CUTT

Program Spotlight

Golf turf managers faced with operating their facilities under constraints on the use of chemical technology need information on how to maintain acceptable, playable golf course turf. At the same time, those advocating pesticide restrictions need to be aware of the costs of implementing the policies and the resulting impacts on golf turf performance.

Evaluating Reduced and Nonchemical Turf Management

This project was designed to provide information on the feasibility and performance of golf course turf managed with an IPM approach to reduce or completely eliminate chemical pesticide use. The need for this information is urgent in light of recently passed and pending legislation in New York State and other regions of the country. Golf turf managers faced with operating their facilities under constraints on the use of chemical technology need information on how to maintain acceptable, playable golf course turf. At the same time, those advocating pesticide restrictions need to be aware of the costs of implementing the policies and the resulting impacts on golf turf performance.

Our objective is to evaluate the aesthetic and functional performance of golf putting greens managed under various cultural and pest management systems for feasibility, biological/physical response and golfer satisfaction. The project explores total management systems, as practiced by turf managers, rather than focusing on individual technologies and isolated practices. The work is being conducted on the Bethpage Green Course, Long Island, New York. This course accommodates more than 50,000 rounds of golf annually, has greens constructed of native sandy soil, and is typical of a high-use public course in New York State.

The experiment was designed as a 2 x 3 factorial, with 3 pest management and 2 cultural management regimes.

Pest Management

Unrestricted: All legal and currently available chemical pesticides in New York State may be used to manage pests, both preventatively and curatively. Practices similar to the Bethpage Black Course management were followed.

IPM: Pest management practices are determined by the specific needs of individual greens. Actions are based on scouting information, action thresholds (when feasible) and site history. Cultural and biological approaches to prevent and minimize pest problems are emphasized, but any legal practice or pesticide may be used. When pesticides are deemed necessary, the least-toxic one is selected based on potential risk factors such as water quality impact, effects on nontarget organisms and toxicity to humans. In this system, acceptable turfgrass performance is not intentionally sacrificed. Therefore, it is sometimes necessary to select a more toxic method in order to maintain expected performance (e.g. quality ratings above 6 on the NTEP rating scale and ball roll distance >2.4 meters) and to avert significant damage to or loss of turf. Prophylactic chemical treatments are used only when justified by significant site history of problems and lack of curative strategies that are acceptable in the risk assessment process.

Nonchemical: As in the IPM treatments, cultural and biological approaches to prevent and minimize pest problems are emphasized and decisions are based on the specific needs of individual greens. However, no pesticides registered in class I (danger), II (warning), or III (caution) by the EPA may be used. This mimics conditions legislated for implementation by 2003 and beyond in several municipally owned golf courses and other turf facilities in New York State.

Cultural Management

Current Standard: Cultural practices currently being employed at the golf courses of the Bethpage State Park.

Alternative: Modified Bethpage cultural practices that are expected to reduce turfgrass stress and minimize pest problems, while striving to maintain minimum performance standards (e.g., quality ratings above 6 on the NTEP rating scale and ball roll distance > 2.4 meters). Practices such as double-cutting and rolling are implemented if necessary to maintain these performance standards.

The experimental design results in six management systems as shown in Table 1. Each green serves as a replicate, and we are using all 18 greens of the Bethpage Green Course to accommodate 3 replications of the 6 management systems.

Table 1. Treatment Regimes

Pest Management	Cultural Practices	
	Current Standard	Alternative
Unrestricted	I	II
IPM	III	IV
Nonchemical	V	VI

System I is typical management for a high quality public golf course. Systems III and V, are the same management systems with restrictions on pesticide use. The standard and alternative cultural practices are summarized in Table 2. Practices were frequently adjusted during the season to respond to turfgrass quality and weather conditions.

Table 2. Cultural Management Practices

Practice	Cultural Management	
	Standard	Alternative
Mowing Ht. Range (bench settings; mowing performed with triplex units)	2.8–3.6 mm (0.110–0.140")	3.8–4.8 mm (0.175"–0.188") *except velvet bentgrass, mowed at 3.3 mm (0.130")
Mowing Frequency	1x/day, 7 days/week	2x/day, 5 days/week 1x/day, 2 days/week
Roller	groove	solid
Irrigation	automatic, 3-4:00 AM	manually activated, 6-8:00 AM
Hand Watering	when wilting visible	water known dry spots prior to wilting
Fertilization	1/8 to 1/4 lb. N every 2-3 weeks	1/8 to 1/4 lb. N every 2-3 weeks + 1/8 lb. Amm. Sulfate
Topdressing	every 2-3 weeks	weekly, no brushing
Rolling	1x/week	3x/week (if needed for ball roll)
Vertical Mowing	occasional	every 2-3 weeks except during stress periods
Hydro-Ject	occasional	every 3 weeks, May-Sept.
Clean Up Pass	4x/week	2x/week

*Practices adjusted to attain >2.6 m (8 ft) ball roll distance

The three greens in system VI were renovated to velvet bentgrass in November 2001. These greens required a different cultural regime than others in the alternative culture treatments. In June 2002, the course was closed for approximately 14 days during the U.S. Open Championship. At that time, the velvet bentgrass greens were quad tined twice, cores were processed and greens overseeded with SR 7200 velvet bentgrass seed at a rate of 1 pound per 1000 square feet.

Some cultural and biological practices were employed specifically to prevent or reduce pest problems. These practices were implemented on some or all of the nonchemical and IPM greens (when and where appropriate), such as:

2001

- Rolling greens in the morning to reduce incidence and severity of dollar spot.
- Increased fertility to aid recovery from dollar spot injury.
- Application of entomopathogenic nematodes (*Heterorhabditis bacteriophora*) against annual bluegrass weevil larvae and cutworm caterpillars.
- Manual removal of weeds.
- Green closure to reduce traffic and allow for renovation (2 greens, 2-3 months).
- A winter compost cover of AgreSoil to reduce disease severity.

2002

- Increased fertility to aid recovery from dollar spot injury, increased use of ammonium sulfate and use of Sustane fertilizer.
- Regular applications of *Trichoderma harzianum* (TurfMate).
- Renovation with velvet bentgrass (discussed in results section).
- Manual removal of weeds.
- Green closure to reduce traffic and allow for recovery (1 green, 3 weeks).
- A winter compost cover (will occur only if ground freezes).
- Occasional applications of compost tea.
- Nutrigrow phosphite product for summer stress or decline.
- Standard fertility supplied with kelp based materials from Turf Products.

Performance Management and Pest Evaluations

Putting greens systems were evaluated throughout the growing season for aesthetic and functional performance, pest occurrence, species population dynamics, and tissue and soil nutrient content. Greens were inspected 3-6 times per week for signs and symptoms of disease-causing organisms, agronomic stress, insect pests and weeds. Occurrence was mapped and quantified. Additional insect monitoring techniques such as irritant sampling (soap flushes), cutworm pheromone traps, pine litter flotation and soil core examination were used

continued on page 10

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CUTT

Nonchemical Turf Management

continued from page 9

at appropriate times to detect and quantify insect populations. In 2002 bimonthly, putting green visual quality was assessed using the NTEP rating system (1-9, with 1= dead turf, 9= ideal turf and 6= acceptable turf) from August through October. Ball roll distance was measured with a Stimpmeter (6 rolls at designated permanent location on green, 3x in 2 directions) for monitoring and adjusting treatment practices, but was not recorded as a quality indicator in 2002. Annual bluegrass populations have been monitored approximately once a month since the beginning of the project using the point quadrat method. Samples were taken to monitor populations of free-living and plant parasitic nematodes in 2001 and will be again in 2003.

Economic Analysis and Golfer Satisfaction

In an effort to address the practical implications of each management system, this project is accounting for feasibility and end-user satisfaction with golfer surveys and economic analysis. Additional costs for labor and materials for each management regime are being recorded and will be comprehensively analyzed in 2003. A golfer satisfaction survey will also be conducted in 2003.

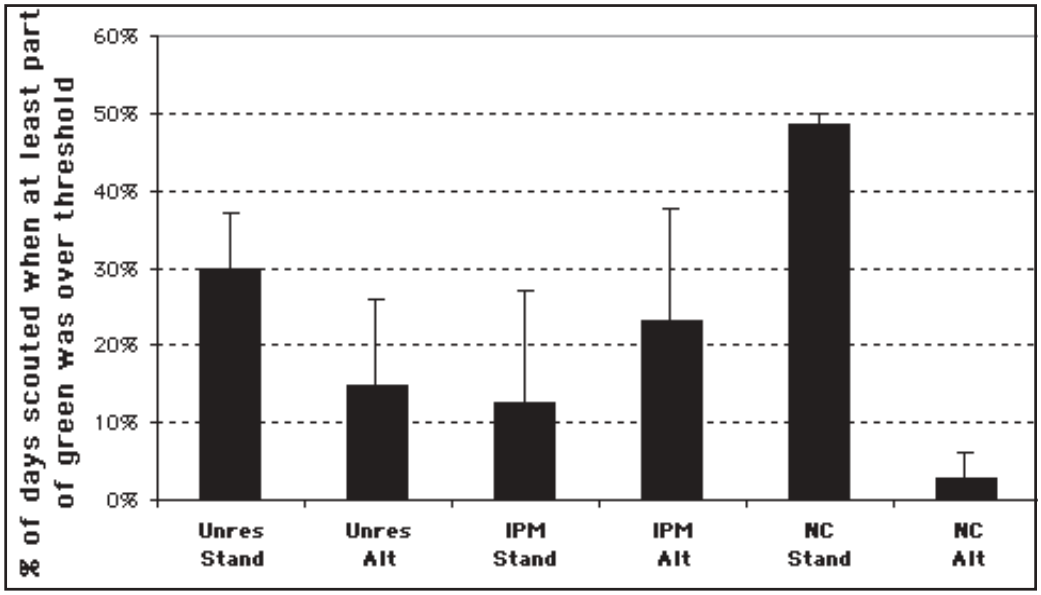
Results: Pests and Pest Management

In the first year, dollar spot was the primary pest in all treatments throughout the season. It was the target of most pesticide applications made, and severely reduced the visual and performance quality of the nonchemical greens. Anthracnose was also problematic at times on greens cut at lower heights, but was usually considered to have stemmed from turfgrass stress rather than primary pathogenic agents. Brown patch was the target of at least one fungicide application on the unrestricted pest management greens, but did not result in loss of turf on any greens. Other diseases were occasionally detected, but were not the target of pesticide applications and did not result in loss of turf.

Velvet bentgrass is a regionally adapted turfgrass species known to be resistant to many turfgrass diseases encountered in the northeastern US. We considered use of this grass to be a radical attempt to culturally minimize disease occurrence and severity. Therefore, the three nonchemical, alternative culture greens were stripped of their poa/creeping bentgrass cover in November 2001, and sodded with velvet bentgrass. In addition to the resodding of greens, two of the three collars were resodded with Kentucky bluegrass to minimize weed encroachment—especially of annual bluegrass which is highly disease susceptible and can pro-

Figure 1.

Dollar Spot: Percent of days scouted when any part of the green was over threshold.



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vide inoculum for spreading pathogens onto the green. Another significant change was the removal of trees around several greens (#2, 3, and 7). However, these greens were targeted because of shading problems, not according to their cultural or pest management treatments. In addition, all nonchemical and IPM greens (except the newly sodded velvets) were covered with compost (1/4 to 1/2 inch thick) from late December to early February for microbial protection from snow mold. The compost cover blew off a few greens requiring a second application of compost to be applied in January to several greens. The use of the biological control agent *Trichoderma harzianum* on the IPM and nonchemical greens and the fertilizer Sustane (exclusively on the alternative culture greens) may also have impacted disease occurrence and severity in 2002.

In 2002, dollar spot remained the primary target of pesticide applications. The disease was first detected on May 12, and was over threshold on 1-40% of the area of four greens during May. All of these greens were managed with "unrestricted" pest management (3 standard culture greens, 1 alternative), and the first dollar spot fungicide was applied on May 23. Dollar spot was most severe on the nonchemical pest management, standard culture greens (Fig. 1). Areas of these greens did not go over threshold until late June, but then rose dramatically and rapidly in July (Fig. 2). One emergency fungicide application was made to these three greens on August 5th, and subsequent disease levels were low in August. Dollar spot severity climbed to high levels again in late September, but subsided in October, and acceptable quality was maintained (discussed later).

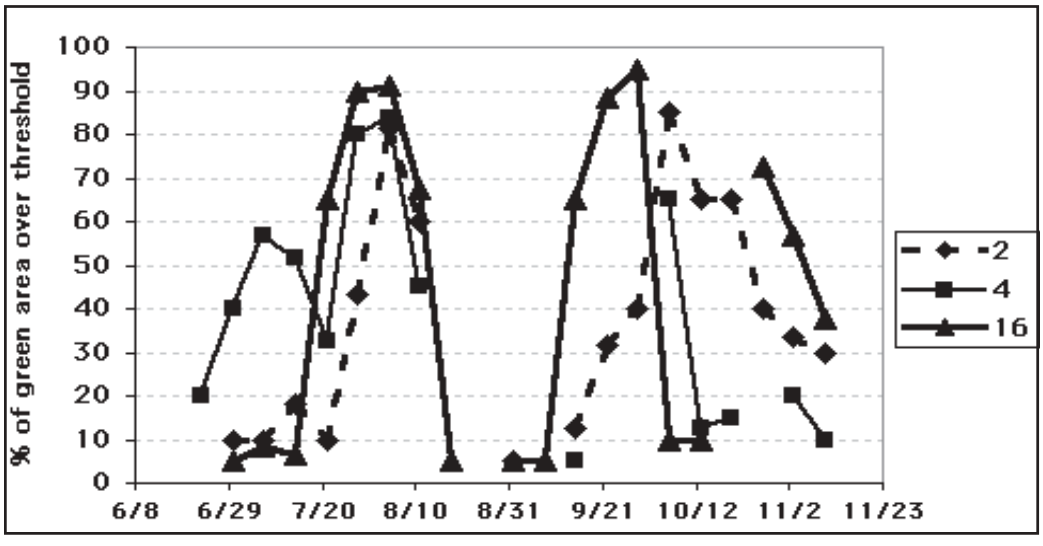
Fairy ring became a prevalent and sometimes severe problem in 2002 (Fig. 3). We associated its occurrence with greens that had been covered in compost the previous winter, and the velvet bentgrass sod. The disease was often severe enough to create hydrophobic conditions and was managed with wetting agents, hydrojecting and fungicides on the IPM greens. Anthracnose was negligible in 2002. Rhizoctonia, however, became more prevalent and was most severe in the nonchemical pest management treatments (Fig. 4).

Insects of significance were black cutworms and annual bluegrass weevils (ABW). In 2001, an application of the biological insecticide *Heterorhabditis bacteriophora* nematodes was targeted for second generation ABW control with the benefit of cutworm population reductions also expected. Nematodes were not applied in 2002 because of their expense and apparent lack of efficacy the previous year. It should be noted, however, that nematode-infected ABW have been detected at low levels in both years. In 2002, the six unrestricted pest management greens each received four insecticide treatments, for management of ABW (1), grubs (1) and cutworms (2). The IPM greens received an insecticide application for cutworms in early July, and again in early September. Cutworm damage was significantly worse on the velvet bentgrass than its poa/creeping bentgrass counterpart (Fig. 5), but no specific insect management actions were taken.

continued on page 12

Figure 2

Dollar Spot on nonchemical, standard culture greens



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CUTT

Nonchemical Turf Management

continued from page 11

Weed concerns in both years were dominated by crab and goosegrass in the poa/creeping bentgrass greens, and *Poa annua* was considered a weed in the new velvet bentgrass greens. Goosegrass incidence was much higher in the standard cultural treatments as opposed to the alternative treatments (Fig. 6). However, differences were not significant due to high variation among greens. Weeds were removed manually from IPM and nonchemical greens, and were treated by one herbicide treatment to all unrestricted greens in both 2001 and 2002. Some IPM greens were also treated, 4 in 2001 and 2 in 2002. Note that both greens requiring treatment this year were in the standard cultural treatment.

The number of chemical pesticide applications is summarized in Table 3. In both years, most pesticide applications that were avoided on IPM greens occurred early in the season, before dollar spot was fully and widely established. This year, the three nonchemical, standard culture greens received one emergency fungicide application in early August. No chemical pesticides were used on the velvet bentgrass greens.

continued on page 14

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Figure 3

Fairy Ring: Percent of days scouted when any part of the green was over threshold

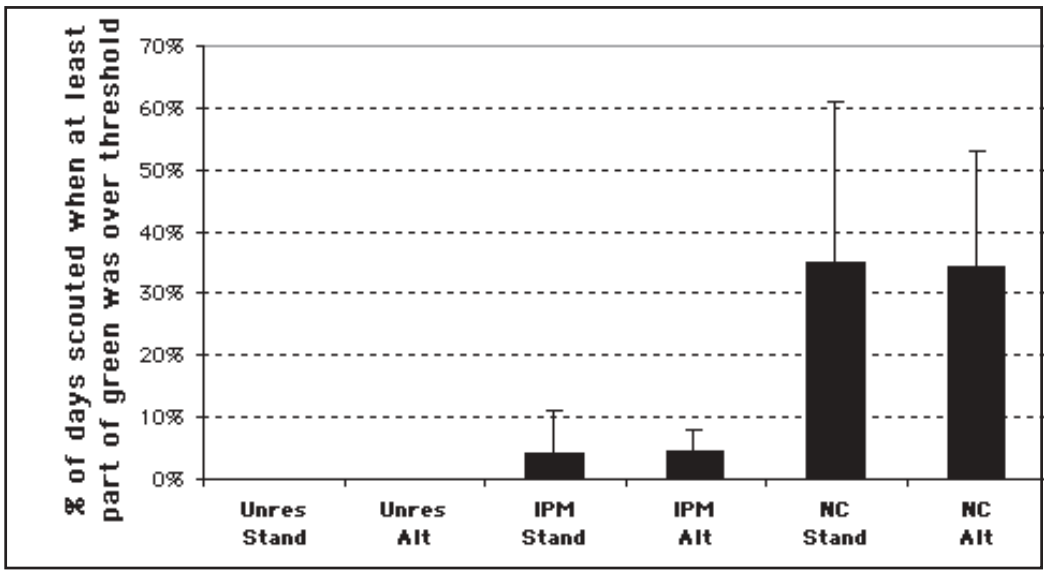


Figure 4.

Rhizoctonia: Percent of days scouted when any part of the green was over threshold

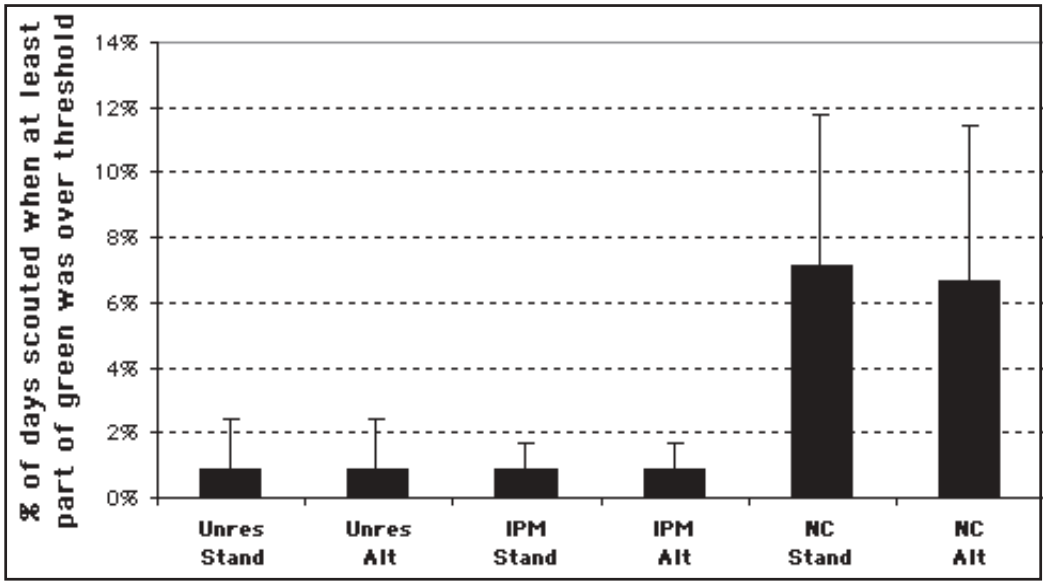


Figure 5

Black Cutworm Damage: Percent of days scouted when any part of the green was over threshold

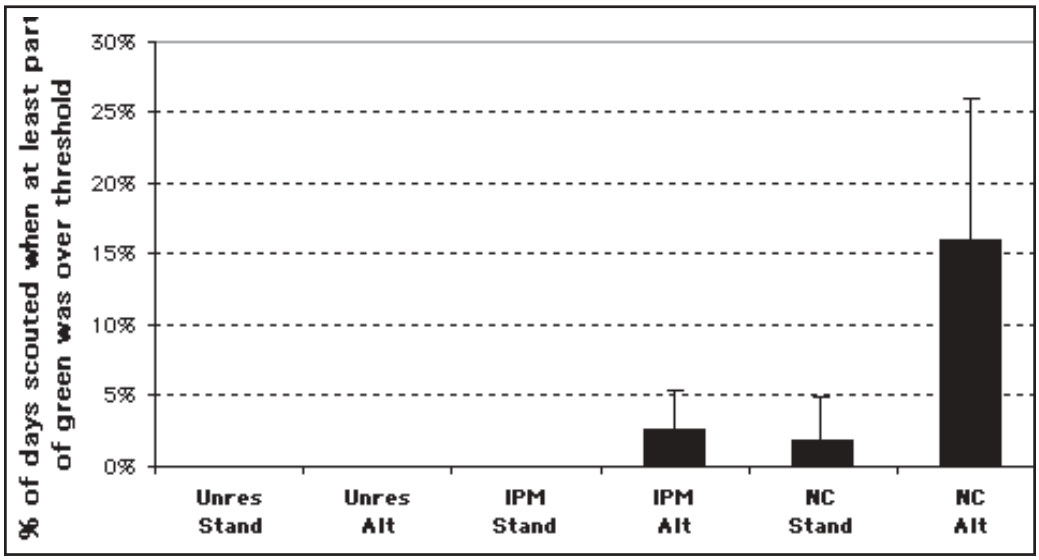


Figure 6

Goosegrass: Percent of days scouted when any part of the green was over threshold

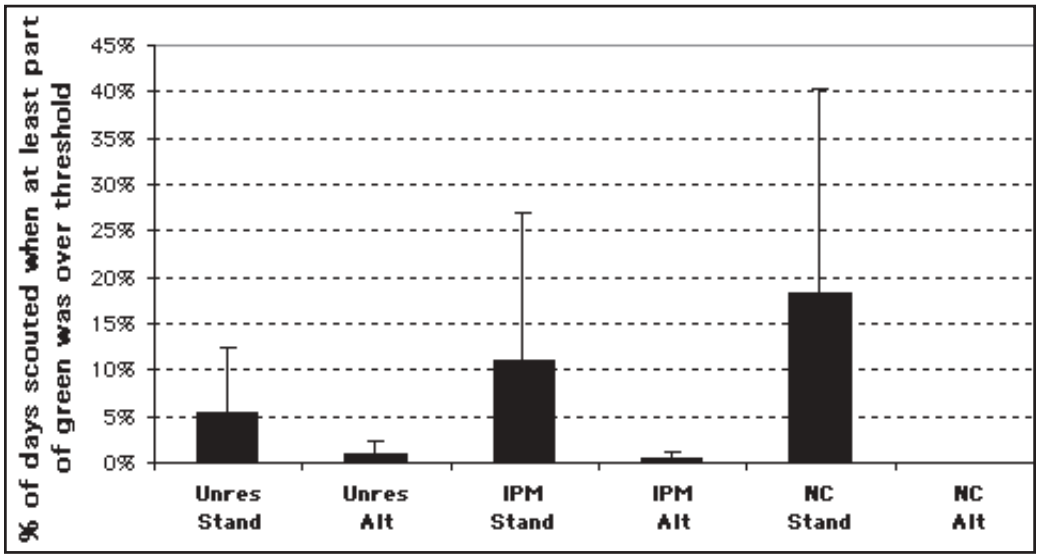


Table 3. Mean Number of Pesticide Applications in Unrestricted and IPM Pest Management Systems

	Unrestricted	IPM—Standard Culture (reduction)		IPM—Alternative Culture (reduction)	
2001					
Insecticides	2	1	-50%	1	-50%
Herbicides	1	0.67	-33%	0.67	-33%
Fungicides	11	8	-27%	7.67	-30%
Total	14	9.67	-31%	9.34	-33%
2002					
Insecticides	4	2	-50%	2	-50%
Herbicides	1	0.67	-33%	0	-100%
Fungicides	14	10.3	-26%	8.30	-41%
Total	19	12.97	-32%	10.30	-46%

Nonchemical Turf Management

continued from page 12

In 2002, the quality of the nonchemical standard greens was very low in August, but was acceptable in September. The velvet greens were marginally unacceptable in August but also improved in the fall. In all treatments, the quality of the alternative culture greens was usually higher than their standard culture counterparts.

Other labor issues to be considered are that many of these tasks must be performed early in the morning in order to be effective, and scouting time may double if the scout does not stay ahead of golfers when play is heavy.

Visual and Performance Quality

In 2001, the quality of all greens was below acceptable in the early season, but quality of 5 of the 6 IPM greens equaled that of the unrestricted treatments. In 2002, all IPM and unrestricted treatments maintained acceptable quality throughout the season (Fig. 7). In 2001, quality of all nonchemical greens was unacceptable as of late August to early September, resulting in closed or very low quality greens for the remainder of the season. In 2002, the quality of the nonchemical standard greens was very low in August, but was acceptable in September. The velvet greens were marginally unacceptable in August but also improved in the fall. In all treatments, the quality of the alternative culture greens was usually higher than their standard culture counterparts.

Turfgrass Populations

Annual bluegrass populations were monitored throughout both seasons. Incidence ranged from 67-100% in 2002, and 27-100% in 2002 (except the velvet bentgrass greens which were all < 1%) (Fig. 8). Counts did not differ by management regime in the first season. In 2002, the poa counts in the creeping bentgrass greens were lowest in the nonchemical, standard culture greens, but were not significantly different.

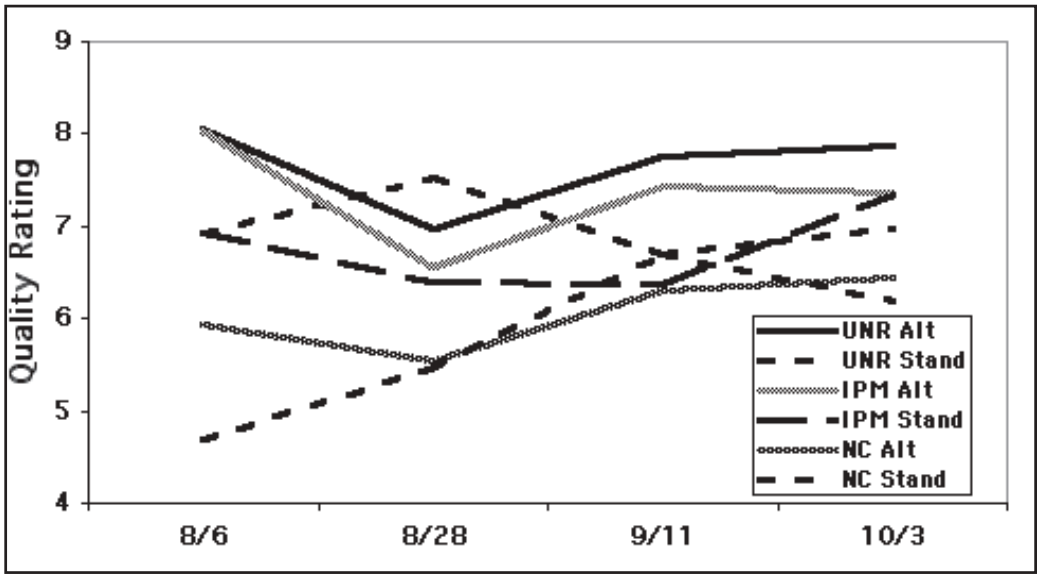
Labor

Increased labor needs are an obvious component of both IPM and nonchemical management. Basic scouting requires 2-3 hours a day, and additional time when specific measurements or sampling protocols must be done (e.g. insect flotations, poa population counts). Other practices essential to these management regimes are listed as follows, with the approximate amount of labor hours required to perform each duty on 18 holes: Rolling (5 hrs), topdressing (6-8 hrs), hydrojecting (6 hrs), verticutting (4 hrs), double cutting (4 hrs), hand watering (5-8 hrs), and manual weeding (variable). In addition, extra time was spent repairing and fine tuning the irrigation system, mixing small individual batches of pesticides, and keeping maintenance equipment in excellent condition for proper IPM.

Other labor issues to be considered are that many of these tasks must be performed early in the morning in order to be effective, and scouting time may double if the scout does not stay ahead of golfers when play is heavy. The Bethpage Green Course operates with one course supervisor, one IPM scout, 4 full-time and 2 part-time employees. This count does not include other park employees such as mechanics and the irrigation specialist, and interns that are sometimes available during the summer months. Nevertheless, it was very difficult for them to carry out the practices mandated by the various management systems in this experiment. A few tasks were made more labor in-

Figure 7.

Quality Ratings 2002 (< 6 is unacceptable)



tensive by the nature of the experiment (e.g. mowing at 2 different heights). However, most labor needs would be multiplied when implementing one of the management regimes on all 18 holes of a golf course. The course supervisor estimates that a minimum of 9-10 employees would be necessary to replicate the IPM or nonchemical systems on an 18 hole course.

Discussion

In 2001, no clear differences were seen between the quality of greens managed with standard vs. alternative cultural practices. In 2002, the alternative culture greens generally performed better in all pest management treatments. Less pesticide was also required to maintain alternative greens under both the IPM and nonchemical strategies. Overall, quality was highest in the unrestricted pest management, alternative culture greens. Also, the quality of the IPM alternative culture greens was usually higher than that of the unrestricted standard culture greens. This demonstrates two management strategies that may be superior to those currently practiced on many public golf courses. However, it must be noted that we had difficulty maintaining acceptable ball roll distances (> 8 ft.), especially on the alternative culture greens.

All greens that received the compost application greened up more rapidly in spring and produced significantly more clippings than the non-composted treatments. In addition, there was general consensus that the compost cover may have aided in reducing early season dollar spot invasion. One of the greens that is typically among the first infected in the park did not show symptoms of dollar spot until mid-June this year, a month later than other areas. A conundrum we faced was that increased fertility in the early season resulted in healthy turf with high density and rapid growth that prohibited us from achieving acceptable ball roll distances. Several attempts were made to vertical mow and thin the turf, but we were not able to reconcile the desire for a healthy turf stand with the unacceptable ball roll distances in the mid 7 foot range.

The spoon feeding approach on the standard cultural management greens provided acceptable turf quality, but we still had difficulty attaining ball roll distances in excess of 7.5 feet. Soil tests indicated a significant lack of potassium, whereas tissue tests did not reveal the deficiency—possibly a result of the light frequent fertilizer approach. Furthermore, we often fell behind on the 1:1 N:K ratio we strove for, yet tissue samples did not reveal any deficiencies.

The alternative cultural systems utilized Sustane 5-2-4 fertilizer to supply greater than 50% of the nitrogen for the season. The remaining N was supplied with ammonium sulfate in an effort to reduce surface pH and thereby minimize certain pathogens of annual bluegrass associated with higher surface pH. Also, elemental sulfur was applied (3 pounds per 1000) to the velvet greens in an effort to reduce the pH. Theoretically, this would make the surface more hospitable to the velvet bentgrass and less so for the annual bluegrass.

The fertility on the velvet bentgrass was considerably higher than we expected it would be yet the surfaces still appeared to be off-color for much of the season. Also, while there has been concern for the recuperative potential of velvet bentgrass, we found no evidence to suggest that the velvet was any less tolerant of the 50,000+ annual rounds of play than the previous mixed stand of creeping bentgrass and annual bluegrass. The velvet, however, was more attractive to cutworms and perhaps more susceptible to their damage.

The major disease this season on the velvet bentgrass was fairy ring—thought to have been brought in on the sod from Rhode Island. While the disease was visually problematic, it did not scar the surface severely and did not appear to disrupt ball roll. The collar of one velvet green was not resodded to Kentucky bluegrass and had high populations of annual bluegrass that was infested with dollar spot. We believe that pressure from this inoculum built up over the season, which eventually resulted in over 50% of the green being over threshold levels for dollar spot in October. Only one of the two other velvet greens ever went over threshold for dollar spot, and that was only 5% of the green for a brief period in October. These observations are critical, as they suggest the role of inoculum, pressure, and the need to renovate an entire area (not just the putting surface) when expecting to reduce pesticide use.

Pesticide use in the IPM systems could have been reduced further in both 2001 and 2002 if it were easier for the superintendent to quickly respond to rising pest levels. Currently, a sprayer is not always available for the Green Course, because equipment is shared among the five

continued on page 16

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Nonchemical Turf Management

continued from page 15

courses at Bethpage. Also, the large spray tank makes small spot treatments difficult. These factors encourage the superintendent to include IPM greens when spraying the unrestricted greens. To solve this problem, we sought an injection sprayer that could easily apply small quantities of material in a custom fashion and would be designated to the Green Course only. Such a machine was donated in 2002 by the Toro company and Raven Technologies. This prototype unit ($40,000) would allow the operator to change active ingredients and rates on the fly—thereby minimizing the need to refill with separate additives. For example, if the front of a green was diagnosed as being above threshold but the rest of the green was not showing symptoms, just the front would be treated with the curative rate. The remaining green would either not be treated, or treated with a preventative (typically lower) rate and thereby reduce overall usage. The sprayer was not in full working order until late in the season, so had little impact on 2002 practices. We expect significantly greater reductions in pesticide use in the IPM systems in 2003 because of this enhanced ability to spot treat.

Additional biological products are being assessed and reviewed for performance during the winter season, and will be incorporated into future management systems if data suggests adequate efficacy. Similarly, cultural modifications such as mowing in the very early morning for cutworm control will be added as appropriate. A few course improvements will also be made such as resodding the collar around the third velvet bentgrass green.

Economic Analysis

A major goal of this project is to assess the economic impact of each management regime. We are collecting data on the cost and labor required for all practices, and will provide a detailed analysis of the cost of each regime after the 2003 season. We are also monitoring the level of play to see if golfer loyalty to the Green Course is maintained, and next season we will survey golfers to determine their satisfaction specifically with each management regime.

Implementation of this project has already impacted the reputation and perhaps the revenues of the Green Course. Outings on the Green Course were cancelled for the late summer and fall of 2001 because of the poor condition of several of the nonchemical greens, and the number of outings for 2002 was reduced. Bethpage State Park luckily has the unique situation of having 5 contiguous golf courses. The park superintendent believes that most golfers who are aware of and are upset by conditions on the Green Course, simply play an alternate Bethpage course. A solitary golf course with playing conditions similar to our nonchemical treatments would likely lose customers. Meanwhile, we continue to strive to improve the quality and performance of all greens, under all management systems, in this project.

Jennifer A. Grant and Frank S. Rossi

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