Managing Turf Sustainably

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Abstract

Turf is often the most visible of plantings in urban areas. While crop production is not the main focus of turfgrass systems, a dense, vigorous sward of turf (often as a monoculture) is a key goal. And it is an extremely challenging one for turf managers, requiring the use of pesticides, fertilizers, and water to provide aesthetic, safe, and performance-acceptable venues. Moreover, to provide modern playing conditions, certain management practices such as mowing have been intensified to achieve desired condition. For example, modern golf course greens are mowed at a height of 2-3 mm and are designed to receive 50% of the play even though the total green area makes up less than 3% of the total playing area of a golf course. However, even under intensive management, the goal of turf sustainability is becoming more of a reality than hype or hope, as turfgrass scientists and managers have worked to identify turfgrass management systems that are more efficient, thus requiring less inputs. In addition, identification and improvements in grasses such as seashore paspalum for amenity use has increased the opportunity for improved performance with reduced quality water. New agrichemicals target pests with increased specificity at lowered rates of active ingredients. Increasing chemical use such as surfactants can also improve aspects of turf sustainability by increasing uniform soil wetting and decreasing irrigation needs by over fifty percent. With these gains, turfgrass landscapes can be maintained with reduced agrichemical and water needs that are consistent with attaining sustainability.

Media summary

The goal of managing turf sustainably has been realized through the development of new grasses and turf management systems that require lower inputs of agrichemicals and natural resources.

Key words

turfgrass, sustainable, water quality, water quantity, agrichemicals, and pollution

Introduction/rationale-turf big business monoculture forced ecology performance/expectation issues, play safety, health vs. environmental concerns

Introduction

Increased population and heightened expectations for sports turf performance has coincided with the utilization of turf in urban areas and use of agrichemicals and natural resources in the management of turfgrasses. Competition for, and concerns over depletion of, and contamination of natural resources has led to restrictions of turf use/and or use of management tools in some regions.

A good example of the challenge facing the turfgrass industry is the state of Florida, USA where the permanent population has increased steadily in the last decade to become the fourth most populous state after California, Texas, and New York. In addition, vast migrations of seasonal residents and tourism put pressure on local resources as people seek warm winter escapes from severe winter weather. Florida leads the USA in number of golf courses (1,500), rounds of golf (60 million), sod production (35,000 ha) and Florida has over 4 million acres of maintained turf. According to an economic impact survey (Hodges, et al, 1994), turfgrass management in Florida had a 7-billion dollar impact on Florida's economy rivaling that of traditional major crops such as citrus. Nevertheless, because of concerns over water availability and potential adverse environmental consequences from turfgrass management inputs, certain Florida communities and governmental agencies have proposed or enacted rules to reduce landscaped areas of turf, reduced irrigation allowances, control fertilizer applications.

Regulations restricting or banning the use of products on turf are occurring in many regions. In Quebec, Canada, the government agency in charge of environmental protection enacted a "Pesticide Management Plan in April 2003 (Royal Canadian Golf Association, October 2003) out of an urgency to reduce non-target impacts of agrichemicals. The plan requires Quebec golf courses to submit a detailed use of pesticides and a three-year plan for the reduction of pesticides by 2006. In addition, the plan forbids the use of pesticides on non-golf playing fields used by youths under the age of 14, bans pesticide on government-owned land and of application of pesticides within 3 meters of a water body throughout the province. In Ontario, lawn pesticide can be banned on a community by community basis.

Others are opting to replace turf with artificial or alternative landscapes to reduce inputs. In Anaheim, California, five homes have replaced their natural turf systems with a synthetic Astroturf lawn (Anaheim Utilities Press Release, January 29 2004). The objective was to increase water conservation. In Colorado, The Echo Basin Golf Course is claiming to soon be the USA's first artificial turf golf course with no pesticides, no water, and playing conditions of natural grass with none of the problems (www.echo.basin.com, 2004).

Communities are adopting Xeriscape^{tm} principles that promote the concept of limiting turf to practical turf areas. Initiated in the late 1980s in regions of the USA with arid climates to help reduce landscape watering, the appeal of resource-conserving landscapes was attractive even in areas such as the humid southeast USA where precipitation exceeded evapotranspiration (ET). The central Xeriscape theme for conserving water is to reduce turfgrass that does not have practical value with other plant materials. In Florida, many communities are utilizing a landscape program similar to Xeriscape entitled the Florida Yards and Neighborhoods (FYN) Program that encourages the reduction of turf areas to reduce resource waste and increase water resource from contamination (Garner, 1996). Using an inches scale as a point system to obtain FYN certification, the program offers more inches (4) to those reducing turf from the landscape than those removing invasive species such as Mealaluca do.

In light of the continuing concerns over turf environmental impacts and regulations ending the use of certain pesticides and limiting the use of natural resources, the turfgrass industry has developed turfgrass management systems which require less inputs. Improved resource efficient turfgasses, increased use of effluent water, and new agrichemicals applied at lower rates of active ingredient and less frequently have combined with traditional programs such as integrated pest management (IPM) and best management practices (BMPs) to provide a path toward the goal of real turf sustainability. In the following sections, examples of the progress made toward turf sustainability are highlighted. Case studies including an attempt at providing an IPM/reduced chemical pesticide maintained public golf course greens and a comparison of landscape type (turfgrass vs. an alternative low impact landscape) on resource conservation are discussed.

New turfgrasses

Grasses that require reduced inputs or can effectively utilize impaired resources are critically important for turf sustainability. Although there are recognized low input grasses such as the warm season bahiagrass (*Paspalum notatum*) and cool season hard fescue *(Festuca longifolia*), they are often limited in use or acceptance due to a lack of performance capability. There are approximately 25 C-3 or C-4 grass species used for turf in the USA and many were introduced as forages or as soil-stabilization grasses (Morris, 2000). Through the support of the National Turfgrass Evaluation Program, the United States Golf Association, academic programs and private breeders, new varieties with turf type characteristics have been selected and varieties with traits consistent with sustainability have been released.

Development of seashore paspalum (*Paspalum vaginatum)* during the 1990's culminated with commercial release of new varieties such as Salam, SeaIsle 1, SeaIsle 2000, and Seadwarf. These seashore paspalums are viewed as improved turf types over older varieties such as Adalayd. Improvements include finer texture, low mowing tolerance, and better turf performance for golf courses and are used on all golf course surfaces. The seashore paspalums have traits that are desirable for sustainable turf. Those traits include the ability to grow on poor quality water such as saline water, increased pest tolerance, and lower and more efficient nutrient retention and reduced water requirements than traditional warm season golf course turf (Duncan, 2000). As a result of the introduction of improved seashore paspalums, golf courses in both regions of poor water quality and were potable water is non-restricting have either been reconstructed or newly planted to seashore paspalum varieties.

"Ultradwarf" bermudagrasses (*Cynodon dactylon* sp.) with increased tolerance to low mowing have provided improved putting surfaces. The grasses also demonstrate slower vertical grow characteristics and require up to 25% less nitrogen than the older standard varieties 'Tifdwarf" and 'Tifgreen' bermudagrass. Although less N requiring, the newer varieties do not appear to possess substantially reduced need for pesticides.

A promising area for plant development is the identification of turf-type characteristics in native grasses. Natives including buffalograss (*Buchloe dactyloides*), Blue grama (*Bouteloua gracilis*), Sideoats grama (*Bouteloua curtipendula*), saltgrass (*Distichlis spicata*), crested wheatgrass (*Agropyron cristatum*), prairie junegrass (*Koeleria cristata*), and tufted hairgrass (*Deschampsia caepitosa*) have shown potential for improved stress tolerance or as low maintenance turfgrasses (Johnson, 2000).

Water Conservation and Quality

Warm season (C-4) grasses require up to 50% less water to fix carbon dioxide and have substantial lower evapotranspiration rates than their cool-season (C-3) turfgrass counterparts. Increasing the adaptive range of warm season grasses has been viewed as a strategy for conservation. Additionally, much work has gone into improvement of seeded bermudagrass (Taliaferro, 2000). The release of improved seeded bermudagrass varieties having turf quality similar to standards that have less cold tolerance may have a major impact on water conservation in the future. Water conservation is also being achieved with improved irrigation systems and with systems that are capable of applying irrigation based on crop coefficients derived from actual measurement of turf ET and predictive ET models.

A novel approach to water conservation has being achieved via the use of surfactants or wetting agents that improve distribution and availability of water in soils affected by soil water repellency (SWR) in turf rootzones (Park, et al., 2004a). Also known as localized dry spots or dry patch, the phenomenom of SWR is often observed in coarse-textured soils used for turf venues (Cisar, et al., 2000). The problem is associated with organic acids that coat sands rendering them difficult to rewet upon drying. The advent of new irrigation technology that just replaces ET, water restrictions, and organic matter deposition from the turf as well as soil microflora has resulted in an increase of SWR. Excess irrigation or rain is required to rewet the soil and preferential flow patterns exist which result in the accelerated movement of water and agrichemicals through the profile thus increasing resource waste and water quality impairment.

Surfactants can temporarily alleviate the symptoms of SWR and improve soil re-wetting. A three-year study conducted on turfgrass maintained on sand soils, demonstrated the utility of using surfactants to improve turf performance while reducing irrigation requirements (Park, et al., 2004a). During dry season months, bermudagrass provided with surfactants required up to 50% less irrigation than non-surfactant treated controls to maintain turf quality (Park et al., 2004a). In addition, surfactant-treated turf had increased photosynthesis, increased growth, increased soil moisture and reduced SWR symptoms.

Maintaining turfgrasses on poor quality water can provide benefits by filtering pollutants and reducing the dependence on potable water resources. Turfgrasses are utilized by regulatory agencies as a tertiary treatment of effluent of reclaimed water. Many golf courses are required to use reclaimed water or face restricted and more costly potable water resources. A golf course study evaluated the effect of reclaimed water aquifers. It was demonstrated that the application of reclaimed water with up to 10 mg/L N to turf did not increase the loading of N to the aquifer and that the turf reduced N leaching (Snyder and Cisar, 2000).

Saline irrigation is increasing for turf. Some turfgrass species can be grown on brackish to complete seawater. Utilization of new turf varieties such as seashore paspalum and saltgrass and the use of standard salt tolerant varieties of bermudagrass, zosyiagrass (*Zoysia* sp.), and salt tolerant cool season grasses have enabled turf managers to cope with salinity. Moreover, water quality blending and the use of chemicals to alleviate destruction of soil structure have minimized the impact of saline irrigation.

Reductions in agrichemicals for control of economically-damaging pests

Due to concerns over potential toxicity to non-target organisms and potential adverse environmental impacts to soil and water quality, turf research has focused on the fate of agrichemicals applied to turf for control of pests. Although much of the research has demonstrated the relative safety of many products, concerns persist. The turfgrass industry has developed products that have resulted in a decrease in the active ingredients of agrichemicals applied for control of pests. Traditional Integrated Pest Management, bio-control, and Best Management Practices have been in place in turf systems to help reduce pesticide application and improve efficacy with tangible impact. However, the requirement for high performance sports turf compromises to some extent strategies that tolerate some threshold of damage.

During the past decade notable achievements toward reducing the active ingredient rates applied to turf to control pests have been made. This has been done through the replacement of older technologies requiring high application rates and/or frequencies with new products applied at reduced rates and frequencies. As a trade-off, some of new products have a narrower range of control than the older standards. An example is Chipco Choice (fipronil, a member of a class of insecticides called pyrenol pyrazoles) for the control of mole crickets in turf.

Mole crickets (*Scapteriscus* sp.) are perhaps the most economically damaging insect pest of bermudagrass turf in the southeastern USA. Introduced into the USA from America in the early 1900s from ship ballasts, several mole cricket species have spread unabated throughout the southeastern USA. Mole crickets quickly spread by flight during the mating season ensuring wide distribution and economic turf damage from tunneling and foraging habits. The conventional chemical strategy was to apply broad-spectrum organo-phosphate (OP) and carbamate pesticides at relatively high rates, and sometime very frequently to control mole cricket activity. Chipco Choice is applied precisely to soil via slit injection systems, at a 0.1% ai rate (at 12.5 lb product/acre). Thus, the rate of application has been reduced substantially and frequency of application was reduced from many times for organophosphate standards to once every six months or longer. On an active ingredient basis, the efficacy of one pound of Chipco Choice is equal to 200 pounds of OP for mole cricket control based on five applications of the OP insecticide.

An example of a broad-spectrum insecticide is Merit (imidacloprid, the active ingredient in Merit is in the chloronicontinyl chemical class). Merit is applied at rate up to 75% lower than other registered soil insecticides for use in turf for grub and other insect control and/or suppression.
Arsenical herbicides are widely used for post-emergence control of grassy weeds in turf. Approximately 96% of Florida golf courses spray MSMA (monosodium arsenate) 2-3 times each year at an application rate of 2 lb/acre (Chen, et al., 2003). Arsenic has received increasing attention due to its potential toxicity and considerable environmental contamination. The U.S. Environmental Protection Agency (EPA) has lowered the maximum contaminant level of arsenic in drinking water from 50 to 10 ug/L (Anon., 2001). Revolver (foramsulfuron) is an example of a MSMA alternative that can be applied for grassy weed control at an ai of 0.1 lb/acre**.**

Genetically modified turfgrasses are being developed for the marketplace. Roundup resistant bentgrasses and St. Augustinegrasses are being evaluated across the USA. The use of roundup resistant turf will help to improve difficult to control weeds such as annual bluegrass (*Poa annua* L.) and act as a replacement for older chemistries that may be removed from the marketplace in the future. Aldous (2000) reported on selective control of *Sporobulus indicus* using the Weedbug^R system, which uses the height differential of grasses as a means of maintaining the more desirable grass.

Heritage (azoxystrobulin) is an example of a new class of fungicides with broad-spectrum disease control at low rates (0.5-1.0 lb ai/acre). Bioherbicdes, consisting of fungi have been used to control tropical signalgrass (*Urochloa subquadripara*). Tropical signalgrass one of the most difficult to control invasive weed species (Chandraohan, et al., 2003). Other products such as cornmeal, alfalfa pellets, vinegar, corn gluten, liquid seaweed and molasses have been used as bio-pesticides to control weeds, insects, and diseases or promote suppressive soils through microbe stimulation (Hall, 2004).

Biological control options are emerging to help offset the need for conventional pesticides. A new biological control is the use of *Pasteuria* sp. to control sting (*Belonolaimus longicaudatus)* nematodes (Giblin-Davis, 2000). Sting nematode is a major belowground pest of turfgrasses (Giblin-Davis 2000). There are few effective post plant chemical control options for nematodes. In addition, pre-plant fumigation options such as methyl bromide are being phased out of use due to concerns over global warming. Giblin-Davis (2000) reported on a golf course survey conducted in south Florida on *Pasteuria* sp. Parasitizing sting nematode and suppressing sting populations. Giblin-Davis (2000) also demonstrated the successful soil introduction of *Pasteuria* sp. into established turfgrass sites.

Sustainable Nutrient Management
There is a wide range of fertilizer requirements for turfgrasses based on turfgrass performance expectations and soil medium used. For modern sports play, turfgrasses are often grown on coarse-textured soils such as sands and require routine application of nutrients from fertilizers. There is considerable concern over the water quality impairment for N and phosphorous (P), two elements applied in relatively large amounts. Strategies to reduce N and P leaching include regulations that limit the amounts of N and P applied and management systems that minimize off-site losses. Turfgrass management practices that include the use of slow or controlled release fertilizers, reduced rates of applied nutrients such as applying low rates of fertilizer frequently through the irrigation system (fertigation) and adjusting irrigation to replace ET can substantially reduce nutrient leaching and conserve natural resources.

With regard to fertilizer sustainability, emphasis has been placed on the development of organic-based fertilizers and the use waste products to replace or reduce the dependence upon synthetic fertilizers. Composted sewage sludge (Milorganite), turkey litter, and soybean-based extracts are examples of by-products that have been successfully used to maintain turfgrass areas.

Case Study 1: Using an IPM approach to reduce chemical pesticide use for managing greens.
Although the potential for reducing or eliminating the need for agrichemicals on turf venues is discussed, there are few concrete examples. A study was recently conducted at the Bethpage State Park golf over a three years, 2001-2003. Bethpage is a public golf course on Long Island, NY (Grant and Rossi, 2003). One of the golf courses in the park was the site of the 2002 United States Golf Association Open. The golf course in the study accommodates approximately 50,000 rounds of golf per year, with pushup greens that have been heavily topdressed. The experimental design consisted of 3 pest management programs and 2 cultural management programs. The pest management programs were either unrestricted (all legal and available chemical pesticides), IPM (pest management determined by the specific needs of individual greens), or non-chemical (cultural and biological approaches to prevent and minimize pests were emphasized). The cultural management programs were either the current standard of what was routinely employed by the golf course or an alternative program that was used to reduce turf stress while maintaining performance standards.

Among the summary points of the study, the authors reported that IPM greens received 28-46% less pesticide applications than the unrestricted pest management greens (Grant and Rossi, 2003). Velvet bentgrass (*Agrostis canina*) outperformed annual bluegrass/creeping bentgrass (*Agrostis palustris*) grens when managed without chemical pesticides for most of 2002 and parts of 2003. In 2002, the alternative culture greens generally performed better than the standard culture in all pest management treatments. The authors (Grant and Rossi) reported less pesticide used in alternative greens under both the IPM and non-chemical strategies in 2002 but no difference was observed in other years. In 2003 (a wet year), cultural and biological methods for disease suppression were less effective. Grant and Rossi (2003) noted “that management with few chemical pesticides continues to be a challenge during summer months with these species”. They concluded “that pesticide use can be significantly reduced in some years, without compromising quality” and cautioned that “research is still needed to develop tools and knowledge to deliver consistent and reliable results with few or no chemical pesticides”.

Case Study 2: Documenting the effect of landscape type for resource conservation.
Alternative landscapes have been promulgated for use in Florida and elsewhere for reducing the fertilizer inputs and irrigation requirements. A study was conducted in south Florida comparing a monoculture St. Augustingrass (*Stenotaphrum secundatum*) and a mixed species landscape consisting of commercially-available native and non-native ornamental plantings for reducing N, P, and potassium (K) losses and water use from 1999-2002 (Erickson, et al., 2001, Erickson, et al., 2004). The lawn and mixed species models were maintained judged consistent for south Florida standards. The authors reported less N, P, and K leaching from the St. Augustinegrass lawn model and decreased drainage water in the mixed species model over time (Erickson, et al., 2001, Erickson, et al., 2004, Park, et al., 2004). The authors concluded that reductions in nutrient leaching and water use are complex issues and that landscape type alone is only one of the factors that influence off-site losses.

Conclusions

New grasses, water conservation strategies, and agrichemicals designed for application at reduced rates and frequencies have combined with traditional IPM and BMP approaches to reduce turfgrass dependence on natural resources and agrichemicals without reducing turf aesthetics and performance. While the goal of turf sustainability appears promising based on limited case studies, future work is needed to identify optimal sustainable turfgrass management programs for the wide range of turfgrasses and venues that utilize turfgrass systems.

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