessing the risks

Historically, insecticides, fungicides and herbicides have been the major control tactic used against insect, pathogen and weed pests of ornamental plantings. However, because many of the plants attacked by these pests are grown in urban or suburban areas (golf courses, parks, home lawns and gardens, landscaping around commercial buildings), the potential for human exposure to pesticides directly through application or indirectly through environmental contamination is considerable. Growing concerns about the hazards of urban pesticide usage, especially ground water contamination and runoff, and the potential risk to human health will eventually mandate that the landscape and ornamentals industry make greater use of alternative pest management methods (U.S General Accounting Office, 1990).

The determination of risk of specific tactics in pest management of ornamental plantings is difficult because each player perceives the risk of a specific management tactic from his or her own perspective and self interest. Perception of risk involved in a particular action is a very personal issue. Although the actual danger or 'risk' of an activity such as being struck by lightning, drowning while surfing, or being poisoned by an insecticide on a golf course may be analytically determined (the probability of an action occurring in chances per million) (see Kenna, USGA Grounds Record, July/August 1995), the public may not define risk solely as the number of deaths or injuries per unit time (according to M. Granger Morgan 1993). For example, the actual risk of any individual being killed in a nuclear war is extremely small, but this is clearly a risk few are willing to take. Instead, the risks associated with some action are ranked by the public based on a number of quite reasonable criteria, only one of which is the probability of being harmed by that action. These additional risk factors include: how well the action being considered is understood; how equitably the danger is distributed; how well individuals can control their exposure; and whether risk is assumed voluntarily. Morgan suggests that the public perceives the development of DNA technology, the use of pesticides, and the application of nitrogen based fertilizers as relatively high risk actions, based on the criteria outlined above, and therefore these are most likely to provoke calls for government regulation (Figure 1).

To the ornamentals producer or landscape manager, the primary risks in pest management of ornamentals involve the loss of customers due to damaged plants. This economic risk must be balanced by the risk of litigation and public outcry from actual or perceived environmental degradation caused through their pest management tactics. Consumers, those who buy ornamental plants or contract landscape pest management professionals, must weigh the risk of plant loss on the

one hand with the exposure to potentially harmful pest control products on the other. They must also consider the impact of the use of specific management tactics on their neighbors and the reaction of their neighbors to those decisions. Finally, public administrators, guided by public opinion, must weigh the associated risks to the public at large. The public is passively exposed to pest management tactics, yet receive little direct benefits for assuming those risks.

Where do all the pests come from?

Over time, plants have evolved a wide array of biochemical, mechanical and ecological traits that help protect them against injury from pests. However, traditional ornamental breeding programs have generally focused on enhancing agronomic characteristics such as growth patterns, flowering, or tolerance of environmental stresses such as drought. As a result, plant characteristics that contributed to resistance against pests have been lost or diluted over time through benign neglect. We have stripped the natural armor off ornamental plantings, making them vulnerable to attacks by insects, plant pathogens and weeds. In many cases, the addition of pesticides into horticultural systems represents our feeble attempt to replace the protection factors we have inadvertently bred out of our ornamentals over time.

Some plant species have evolved the ability to 'hide' in space or time from specialized pests. These plant species colonize new areas well, grow rapidly and unobtrusively, set great numbers of highly mobile seeds, then disappear from the site. In undisturbed areas, heterogeneity in plant species types often allows individual plants to avoid potential pests. Large, homogeneous expanses of lawns and landscape ornamentals, grown in perennial plantings in urban and suburban settings, deprive these plants of their hiding places. Lush islands of unprotected greenery provide inviting sites for the rapid proliferation pest populations.

Large numbers of the turfgrass, woody ornamental and floricultural plant species have been imported from other lands. Many of the insects, weeds and pathogens that are important pests of ornamentals were carried over with these exotic plants, often without their associated predators, parasites and pathogens. Freed from their natural control agents, these pests soon spread unchecked, causing extreme feeding damage to plants. Over time, endemic beneficial organisms often reduce pest populations, but in other situations, researchers must travel to the home of the pests to find and import specific predators, parasites or pathogens to control these introduced pests.

Integrated Pest Management

What is IPM?

IPM is an approach that utilizes all suitable technologies in a compatible manner to maintain pest densities below levels causing unacceptable damage. Pest management strategies will differ depending upon the value of planting, the degree of damage deemed acceptable by growers or consumers, and the conditions under which the ornamentals are grown.

Educating the public

Untrained and unregulated consumers pose one of the greatest risks for misuse of pesticides. Awareness and training in basic Integrated Pest Management (IPM) techniques such as detection and proper identification of pests, minimization of pest problems through cultural means, optimized pesticide use, and employment of chemical alternatives would greatly increase consumer awareness. As an example, through an intensive and appropriate education program, consumer awareness was increased by 45-83% in an IPM program on landscape ornamentals in Maryland (Raupp et al. 1989).

Directly involving consumers in practical IPM programs on their own lawn, and at local schools, parks and businesses, is an excellent way to provide that understanding. One public group that has expressed a strong interest in alternative to turfgrass

pesticides is local school districts. In New York State, extensive educational efforts since the mid 1980's have trained golf course personnel in the use of IPM techniques. In addition, intensive State-sponsored pilot programs have demonstrated the feasibility of applying these techniques, resulting in pesticide reductions of up to 65%. Currently, over 25 golf courses are involved in these programs in three focal areas of the state.

Although landscape management professionals have more training in pest control than the average homeowner, pesticide use would be reduced if an intensified IPM training program were developed for this audience. The problem is exacerbated by the fact that many lawn care companies have traditionally based fees on pre-scheduled pesticide applications. As public environmental concerns increase, and pollution regulations grow, those companies adopting an IPM approach will survive and prosper. IPM-specialized professionals who detect and identify pest problems, rather than simply apply pesticides, can greatly expand the market for alternative landscape management.

Current industry sentiments are reflected by local landscape companies whose interest precipitated research on sampling for grubs in New York lawns. These companies felt that consumer pressure warranted development of appropriate IPM techniques, and that these techniques made commercial sense.

What are the essentials of an IPM Program?

(adapted from Ferrentino et al., 1993)

A. Scouting

"Scouting" is the process of systematically looking at plant health and monitoring for pests and their symptoms. Turf scouting provides important pest information, which can be used to determine the need for pest control actions. As a result, pesticides are used only when necessary to preserve quality, at the optimal time in the pest life cycle, and can be optimally selected based on site specific knowledge. Scouting information is even more essential when using alternatives to chemical pesticides, such as cultural and biological controls. Residential scouting procedures can be readily adapted from existing procedures for golf course turf in New York State, and from scouting programs in other states. A well integrated, grower supported scouting program for pests of poinsettias in greenhouses has been developed and implemented through the efforts of the New York IPM Ornamentals Program. This program couples scouting of poinsettias for arthropods (whiteflies, mealybugs, fungus gnats, spider mites), diseases (powdery mildew, pythium, phytophora, rhizoctonia, botrytis, scab,) and weeds with recommendations for appropriate control measures should pest populations rise above economic injury levels.

B. Pest identification

Accurate identification and knowledge of insect, mite, disease and weed pests enables the grower to select an appropriate, pest-specific management strategy. It is important to know the major pests that are likely to appear, where to look for them, and how to identify them. With IPM it is necessary to understand the biology of a pest and its interaction with other organisms and the environment. Identification can be accomplished by a professional scout, by the grower or consumer, by county extension personnel, or in difficult cases by public or private diagnostic laboratories.

C. Records keeping

Brief, concise and accurate information recorded on a data sheet is the best tool available to make a diagnosis or decision. IPM programs rely on records to make field recommendations. When program evaluations and future plans are developed, field records and data analysis are priceless.

D. Appropriate intervention technology

There are many possible pest management tactics that may be appropriate for controlling the pest

complex in ornamental plantings. Pest management technologies must be developed that improve individual management tactics and optimize the integration of various techniques. Although some control technologies fit more comfortably into an integrated management program than do others, there are no technologies that must be dismissed out of hand as incompatible with an IPM philosophy.

Ornamental pest management tactics

Host plant resistance

Resistance of plants to pests is the property that enables a plant to avoid, tolerate, or recover from injury by pest populations that would cause greater damage to other plants of the same species under similar environmental conditions. There has been considerable progress in the identification of ornamental cultivars that show increased tolerance to insect feeding damage and decreased susceptibility to plant diseases. In most of these instances, this increased level of pest tolerance has not been the focus of a directed breeding program, but was instead a fortunate by-product of the breeding of agronomically important traits. Traditional and molecular ornamental breeding programs are now focusing on pest-related issues, a primary objective in cultivar improvement. Advances in genetic engineering make the insertion of Bt and protease inhibitor genes into ornamental cultivars for insect control technically feasible.

Complex plantings

The trend towards large monoculture systems with low intra-cultivar genetic variability has been cited as a cause for rapid build up of large pest populations. Complex landscapes, where many types of plants are grown on the same piece of land, has been suggested as a tactic to lessen plant injury. Mixtures of ornamental plants in landscapes and mixtures of grass varieties on lawns, each with its own level of tolerance and susceptibility to pest problems, will often reduce overall pest impact in an area.

Cultural practices

Factors such as plant species, fertilization application rate and timing, mowing height, and irrigation can greatly affect pest population numbers.Temperature, relative humidity, irrigation and light may be manipulated to provide conditions unfavorable to plant disease. Conversely, improper environmental management may exacerbate disease problems. Environmental factors that give a competitive advantage to desirable plants over undesirable species will decrease weed problems. Additionally, healthy ornamentals and turfgrass should be more tolerant of moderate levels of insect feeding injury than those stressed by insufficient nutrients and water.

The time of planting or harvesting of a horticultural crop to avoid specific pest problems is well understood by growers and landscape managers. Plants taken from greenhouses in early spring, before the flight of Oriental beetle females, will prevent infestation of these plants by beetle grubs and avoid the need to treat the crop before shipment. Starting a new lawn in the fall rather than in the spring will greatly reduce possibility of weed infestations, because most annual weed seeds germinate in early spring.

Protection, encouragement and introduction of natural enemies

A large number of turfgrass, woody ornamentals and floriculture plantings have been imported from other lands. Many of the insects and weeds and some of the pathogens that are important pests of ornamentals were carried here with these exotic plants. Freed from their natural control agents these pests soon spread unchecked, causing extreme feeding damage to plants. Over time, endemic beneficial organisms often reduce pest populations, but in other situations, researchers must travel to the homes of the pests to find and import specific predators, parasites or pathogens to control the introduced pest. Japanese beetles colonizing a new territory will typically follow a pattern of several years of population build-up, followed by a reduction to levels commonly found

in established areas. This suggests that natural biotic factors are reducing and stabilizing the population. Due to the constraints governing the use of naturally occurring biological control agents, considerable efforts have been directed to the introduction of predators and parasites isolated in geographic regions from which the exotic pest species originated.

Microbial pathogens, plant pathogen antagonists, and entomogenous nematodes

Insect pathogens that have been observed in nature to decimate pest populations can be encouraged through proper manipulation of the environment or through inundative release of laboratory-reared infective stages. Augmenting the natural levels of the Milky disease pathogen (Bacillus popilliae) to control Japanese beetle, first attempted by White and Dutky in the 1930's, continues to be an effective long term management option in many regions. Epizootics caused by endemic fungal and bacterial pathogens have also been reported for many other insect pest species. Entomogenous nematodes are potentially useful in the management of a wide number of ornamental insect pests. The most promising use of entomogenous nematodes is against soil insects; in the soil, nematodes are protected from desiccation, ultraviolet radiation and temperature extremes. Increased knowledge concerning nematode biology and mass-rearing techniques for entomogenous nematodes has led to increased research in recent years.

Biological control of root pathogens may be achieved through the addition of 'antagonist' microorganisms found in composts or through the manipulation of antagonists already present in soils and on plant parts. The goal in either case is to reduce or eliminate pathogen activity by parasitizing pathogen proprogules and mycelium (Trichoderma), producing antibiotics inhibitory to pathogen growth and development (Pseudomonas), or out-competing plant pathogens for growing space on roots, or for nutrients (Enterobacter) (Smiley et al. 1992).

Exclusion

Physical barriers to pests are a "low-tech" but effective weapon in reducing pest problems. Proper screening of greenhouses can greatly reduce insect pests, while weeds are often a problem in turfgrass, where disease, arthropods or construction has opened an area for weed establishment. Mulches and geotextiles are established tools for excluding weeds and soil insects from ornamental plantings.

Trapping and monitoring

Chemical attractants or arrestants may lure insects from their hosts, thereby lowering the number of insects feeding on plants. These chemicals, alone or in traps, may be used in conjunction with insecticides as baits to attract feeding stages, thereby increasing the effectiveness of the insecticides and potentially lowering the application rates.

Pheromones, black lights, food lures and trap crops may also be used to reduce or to monitor adult populations. Special circumstances may improve the efficacy of trapping strategies. For example, pheromone trapping may be effective against the Oriental beetle because the majority of males emerge before females and may be trapped without female competition. A major effort has been instituted to develop chemicals attractive to adult scarab beetles and black cutworms as tools for monitoring pest populations.

Pesticides

The use of pesticides is often the corner stone of pest management programs. Historically, pesticides were often considered the first line of defense against plant pests. Concerns about the hazards of urban pesticide usage have mandated that the landscape and ornamentals industry make greater use of alternative pest management methods. However, the prudent use of effective pesticides, often as the tactic of last resort, is the safety net of control that permits the practice of the more benign tactics of an integrated pest management program.

Effective long-term control of insects was achieved with organochlorine insecticides. Less effective control has been achieved with the organophosphate and carbamate insecticides that replaced them. Many factors, including soil pH, organic matter, moisture, thatch and microbial degradation of insecticides influence the efficacy of currently registered insecticides. Resistance to organophosphate insecticides and miticides has been documented in many instances.

Weeds can be removed from the environment only through physical removal (often reasonable if small areas are affected) or through the application of pre or post emergence herbicides. Such factors as the herbicides' impact on target weed species, secondary weed species present and non-target plant and animal species present are of primary concern. Product residual, leaching characteristics and costs will also determine the proper herbicide to be used. Pesticides that control plant diseases include fungicides, nematicides and fumigants. Fungicides are formulated to kill certain groups of plant pathogens, or temporarily render them incapable of growth. Nematicides generally kill plant parasitic nematodes, plus some insects and other soil fauna; and fumigants are highly toxic gases that kill all living entities, including weed seeds, insects and nematodes (Smiley et al 1992).

Quarantines

Exotic pests that are potentially damaging or difficult to control are often best managed by reducing the chance of their introduction into uninfested areas. Quarantine efforts may be based on predicted spread of the pest into new areas. This is derived from a knowledge of the physiological ecology of the pest, including overwintering requirements and host range and movement behavior.

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