Evaluation of Golf Turf Management Systems with Reduced Chemical Pesticide Inputs

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BACKGROUND

Golf courses throughout the United States are being challenged to reduce or eliminate the use of chemical pesticides. In New York State, many public golf courses have been affected by legislation that phases-out and/or eliminates chemical pesticide use. Such laws have been passed for municipal properties in Suffolk County (Long Island), the City of Buffalo, and Albany and Westchester Counties. In addition, at least 20 laws that would restrict pesticide use on golf courses in other areas of the state are currently under consideration. Specifically, a majority of this legislation phases-out pesticide usage by toxicity class over a 3-6 year period. Pesticide use is eliminated by EPA toxicity classification with class I (Danger) compounds being removed first, followed by class II (Warning), and III (Caution) in subsequent years. Advocates of this type of legislation are often unaware of the "costs" of implementing the policies and the resulting impacts on turfgrass quality and golf turf performance.

Golf turf managers faced with operating their facilities under constraints on the use of chemical technology need better information on how to maintain acceptable, playable golf course turf. However, there is a dearth of information available on individual practices and technologies to reduce pesticide use, and especially on how these alternative cultural and pest management technologies would integrate and work together in a system. For example, Plumley *et al.* (1992) found that increasing the height of annual bluegrass putting greens from 3.2 mm to 4 mm reduced incidence of summer patch (*Magnaporthe poae*) by 40%, yet very few managers have implemented this practice because of the effect on ball roll distance. However, if increased mowing height was combined with increased mowing frequency, aggressive topdressing and rolling, it might be possible to maintain acceptable ball roll distance. Recently, Huang et al. (2000) have shown the favorable influence of increased mowing heights on plant energy dynamics that will result in healthier plants. Furthermore, with the introduction of azoxystrobin (Heritage), a chemical that effectively manages summer patch and anthracnose (*Colletotrichum graminciola*), golf turf managers have grown confident in maintaining annual bluegrass through stressful months under intense maintenance pressures. This reliance on a specific class of fungicides, and flagrant disregard of healthy cultural practices is counter to the principles of IPM. Such reliance can lead to increased stress on putting surfaces and ultimately the development of resistant fungal strains.

Our project is a systems-based approach to golf course greens management. It explores total management systems, as practiced by turf managers, rather than focusing on individual technologies and isolated practices. In addition to this project being conducted at a research facility, we have received funding from the USGA to conduct a sister project on the greens of an operational golf course on Long Island. The two projects conducted simultaneously will provide important complimentary information from two settings. One site has sand-based greens in a research setting in a central New York climate; the other has soil-based greens on a public golf course in Long Island's climate.

GOAL

The goal of this project is to provide information on the costs, feasibility and performance of golf course turf managed with few or no chemical pesticides.

OBJECTIVES

• Evaluate the aesthetic and functional performance of golf putting greens managed under various cultural and pest management systems.
• Determine the costs of implementing the various management systems.
• Determine golfer satisfaction with each management system.

PROCEDURES

The following cultural and pest management regimes have been imposed on a large sand-based, bentgrass putting green area at the Cornell University Turfgrass Research and Education Center in Ithaca, NY.

Cultural Management

A) Current Standard: Cultural practices typically followed at public golf courses in central New York.

B) Alternative: Modified to reduce turfgrass stress, minimize pest problems, while attempting to maintain minimum performance standards.

Pest Management

1) Unrestricted: All legal and currently available chemical pesticides in New York State may be used to manage pests, both preventatively and curatively.
2) IPM: Management decisions based on monitoring information. Emphasize least-toxic approaches as defined by factors such as water quality impact, effects on non-target organisms and toxicity to humans. Allow for higher-risk treatments when necessary to maintain expected performance.
3) Non-chemical: Emphasize biologically-based and cultural management of pests, but do not allow the use of pesticides registered in class I, II, or III by the EPA. This mimics conditions currently legislated for implementation by 2002 on many public courses and other turf facilities (parks, schools, etc.) in New York State.

Cultural and pest management systems have been implemented in all possible combinations, for a total of six management regimes as follows.

	Cultural Practices	
Pest Management	Current Standard	Alternative
Unrestricted	I	II
IPM	III	IV
Non-chemical	V	VI

I. Current Standard Culture, Unrestricted Pest Management

Golf turf management typically practiced at public golf courses in central New York is being implemented. This system must produce acceptable turfgrass performance (e.g., quality ratings above 6 on the NTEP rating scale and ball roll distance > 2.5 meters). Any legal cultural or pest management practices may be used, including prophylactic treatments (e.g. snow mold preventative fungicides).

II. Alternative Culture, Unrestricted Pest Management

This system allows for a full compliment of legal chemical pesticide use (preventative and curative). However, cultural practices are modified to minimize turf stress (Table 1). Modifications include slight increases in mowing heights, light frequent topdressing with dry sand (to reduce abrasion and maintain surface integrity), water injection cultivation every three weeks (to increase oxygen penetration into the root zone), light frequent fertilization (based on turfgrass tissue analysis and annual soil testing), hand watering to minimize dry spots, and aggressive traffic management that may require cup changes twice a day.

III. Current Standard Culture, IPM

Cultural practices for golf turf management, typical of public golf courses in central New York, are being implemented. Pest management products and practices are selected by a risk assessment (RA) process (described below), but this system must produce acceptable turfgrass performance (e.g., quality ratings above 6 on the NTEP rating scale and ball roll distance > 2.5 meters). Prophylactic chemical treatments are used only when justified by significant site history of problems and lack of curative strategies that are acceptable in the RA process. In this system, acceptable turfgrass performance is not intentionally sacrificed. Therefore, it may be necessary to select a more toxic method in order to avert significant turfgrass damage or loss of turf.

IV. *Alternative Culture, IPM*

This system allows for a variety of cultural management options designed to provide acceptable turf performance while attempting to minimize stress, as outlined in system II. In addition, pesticide selection is restricted based on the RA approach utilized in system III.

V. *Current Standard Culture, Non-chemical Pest management*

Cultural practices for golf turf management, typical of public golf courses in central New York, are being implemented. This system strives to produce acceptable turfgrass performance (e.g., quality ratings above 6 on the NTEP rating scale and ball roll distance > 2.5 meters). However, no pesticides carrying an EPA toxicity classification of I (Danger), II (Warning), or III (Caution) are allowed. Pest management options include the use of biostimulants, increased fertility, microbial inoculants, incorporation of disease-suppressive composts, and entomopathogenic nematodes and fungi. Severe damage or loss of turf may occur under some conditions and the cost of reestablishing the areas through overseeding and sodding will be included in the economic analysis of the management programs.

VI. *Alternative Culture, Non-chemical Pest management*

The cultural practices in this system are modified to minimize turf stress, as described in system II. Pest management options exclude all pesticides carrying an EPA toxicity classification of I (Danger), II (Warning), or III (Caution) and rely on the cultural and biological methods described in system V. Severe damage or loss of turf may occur under some conditions and the cost of reestablishing the areas through overseeding and sodding will be included in the economic analysis of the management programs.

Table 1 Cultural Management Practices

	Cultural Management	
Practice	**Standard**	**Alternative**
*Mowing Ht. Range**	0.100 to 0.156"	0.172" to 0.187"
Mowing Frequency	Once per day/ 6 days per week	Twice per day/7days per week
Irrigation	Allow stress	Hand water to prevent stress
Fertilization	Approx. 2 lbs. N/M/yr. All but fall app. will be liquid feed.	Approx. 3 lbs. N/M/yr. All but fall app. will be liquid feed.
Topdressing	Every 3 weeks	Every week
Rolling	1x per week	3x per week
Vertical Mowing	None	Every 2 weeks
Hydro-ject	Every 3 weeks	Every 3 weeks

*Range will be adjusted to achieve desired ball roll distance (≥8.5 ft).

Risk Assessment (RA)

The RA process will be implemented in 2001. Pest management strategies will be evaluated based on criteria such as water quality impact, effects on non-target organisms and toxicity to humans. An "Environmental Impact Quotient" (EIQ) was previously developed to determine the environmental impacts of pesticides used in agriculture (Kovach et al. 1992). We are currently adapting this model to aid in selection of turfgrass pest management products for our IPM treatments. In addition to our "Turf EIQ", we will incorporate water quality models such as Augustin-Beckers, GUS, and WINPST.

Performance Management Evaluation

Beginning in 2001, systems will be evaluated for aesthetic and functional performance, pest occurrence, turfgrass species population dynamics, tissue and soil nutrient content, organic matter dynamics, rooting, nematode populations and pesticide impact (as measured by the turfgrass EIQ). In addition, the feasibility of each system, will be assessed with a golfer satisfaction survey and an economic analysis. The following evaluations will be performed.

Daily visual inspections (a minimum of five times per week).

All areas of each green will be inspected from ≤ 1 meter distance. Irregular areas will be closely examined for signs and symptoms of disease-causing organisms, agronomic stress or insect pests. The location of all symptoms will be mapped and quantified. The Area under Disease Progress Curve (AUDPC) method will be used when appropriate to increase the statistical validity of the ratings.

If a <u>disease</u> is suspected, turf will be examined microscopically. If a positive identification is not obtained, a sample will be sent for identification to the Disease Diagnostic Laboratory at Cornell University in Ithaca, NY. Results from the labs will be returned to the golf turf manager within 24-48 hours.

If <u>insect pests</u> are suspected, signs of feeding damage and the presence of insects will be sought. Additional insect monitoring will be used as appropriate, such as pheromone trapping for cutworm adults and oriental beetles, mowing box inspections for annual bluegrass weevil adults, and soap flushes for cutworm caterpillars and armyworms.

If no causal organism is found to be associated with the observed malady and <u>agronomic stresses</u> are suspected, specific indications will be sought by examining the grass plants, thatch and soil; previous scouting records; and records of previous cultural and pest management practices at that location.

Weekly quality and pest assessment

<u>Functional and aesthetic factors</u>

Overall putting green visual quality--Assessment will be rated on a scale from 1-9 based on the NTEP ratings with 1= dead turf, 9= ideal turf and 6= acceptable turf.

Ball roll distance--Measured with a Stimpmeter at the same time of day in an area representative of the putting green, 3 hours after rolling. Three rolls will be conducted in two directions to determine average distance.

Turfgrass Tissue nutrient analysis--Monitored weekly by collecting clippings and submitting to the Cornell Nutrient Analysis Lab. These measurements will be used to develop nutritional history, determine correlations with pest and stress incidence, and establish a precise nutrient management program.

Pest monitoring

Irritant sampling--Insects will be sampled from three randomly selected individual square meter areas on each green, using a soap-based irritant as described by Vittum, *et al*. (1999). All pest, beneficial, and incidental insects will be counted by species and life stage, if possible. Unknown insects will be collected for later identification.

Cutworm traps--Pheromone traps for monitoring adult cutworm flights will be near the research greens. Cutworm moths in the traps will be counted weekly and the information will be used for the IPM and non-chemical treatments.

Weed mapping--Weeds will be identified and mapped on all plots, and updated weekly, with the exception of *poa annua* which will be quantified bimonthly (see below).

Bimonthly assessments

Rooting--Monitored every two months by extracting 5 cm cores to a depth of 25 cm, removing the soil, oven drying and recording dry weights at 7.5 cm increments.

Organic matter--Dynamics in the top 3 cm will be monitored by establishing a baseline prior to initiation of treatments using the weight loss upon ignition method.

Surface species population dynamics --Vegetative assessments of the putting greens will be conducted across the entire surface. In addition, annual bluegrass populations will be monitored in specific locations on each putting green with the point quadrat method.

Nematode sampling --Soil nematodes will be monitored bimonthly as indicators of soil health status (Niles and Freckman, 1998). Six separate soil cores (1" diam x 6" depth) will be taken from each green. Nematodes from each soil core will be extracted by the sugar-floatation method and identified (to genus, family or order where possible). The following will be recorded: the ratio of free-living (beneficial) nematodes to plant parasitic nematodes, numbers of dominant species or genera, P_f/P_i ratios, and corresponding juvenile-to-adult ratios (Kammenga et al., 1996).

Economic Analysis

The costs of labor and materials will be quantified for each management regime, and extrapolated to estimate the economics for an 18-hole golf course.

Golfer Satisfaction Survey

Two golfer satisfaction surveys will be conducted in 2001. Golfers will be invited to our research area and invited to golf on the plots. They will answer a questionnaire as to their perceptions of the quality of each treatment.

CONCLUSIONS AND FUTURE EXPECTATIONS

Plots were established and cultural practices implemented in 2000. The full compliment of pest management practices and evaluation procedures will be added beginning in the spring of 2001. Management systems must be evaluated over the long term to properly assess differences, costs and benefits. We expect to gain the following information from this project.

- Golf course superintendents, golfers, lawmakers and environmental advocates will have greatly increased their comprehension of quality and economic expectations for golf course turf managed under various cultural and pest management regimes.
- Golf course superintendents who chose to manage with limited pesticide inputs, and those who are legislated to do so, will be better informed of their options. Their appreciation of specific cultural and biologically-based approaches to reduce chemical usage will be enhanced.
- Turfgrass researchers will identify areas needing further research within the constraints of each management system.
- The results of this systems-based approach will be communicated to the audiences cited via extension publications, and articles in scientific journals and the popular press. Educational programs will provide these audiences with tangible comparative information for decision making.

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