Principles and Components of Integrated Pest Management for Turfgrass Systems

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Integrated pest management has been defined as the selection, integration, and implementation of pest control based on predicted economic, ecological, and sociological consequences (Bottrell 1979). Today, perhaps more than ever, this approach is relevant to producers and maintainers of turf grasses. Never before have societal concerns regarding pesticide use so greatly affected the day to day operation of the turfgrass and related green industries in the United States. At the time of this writing more than a dozen states have enacted legislation requiring the posting of signs to areas treated with pesticides. Several states require written notification to neighbors or pesticide sensitive individuals adjacent to application sites. These changes in legislation occurred largely in response to societal concerns related to pesticide use. They clearly affect the economics of managing pests in turfgrass systems.

In addition to societal concerns, ecological considerations associated with pesticide use have become increasingly important in shaping management decisions and practices in turf. When pesticides are not managed wisely, unwanted ecological consequences can occur. For example, Tashiro (1987) provided examples of six insect pests of turfgrass known or suspected to be resistant to one or more types of synthetic organic pesticides. In addition to the evolution of resistance in pest populations, pesticides may have other undesirable ecological effects. Although the exact role of predators in determining the dynamics of prey populations remains unknown for most systems several authors have suggested that predators play an important role in reducing pest problems in turfgrass (Potter et al. 1989 and references therein). Cockfield and Potter (1984) demonstrated that a single application of synthetic organic pesticides to control sod webworms significantly reduced webworm mortality caused by beneficial predators in turf plots. Outbreaks of secondary pests have been observed in other systems involving landscape plants (Luck and Dahlsten 1975, Merritt et al. 1983). Other adverse ecological consequences associated with pesticide use in turfgrass include the disruption of organisms such as earthworms that remove thatch (Potter et al. 1989). In addition long term pesticide use in the same location can result in enhanced breakdown of pesticides by soil microbes (Niemczyk and Chapman 1987). These and other adverse ecological effects threaten the utility of pesticides in turfgrass systems.

Bottrell (1979) outlined several principles fundamental to the development of an IPM program. First, the pest manager must accept the idea that potentially harmful species (pests) will continue to exist in the system. The usual goal of a pest management program should not be the eradication of all pests from the system. No golf course or lawn can be kept totally free of pests such as grubs, mites, chinch bugs, and webworms for extended periods of time. The cost of materials and labor to eliminate all pests is not justified. A more reasonable management objective is to maintain pest populations below a damaging level.

Low levels of pests may provide food for beneficial organisms in the managed system. These beneficial organisms may help to control pests at a later time (Bottrell 1979).

A second fundamental principal of IPM is that the ecosystem is the management unit (Bottrell 1979). Turf is a complex ecosystem composed of interacting populations of plants, animals, and fungi. Abiotic factors such as temperature, rainfall, irrigation, soil structure and nutrients will affect associations between the living community of organisms found in turf. Turf managers have the ability to alter many of these associations to the benefit or detriment of pests. For example, Vargas et al. (1989) demonstrated that alterations in a physical factor (irrigation frequency) has a major impact on the abundance of beneficial fungi and bacteria in bluegrass turf. They suggested that frequent watering encouraged the buildup of beneficial microbes which in turn helped to suppress pathogenic fungi (Vargas et al. 1989).

A third basic premise of IPM is that the use of natural control agents is maximized (Bottrell 1979). A great diversity of beneficial organisms inhabits turfgrass (Tashiro 1987, Potter et al. 1989 and references therein). When chemicals must be used to control turf pests, there are several ways to reduce potentially adverse effects on beneficial organisms. First, treat only areas requiring treatment. This practice of spot treatment has been shown to greatly reduce unnecessary pesticide use in a variety of ornamental plant systems (Olkowski et al. 1978, Holmes and Davidson 1984, Smith and Raupp 1985, Davidson et al. 1988). Second, apply materials at the time when they will be most efficacious against the target pest. Most pests have specific times in their life cycle when they are relatively immune to control by pesticides. Pesticides should not be applied during these times. Third, select pesticides that are least disruptive to the complex of beneficial organisms found in the turfgrass ecosystem. Recently, there has been great interest in developing biorational pesticides for turfgrass systems. Biological control agents such as pathogens (Bacillus popilliae) and nematodes may be less disruptive to beneficial organisms found in turf then conventional synthetic organic pesticides. Much work remains to be done in this area.

A fourth principle of IPM is that any control procedure may produce unexpected and undesirable effects (Bottrell 1979). For example, Potter et al. (1989) described a scenario in which pesticides and fertilizers may directly or indirectly reduce earthworm populations in turf. They also demonstrated that earthworms were vital in breaking down the thatch layer. When thatch accumulates, the movement of fertilizers, pesticides, and water may be restricted. Turf may become more vulnerable to heat or drought stress or pest attack (Potter et al. 1989). This example demonstrates that a single control action can have an unexpected and unwanted effect on the managed ecosystem.

A fifth and final tenant of IPM is that the management approach is interdisciplinary (Bottrell 1979). This simply means that effective programs will be developed through the cooperation of people in several disciplines such as entomologists, pathologists, weed scientists, agronomists and economists and interested clientele groups including sod producers, golf course managers, lawn maintenance firms and landscape designers, etc.

The IPM approach has formed the foundation for pest management in many agronomic systems for more than two decades (Metcalf and Luchmann 1982). This concept is especially relevant for turfgrass managers now that concerns of groundwater and environmental contamination and pesticide use are in the focus of public attention. Moreover, the IPM approach is a sound alternative to control programs that encourage the development of resistance by pests and have unwanted and unnecessary effects on beneficial non-target organisms. Programs developed at the University of Maryland during the past decade have taken the IPM approach from the domain of the farmer and demonstrated its utility in several ornamental plant systems including home grounds, city-owned plants, parks, corporate landscapes, and commercial nurseries (Davidson et al. 1981, Hellman et al. 1982, Holmes and Davidson 1984, Raupp and Noland 1984, Smith and Raupp 1986, Davidson and Cornell 1988, Davidson et al. 1988ab).

Several components must be implemented if an IPM program is to be effective. First, the pest manager must have a thorough knowledge of the key pests, key plants, and key locations in the managed system. These are the pests that are found in damaging levels year after year and usually involve a relatively small number of insects, diseases, weeds, and nematodes. Some of these pests will be the same over broad geographic regions but others will vary in turfgrasses in different locations. When the manager has obtained a sound knowledge of the identification, biology, and control of these pests his or her job is greatly simplified. Key plants are those most likely to incur damage and require treatment year after year (Raupp et al. 1985). By knowing the cultivars and species most susceptible to pests, managers can reduce losses by growing resistant materials and by focusing their monitoring and management activities on pest prone plants. Turfgrasses vary widely in their susceptibility to insect pests, diseases, and their response to environmental stresses. Hellman (personal communication) has suggested that key locations also occur in turfgrass ecosystems. These are locations that have a history of pest problems or are especially likely places for problems to develop. For example, in Maryland billbug problems usually appear first in the turf adjacent to paved areas such as driveways or sidewalks. Areas like this should be identified, recorded, and monitored closely.

Monitoring is the regular inspection of turf to detect the presence of damaging insects, weeds, diseases, nematodes or other adverse environmental conditions (Raupp 1985). Monitoring provides the information to pinpoint the location of pests and apply controls in the most efficacious and timely way. It also provides information on the presence and activity of beneficial organisms that may eliminate the need for other controls. It also informs the manager regarding how effective previous controls have been. Monitoring is accomplished through the use of visual inspections, a variety of trapping devices, and may be facilitated by recording environmental data such as temperature, rainfall, and humidity.

If a problem is detected, the pest manager must go through a decision-making process that involves a minimum of the following considerations. First, is the problem severe enough now or does it have the potential later to cause true damage? Is control most efficacious at this time or would another time be better? What is the best combination of control tactics that will provide results which are economically and environmentally sound? At the present time pest managers must rely on their own experience and information from all sources in making these decisions. For some insect pests of turf, action thresholds have been adopted. For example, Hellman (personal communication) recommends control for hairy chinch bugs when populations reach 15-20 bugs/sq ft. The decision-making process will be greatly improved when quantitative thresholds are developed for the key turf pests.

Once the decision has been made to control a problem the pest manager combines one or more control tactics such as cultural controls, mechanical controls, chemical controls, biological controls and resistant plant materials, into an integrated management plan or strategy. Now is an exceptionally exciting time in the development of alternative control tactics for managing pests of turf. Endophytic grasses resistant to many insect species provide an outstanding alternative to synthetic organic pesticides for managing insect pests found in turf (Funk et al. 1989, Siegel et al. 1989). Renewed interest in biological control agents such as Bacillus popilliae and the steinernematid and heterorhabditid nematodes will provide a better understanding of the efficacy and utility of these agents in turf systems (Klein 1989, Shetlar 1989, Georgis and Poinar 1989).

The final component of IPM is an evaluation plan. Among other things, this plan allows the manager to determine the biological outcome of controls, the cost effectiveness of activities such as monitoring and control tactics and the overall value of the management program.

Integrated pest management programs conducted by the University of Maryland with homeowners, communities, arborists, commercial nurseries and Christmas tree growers have demonstrated the feasibility of this approach for some members of the green industry. Similar programs for homeowners have demonstrated the feasibility of the IPM approach in lawns (Vittum 1988). Benefits have included substantial reductions in losses due to pests on many crops, reductions in the overall costs of pest control, and dramatic reductions in the unnecessary use of chemical pesticides (Olkowski et al. 1976, Holmes and Davidson 1984, Smith and Raupp 1985, Davidson et al. 1988b). These results were achieved without a reduction in the quality of the crop and with a high degree of grower satisfaction (Hock 1984, Davidson et al. 1988b, Raupp et al. 1989). The implementation and adoption of the IPM approach will not occur overnight. It will not be immediately feasible in all situations. However, due to ever growing societal concerns regarding the use of pesticides, a more comprehensive understanding of the ecology of turf ecosystems, and the reality of economic constraints, IPM will provide a viable alternative to conventional pest management approaches for many turf producers and managers.

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