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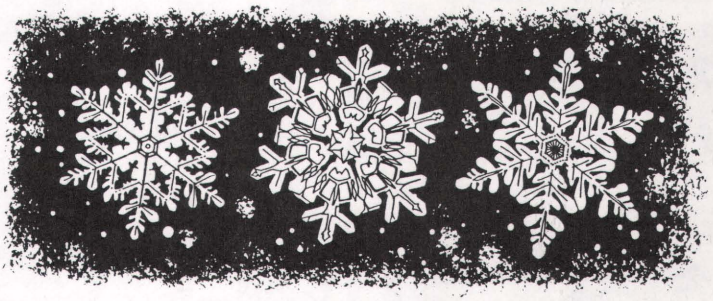
...for better, safer Sports Turf

PRESIDENT'S MESSAGE



The Christmas season is fast approaching and the Directors and Executive wish all members and their families best wishes for a joyous holiday season.

In reflecting on 1996 outside the affairs of the Association, it seems during the past year one was constantly being filled with doubts, uncertainty, and reservations for the future. It appeared that every time one listened to the radio or read the newspaper, negativity and hardship was a common theme. It seemed like every labour group and profession has had enough and is fed up; teachers, nurses, doctors, day care workers, many municipal employees; all culminating in Days of Action. From the Somalia Inquest, to several jet airliners crashing and taking hundreds of lives, a bombing at the Olympics in Atlanta, to the human suffering and tragedy in Rwanda - maybe it's just me but it seems like it has been a painful and confrontational year. Every issue seems highly charged, tempers are short, and the gap between the have and the have not in our society seems to be growing with each passing month.

It is wonderful to hear the deficit is shrinking and interest rates remain low, and Stats Can says consumer spending rebounded in the third quarter of '96. But does it all seem so positive when the result is child poverty rates continue to climb, wheel trans service is eliminated for those people in our communities who need the assistance to maintain their personal freedom and independence, and injured workers, already on permanent disability may get their benefit reduced. It seems at times our political masters at all levels have priorities confused, and like the tin man in the Wizard of Oz could use a heart.

On a cheerier note, with Christmas and the spirit of fellowship and giving just around the corner, I would like to take this opportunity to thank all Directors and our Executive Secretary for all their efforts over the past year. Sonja Schneider provided tremendous support for the Association and Bob Sheard once again produced four top notch issues of the *Sports Turf Manager* which provided our members with a publication that is one of the best in the industry for content and value. This is the last *Sports Turf Manager* with Bob as Editor. My heartfelt thanks for his total commitment to the newsletter over the past few years.

During 1996 our membership increased, and our goal is to maintained, service and support those new as well as our existing members. The Ontario Turf Symposium is rapidly approaching on Jan. 7 - 9 at the Regal Constellation and from all appearances it looks like a show case event once again. If you have not registered yet, or plan to register at the door, please remember to ***check off the box indicating your STA membership.*** It does make a difference. Our Annual General Meeting is on Jan. 7th, as well as our 10th Anniversary dinner. It promises to be a wonderful night where we celebrate our past and look to the future. I hope you can attend.

As we enter our second decade I am confident the next ten years will be as successful as the first. It will not be easy; it will require the total commitment of all Directors and the members to support our mission. We have had a wonderful first decade, and I challenge everyone to make the next one even better. As always, if you have any comments or ideas about the Association, please do not hesitate to call or drop us a line.

From all of us, a prosperous and healthy 1997 to you and your family.

As always, wishing you better, safer sports turf.

Christopher Mark,
President

IN THIS ISSUE

EDITORIAL

This will be the last issue of the *Sports Turf Manager* for which I will be your Editor.

Fifty years ago this week I was completing my first semester at the University of Saskatchewan. Thus began a career which has been dedicated to trying to grow two blades of grass where one grew before. It does not matter whether that grass species was wheat or corn, or in latter years, turf species.

It has been an interesting half century, sometimes frustrating, most often rewarding, particularly when some new technology was implemented, in part as a result of my efforts. Even more rewarding was when a student, a farmer, or a turf manager received recognition for his or her achievements as a result of some assistance I may have been able to give them.

The last six years have been among the most rewarding as many hours, yes, days and weeks, have been spent assisting the Sports Turf Association in becoming a recognized part of the turf industry.

Why go fishing when I am not a fisherman.

The basic reason is that my well of ideas which has enabled me to fill the pages of the *Sports Turf Manager* has run dry. While I enjoy writing, the pressure of deadlines and reminders that an issue is overdue reduces that enjoyment to the negative side.

Someone will be taking on the role of Editor. The success he/she will have will depend on the assistance each and every member of the STA is willing to provide. The *Sports Turf Manager* is well accepted as an informative turf publication. It is now up to each of you whether it continues to be a success.

Black Layer Formation in Turf

Characteristics, Causes and Cures

R.W. Sheard, P.Ag.

The occurrence of black layer in turf for sports facilities has been a continuing problem over the past two decades. Generally the condition has been associated with construction of the fields using U.S.G.A. Green Section specifications or variations thereof. The condition is recognized by chlorosis and die back of the turf which can not be identified as a nutritional or pathogenic problem but which appears associated with it certain characteristics of the root zone.

What are these characteristics?

As the name suggests the condition is black discolorations on the soil particles and slime materials in the root zone which occur as continuous horizontal plates of varying thickness or vertical columns of black, often slimy, root zone material. Associated with the black layer are unpleasant swampy or sewer like odours; even that of rotten eggs which is the aroma of hydrogen sulphide.

The black layers may be from 0 - 10 cm below the surface. The layers may range from 2 to 7.5 cm thick where they occur at or near the surface to 1 to 3 cm thick where they are deeper in the profile. The affected areas may be associated, but not necessarily, with minor depression in the playing surface.The affected areas have a reduced infiltration rate, combined with a reduced hydraulic conductivity. Due to the black slime of bacteria - metal complexes the condition is often referred to as a "black plug layer".

While generally a condition that occurs on sand based root zones, it is also found in natural soils where a program of sand topdressing has been employed to control thatch or modify poor physical conditions. In the latter case the black layer generally occurs at or near the surface

The turf growing on the affected areas dies in a relatively nondescript pattern. The grass may die rapidly by turning a straw to reddish-straw or bronze colour; or occasionally, the affected turf may become chlorotic before dying.

A parallel phenomenon is know to occur in water wells and in drain lines. In water wells slime producing microorganisms proliferate on the screens of sand points and out into the surrounding aquifer. This brown to black slimy growth gradually becomes sufficiently dense enough to plug the screen and reduce the water flow. When tile lines are placed in high iron content soils and backfilled with high organic content top soils a reddish brown slime deposit occurs within the tile which eventually plugs the tiles. In the first case the colour is associated with reduced manganese whereas with the tile lines the material is precipitates of reduced iron compounds.

What are the causes?

Many theories have been promoted for the formation of the black layer but they all accept the basic cause is an anaerobic condition; that is, a lack of oxygen in the soil atmosphere. Work at Michigan State has provided rather definitive data that the anaerobic condition results in the reduction of sulphate sulphur by sulphur reducing bacteria to sulphides. The reducing conditions

created by the responsible bacteria in turn results in the formation of iron and manganese suphides, the latter causing the black colour. Also associated with the reduction of sulphur compounds is the formation of hydrogen sulphide which gives rise to the "rotten egg" odour. Furthermore, hydrogen sulphide is a weak acid which can be very toxic and damaging to the turf root system

There are four prerequisites necessary for the formation of the black layer: 1) an anaerobic (oxygen deprived) atmosphere in the soil, 2) an organic material available for microbial decomposition, 3) a source of sulphur compounds, and 4) the occurrence of sulphur reducing bacteria. Without any one of these conditions the black layer will not form.

The first condition is satisfied any time you have a poorly drained or waterlogged condition. The waterlogged condition may result from a perched water table or a permanent water table caused by a number of factors. With regard to the second prerequisite decomposable organic material is always present in soils where the root system is in a continuing process of regeneration. Sulphur compounds occur in all soils and are constantly being added as a product of acid rain and in fertilizers. Sulphur reducing bacteria are found in all soils and can soon be spread by dust to pure sand root zones and rapidly proliferate when the conditions are right.

What are the cures?

It is obvious from the four prerequisite noted above that one, the occurrence of sulphur reducing bacteria, cannot be eliminated. Likewise the occurrence of decomposable organic material cannot be avoided. Steps, however, can be taken to reduce the impact of the other two.

The ultimate cure is in the beginning, during construction of the facility. At this stage the design and construction should be to insure adequate drainage to avoid potential anaerobic situations. Prudence requires that the final contouring be done on the subgrade, not the final surface. Thus the depth of the root zone will be uniform and the water content will remain constant across the field with no localized wet spots.

Table 1: The formation of black layer and turf quality resulting from the source of nitrogen used for turf production under poorly drained conditions.

Nitrogen Source	Black Layer Rating*	Turf Quality
	(ave. 25 labels)	(rating**)
Ammonium sulphate	3.36	1.96
Urea	3.08	3.44
Ammonium nitrate	0.76	0.68

*On a scale 0 -4, where 0 was no peg discoloration

** On a scale 0 -5, where 0 was no injury and 4 was death of the turf.

The ultimate cure is in the beginning, during construction of the facility.

As part of the system to remove excess water is the system used to provide water - the irrigation system. Excess irrigation through reliance on electronic gadgets and not through thoughtful use of weather data adds to the drainage problem.

At the construction stage uniform, offsite mixing of the sand, organic source and any soil materials is essential to avoid localized interruption in drainage flow. When a cross section of the root zone has the "marble cake" appearance one may be suspicious of poor mixing being the cause of the black layer. Some designers of fields will place 20 cm of pure sand below a final 10 cm of sand:soil:organic mix - "the two layer cake." Again a condition for a perched water table is created, which in combination with the other three prerequisite conditions may lead to black layer.

Since the black layer condition reflects a lack of oxygen in the root zone and as it occurs in the top 10 cm of the profile, deep coring, with hollow tines, and removal of the cores will give temporary relief. Observations by sports turf managers have found the black layer to disappear in the area of the core hole and in the core itself as it is exposed to the atmosphere.

Where topdressing is practiced it is imperative that the material used conforms as closely as possible to the existing material to avoid layering. Changing topdressing materials from year to year result in the "multi-layered cake."

The use of nitrate fertilizers can afford some relief. Work by Drew Smith at Saskatoon demonstrated that a nitrate source of nitrogen could alleviate the condition. The nitrate ion acts as a substitute for oxygen under the waterlogged conditions associated with the black layer. Using wooden plant labels which discoloured according to the degree of black layer formation, he assessed the effect of sources of nitrogen applied to turf growing in pots of course sand which were kept in an waterlogged condition for approximately six weeks (Table 1). The data clearly show nitrate forms of nitrogen were superior to urea and ammonium sulphate in deterring black layer formation.

When black layer is a problem avoiding sulphur containing fertilizers by substituting nitrate carriers for the nitrogen source will provide some degree of relief.

My thanks to Pam Charbonneau for her extensive file on the Black Layer.

Exposure to Granular and Liquid Formulations of the Turfgrass Insecticide Chlorpyrifos [DURSBAN]

Beginning in the summer of 1989, a research team, headed by Prof. Gary Stephenson of the Deptartment of Environmental Biology have been investigating the exposure of home owners and applicators to pesticides, commencing with work on the herbicide, 2,4-D. Their focus has recently changed to the insecticide, chlorpyrifos, which is marketed under the trade name of Dursban. This insecticide is used extensively to control chinch bug, sod webworm and the grubs of European chafer, June and Japanese beetles. The chemical is available in the granular form as an impregnated fertilizer and as a liquid formulation.

The researchers' objective was to determine the effect of clothing worn and formulation on the exposure level of the operator when applying granular or liquid chlorpyrifos. In addition they looked at the potential harm to the public or to the home owner who might be in the vicinity during and after the application.

Chlorpyrifos is an enzyme inhibitor [acetyl cholinesterase] with a oral [ingested] LD_{50} of 135-163 mg/kg body weight and an acute dermal [skin] LD_{50} of 202 mg/kg body weight. Pesticide applicators who routinely spray organophosphorous pesticides are advised to have their cholinesterase determined prior to the spray season and to have weekly blood tests during the spray season.

The researchers applied granular 0.5% chlorpyrifos impregnated fertilizer with a cyclone spreader during early May to the first week in June to provide 1 kg ai/hectare for white grub control. A liquid formulation of chlorpyrifos at 100 ai/ hectare was applied with a hose-end sprayer delivering 5 kg/hectare during late July through to September.

Volunteer applicators were divided into two groups, those using protective gear and those not using any special protection. The protective gear consisted of long pants, long sleaved shirts, rubber boots and nitrile gloves. Those not using protection used their choice of shirts and pants, but had no rubber boots or gloves. The protected group of applicators were instructed in the careful application of the chemical whereas the non protected group received no instructions. Bystanders were those normally present in the household but may not have been present when the actual spray operation occurred.

The exposure to chlorpyrifos was determined by measurement of a metabolite of the chemical in the urine of the participants for four days after the application. The limit of detection of the metabolite in

Table 1: The exposure of protected and unprotected applicators of chlorpyrifos and bystanders to a granular application (total urine chlorpyrifos equivalent in four days).

Volunteer No.	Protected		Volunteer No.	Not Protected	
	Applicator	Bystander		Applicator	Bystander
1	trace	trace	1-7,9,13	non detectable	non detectable
10	non detectable	non detectable	2	604	non detectable
			10	540	trace
			13	Trace	non detectable

Table 2: The exposure of protected and unprotected applicators of chlorpyrifos and bystanders to a liquid application (total urine chlorpyrifos equivalent in four days).

Volunteer No.	Protected		Volunteer No.	Not Protected	
	Applicator	Bystander		Applicator	Bystander
1,2,6,8,10	non detectable	non detectable	1	802	non detectable
3	non detectable	trace	2	239	non detectable
4,11	trace	non detectable	3	249	non detectable
5	373	367	4	446	non detectable
7	291	non detectable	5	443	trace
9	485	non detectable	6	268	non detectable
			7	321	non detectable
			8	trace	non detectable
			9	trace	non detectable
			10	383	non detectable

the urine was 18 ppb and the limit of establishing a quantitative amount was 25 ppb.

The results of their studies are summarized in Table 1 for those using granular applications and in Table 2 for those using liquid applications. Trace amounts, that is a level between 18 and 25 ppb were detected in one applicator of granular material and one bystander among those using protective gear (Table 1). Amounts ranging from a trace to 604 g were excreted in the urine of applicators not using protective gear and a trace in one bystander.

Exposure occurred more frequently among those not using protective clothing. Three applicators and one bystander showed trace or greater amounts of the insecticide in their urine

The use of a liquid formulation significantly increased the number of applicators showing a trace amount or greater of chlorpyrifos in their urine (Table 2). A trace or quantifiable amount was determined in three bystanders where the liquid formulation was applied. Where no protective clothing was used all 10 applicators had trace or greater amounts of the insecticide in their urine in contrast to three of the eleven applicators taking some degree of protection.

The highest level of exposure was with applicator # 1 who used no special clothing. His exposure level on one day was 0.798 mg which for an individual weighing 91 kilograms results in daily intake of .009 mg, close to the allowable average daily intake of .01 mg/kg body weight/day.

The study was primarily focused toward the home owner applicator and the risk of exposure of his immediate family. Nevertheless, the turf manager must recognize his personal exposure but also those who may be in the immediate vicinity, whether he is in parks, playgrounds and sports fields, and schedule his spray operations accordingly.

The low exposure resulting from the granular impregnated fertilizer appeared to be the safest system. The use of this product, however, requires the simultaneous need for a plant nutrient and an insecticide. This is not always the case in a well managed sports field.

Caught in the Web - Using the Internet

Prof. Brian Holl

Dept. Plant Science,
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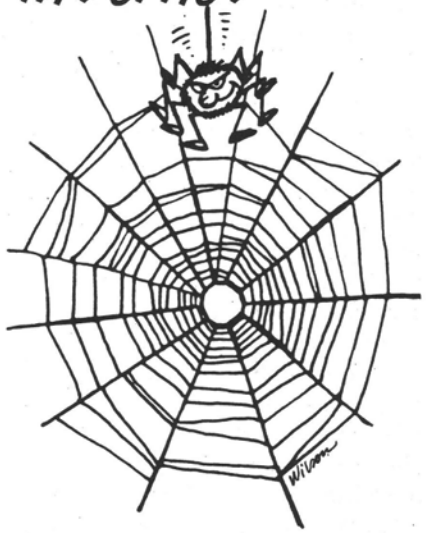

Seldom a day goes by that the popular media doesn't include an article relating the benefits [and necessities] of being linked to the Internet. Major businesses and institutions have established "Web Sites" and increasingly, information is being transmitted, and businesss being conducted, over the Internet. A significant number of readers of this article may already be linked to this global network via computers at work and/or at home. For many others, the Internet remains a black box [or a black hole], clouded in mystery and confounded by the jargon related to its use. For those who have ventured onto the Web - the experience may have varied from enlightenment to total frustration. In 1996, the volume of useful information remains a minuscule fraction of the total information available. The purpose of this article is to provide for complete neophytes an introduction to using the Internet, and to suggest some useful or interesting sites to travel to for information related to turfgrass and turfgrass management.

What is the Internet and how do I get on it?

The internet is a network of different intercommunicating computer systems funded by governments and commercial organizations and linking more than 40 countries around the globe. The network may be accessed in a variety of ways - probably the one we hear about most is the World Wide Web (WWW or W3) [also known simply as the Web]. The Web arranges information in documents with links between them. The links facilitate rapid movement between related documents.

What can I do on the Internet?

Of the many uses which may be made of these global computer linkages, the most common activities include:

- Electronic mail (E-mail) - a method of communication between individual or groups (the latter route uses collective "mailing lists" where all members of the group receive all communications).
- File Transfer Protocols (FTP) - used to download files from other sites to your computer.
- Search functions - used to search the Internet for information, contacts and databases.
- Discussion groups/bulletin boards - groups with more or less targeted subject matter which allow general discussion and interchange. These groups may be mediated, allowing for some control of what is acceptable and what is not.

How do I connect?

For most of us, access to the Internet will be via a "dial-up connection" through a modem and telephone line. If you are looking at the purchase of a modem, buy the "fastest" model available for your computer - no matter what the capacity, there will always be some days when it

seems unreasonably slow! A number of improvements in connection technology will occur in the next 5 years, in the meantime, a good, fast modem represents the most cost-effective connection for the majority of users who are not hard-wired to a network through their institution.

Your modem connection will allow you to access and communicate with an Internet service provider. Some names may be familiar - CompuServe, Sypatico etc. - but a look at the Yellow Pages will reflect the increasing choice available - almost ten pages of Internet services and service providers. If you are looking to sign up with a service provider, be sure to check on the service and rates provided, how long they have been in business, whether they supply technical support, and whether Internet access is via a local phone connection (historically, some providers' access involved long distance calls whose charges were on top of any direct connection fees). Many services supply a certain number of free connect hours per month - consider carefully whether the rate structure provides adequate access at lowest cost. Ask people you know if they have any experience with a service provider.

I'm connected: Now what?

The value of the Internet and the Web is most obvious if you are using a multimedia browser -this is a software package which facilitates moving around the Web and displays formatted documents, graphics, video and sound. Currently, major market share in the network browser league is held by Netscape Corporation. Strong competition was recently launched by the introduction of the Microsoft Corporation browser called Internet Explorer.

I can hear the groans - more software! more money! This is one time the industry seems to be responsive to a need. Both the Microsoft and Netscape browsers are available by downloading from the Internet itself at no cost except for the connection time. A browser makes moving around the Web both easier and more attractive as it takes advantage of the technology to display images and sound. More information about these browsers can be obtained from service providers and from the company Internet sites listed in the addresses at the end of the article.

Surfing the Web

For those with unlimited time, dedicated telephone lines and a large resource of patience, surfing the Web via your browser can be a fascinating experience. Most Web browsers provide one or more search utilities which can be used to track information in very general subjects, or to look for very specific topics. To avoid too much grief and to use your time efficiently some care should be taken in setting up the terms for the search. For example - the term *turf* will produce numerous "hits". Unfortunately, many of these will not be what either you or your employer may have had in mind - they will include a significant selection of information on horse racing an international physics/math game with this title and numerous personal and business pages that describe someone's personal or corporate "turf". The same search using *turfgrass* as the descriptor will turn up a more useful selection of possibilities (though by no means without some junk).

One other hint learned from painful experience. If you are using a Web browser and find a good site, use the browser's bookmark tool to add this to your list of sites. Web addresses are notoriously complicated (as you will see from the examples) and using the bookmark function saves keeping a separate list as well as reducing the need to type in the entire address each time. Clicking on the bookmark with your mouse will allow you to go straight through to the desired location.

For those of you who are on the net - or nearly there, the following are some useful addresses to look for, or at:

http://home.netscape.comm

Netscape Corporation home page with information on downloading the Netscape Web browser, net directories and a variety of search engines.

http://msn.com

Microsoft Corporation's home page.

http://www.uoguelph.ca.GTI/home.htm

Guelph Turfgrass Institute home page with assorted links to a variety of useful information and other turf resources.

http://www.gcsaa.org/gcsaa

Golf Course Superintendents Association of America home page - various resources, some accessible to the public - others for members only.

http://www.usga.org

United States Golf Association providing a variety of information resources about the USGA, its activities and development and the Audubon Program.

http://worldgolf.com/courses/canada/bc/bcga.html

BC Golf Association home page with a variety of information about the organization.

This is a small sample to start you looking. The Pacific Turfgrass program will have its own home page up and running by the end of the fall season. Part of the access will provide for a discussion group on turf problems and ideas. If you are already linked to the Internet and/or have E-mail access and are interested in the development of such a facility in the BC/Pacific Northwest, please E-mail me at the address below - all you need to do is to indicate "turf group" in the subject area, and your own "address"; you can add a message of interest, but it's not essential. As soon as we are up and running, this is the core group that will be notified.

Dr. Brian Holl: turf@unixg.ubc.ca

*[Editors note: The front page of the **Sports Turf Manager** may now be found on the home page of the GTI]*

Integrated Pest Management in Turfgrass

Dr. Linda A. Gilkeson

Pesticide Management Branch, BC Environment

The Goal: Quality turfgrass with minimum adverse effects on the environment.

The management of turfgrass pests, whether on golf courses, playing fields or in parks and recreational facilities, is coming under increasing scrutiny. Both turf users and non-users that live in the vicinity of the facilities are becoming increasingly concerned about the use of pesticides, whether they are herbicides, fungicides or insecticides. Turf managers have no choice but to address this concern. Golf course superintendents have been particularly aware of this issue and through their professional organizations have been involved in research into turf management practices, including alternatives, for several years. Parks and sports turf superintendents are also becoming involved as more municipalities enact bans on pesticide use and/or adopt integrated pest management policies.

Integrated Pest Management

Integrated Pest Management, or IPM, is a systematic approach to pest management. It uses all available techniques in an organized program to suppress pest populations in effective, economical and environmentally safe ways. Properly implemented, it is a decision making approach based on site specific management and using multiple control methods. The basic principles of IPM are to **reduce** pesticide use by improving the timing of applications, to **replace** pesticides with non-toxic alternatives and good management and to **redesign** the underlying management system to prevent pest problems and to conserve beneficial species. Although chemical and pesticides are a tool in an IPM program, too often they have been used as a substitute for other management methods. Indeed, after four or five decades of relying on chemical pesticides, we have forgotten that there are other, very effective pest control techniques available.

Components of an IPM Program: Identification

Identification of the problem is essential to developing an IPM program because most treatments must be tailored to a particular species. Once a problem is identified, it is possible to find out about the pest's biology, conditions that favour its reproduction and weak points in its cycle when control will be most effective. The BCMAFF Plant Diagnostic Laboratory in Cloverdale provides an important service to turf managers in identifying turf diseases and other problems. To take advantage of this service, make sure that samples are taken and shipped according to instructions from the lab. For example, to identify turf diseases it is important to take samples from the advancing edge of a fungal infection so that the diseased and healthy turf is present in the sample. Include as much written information for the lab as possible, such as when symptoms were first observed, the pattern of disease, how much of the area is affected, pesticides that have been applied and other management information.

Although it might seem enough to simply identify a weed as "broadleaved" or not, specific identification is important because weeds provide clues to soil conditions and management problems. For example, clover does well in compacted conditions, English daisy thrives in moist areas, while other species are indicators of droughty soils, low fertility and other conditions.

To aid identification and inspection, everyone should have a magnifying glass or hand lens; some companies or parks departments find it worthwhile to invest in a microscope. It is a good idea to build

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up a labelled selection of specimens and photographs of pests for future reference. Once these have been identified, the collection remains as a reference for speedy identification the next time the problem occurs.

Monitoring

Monitoring is critical to the development of an IPM program because it provides the information needed to make decisions about the timing of treatments and whether or not they are necessary. Most monitoring programs are based on regular inspections for pests and may include taking samples or recording counts. For example, monitoring for disease out breaks may involve daily visual inspections as well as collecting and counting diseased versus healthy blades of grass. Keeping track of weather conditions that are conducive to the development of fungal diseases would also be part of a disease monitoring program.

Other pests are monitored on different schedules. For example, sampling for craneflies may be done only in the late summer, when the larvae are present in the turf, while monitoring for weeds may be done twice a year, in mid-May and again in mid-August. Sampling methods for weeds involves laying a grid over an entire area, such as a sports field, or laying out a series of random transects in larger areas of turf. The number of weeds along the transects or within the grids is then counted and recorded. If the sampling is conducted the same way each time, it will be possible to tell whether the average weed population is increasing or decreasing. It is common for managers to find that they need fewer pesticides to obtain satisfactory results when they base their treatment decisions on information from a monitoring program.

Injury Level

Injury levels are defined as the unacceptable levels of damage from pests. Work in agriculture has primarily been on economic injury levels, but in turf and other landscape areas, an aesthetic injury level may apply. In this case, the need for treatment depends on how much damage the public will tolerate, which depends on how noticeable the damage is, the type of pest and location of the damage.

In turf management, different injury levels apply depending on the purpose of the turf. For example, most people apparently do not notice weeds in a lawn when the weed cover is 5 - 10% and home owners are often content with higher proportions of weeds. For general use turf in a park, an injury level of 40% weed cover is considered acceptable by some municipalities. On the other hand, weeds on playing fields might be hazardous to the players or disrupt the playability of a surface if they exceed 20% coverage. On a golf course putting green the tolerance for weeds would be considerably lower. Because different areas of turf will have different standards, it is important to separate areas in a park or recreation facility according to the type of use, location, soil condition and other relevant factors. The monitoring programs must be tailored to the different sites to accommodate the differing injury levels for various pests.

Establishing an Injury Level for Weeds in Turf

Although little research has been published in this regard, turf managers can develop a reasonable idea of injury thresholds for weeds in their own recreation facilities. One method is to choose areas of turf with acceptable levels of weeds and count 5 -10 transects or grids in these areas. Then count the same number of transects in areas that are marginal and again in areas that have an unacceptable number of weeds. When the percentage of weeds from each class of turf is averaged, the manager should be able to arrive at a workable guideline for acceptable and unacceptable proportions of weeds.

Action Thresholds

Action threshold are when to apply treatments to prevent pests from reaching injury levels. Action thresholds and injury levels appear to be virtually the same when pesticides are used as controls. Because pesticides act immediately to stop pests, the most economical applications are just before the pest population reaches a damaging level. In contrast, when biological control agents are used, they usually require time to become establish and breed in sufficient numbers to control the pests. Therefore, the most economical time to apply biological controls (the action threshold) might be much earlier in the season, before pest numbers reach the injury level.

Little work has been done on establishing action or injury threshold for pests in the landscape and turf sector. Because it is so subjective, an aesthetic injury level will change with changes in the aesthetic values of the turf users and varies with the different types of turf areas and uses.

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Treatments

Treatments are, naturally, key components to an IPM program. Often more than one type of treatment is integrated into a program to control a particular pest. It is usually necessary to integrate a variety of treatments for several different pests to develop a complete program. Although there is a range of treatments available to IPM managers, for turf the most relevant are cultural, biological and chemical control; these are discussed below. The main physical control used in turf is hand pulling weeds, which is a viable alternative to herbicides in some cases.

Before considering treatment further, perhaps the first consideration for a turf manager is whether it is possible to redesign the system by reducing the area of high input turf. This saves money, reduces impact on the environment and allows more resources to be spent on other areas of turf. Turf area can be reduced by planting to competitive ground covers or wild flowers. Although wild-flower meadows require care to become established and must be mowed at least once in the fall, they can reduce the need for fertilizer, water and labour for mowing. Allowing turf to mature also may be an option. Although mature turf areas and meadows may look ragged at times, some managers overcome this by mowing a single swath along the edges of the area to provide the neat look of parkland. It may also be feasible to reduce high input turf areas by replacing heavily used sports turf with artificial surfaces. High traffic areas that are difficult to maintain, such as jogging paths, can also be paved or mulched.

Cultural Controls

Cultural controls are often called preventative controls because they involve the entire management of the turf. For most turf, it is possible to use cultural management methods to satisfactorily suppress weeds because grasses are highly competitive plants. Healthy, well-managed turf can out-compete even established dandelions.

Choice of plantings:

1. Plant species adapted to conditions. This includes adaptations to climate and soil, to the intensity of use and to specific local conditions, such as shade or low moisture. For example, perennial ryegrass and creeping red fescue are more tolerant of shade; mixtures of fescues and perennial ryegrass are more wear resistant than bluegrass.
2. Plant disease and insect resistant cultivars. There has been substantial success in breeding Kentucky bluegrass for resistance to disease and there are also improved cultivars of fescues with resistance to several fungal diseases. Some cultivars are also available with beneficial endophytic fungal infections, which confer insect resistance and possibly some disease resistance on the grass plants.

Endophytic fungi:

These are fungi that infect grass and live symbiotically inside the grass plants. They benefit the host grass by producing toxins that poison grazing animals, including killing and repelling turf-feeding insects, such as sod webworms and chinch bugs. Endophyte infected grasses are generally more vigorous than the same cultivars without endophytes and there is some evidence that they are more tolerant of moisture stress *and fungal infections.*

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Optimum turf management:

1. Manage the fertility of the turf. It is important to use slow release fertilizers and to fertilize only when turf is able to take up nutrients. Set realistic quality goals and apply the minimum rates of nitrogen and phosphorus necessary to sustain the desired turfgrass quality. Avoid over fertilizing, which produces excess growth and thus more thatch and fungal disease problems.
2. Manage thatch. A 1-cm thick layer of thatch is beneficial to the turf, but a deeper layer leads to stressed roots and increased susceptibility to fungal diseases and sod webworms. Thatch builds up when there is excessive plant growth relative to the ability of soil animals and organisms to break down and digest the organic material. Excessive fertilizer or pesticide use reduces the natural population of soil organisms, including earthworms. Earthworms digest and mix thatch into the soil, therefore killing worms on golf greens to alleviate a problem with their castings increase thatch problems. Studies show it is very rare to see thatch build-up where earthworm populations are abundant.
3. Improve irrigation systems. This includes ensuring efficient and even distribution of water and allowing the maximum drying before turf is used or mowed to reduce disease and compaction. Managing moisture is a very important part of weed and disease control on turf. For example, areas of golf courses with dry soil show increased susceptibility to dollar spot, broad-leaved weeds invade areas that are drought stressed and low moisture conditions are associated with invasions of quackgrass, dandelions, plantain, yarrow and white clover. Many weed species, such as crabgrass and chickweed, are favoured by frequent irrigation and overwatering.
4. Aerate turf to break up compaction. Clover and some broad leaved species compete well in compacted soils. Turf roots under stress from compaction are also more susceptible to disease. Mechanical aeration is usually done at least once a season for actively used turf.
5. Increase mowing heights. Mowing practices alter competitive relationships of plants in turf and have a great effect on turf health. The optimum height for general use turf is 7 - 9 cm (2 1/2 - 3 inches). Generally, the longer the grass, the healthier and more competitive it is. The roots are deeper on grass.Plants with longer leaves and the longer blades shade weed seeds so they cannot germinate. A University of Maryland study showed that resetting the mower to cut at 2 1/2 inches reduced weeds from 53% to just 8% of the total area in the plots (other management was the same for both). Although some turf must be kept considerably shorter than this, any increase in height will benefit the turf.
6. Manage play to protect turf. As compaction and drainage are serious problems in B.C. turf used year around, user expectations of year-around use may have to change. Play should be restricted where possible to coincide with turf conditions and to eliminate late fall to early spring use when grasses are dormant and soils are wet.

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Biological Control

The use of natural enemies of pests as biological controls includes releasing commercially produced beneficial species and conserving native species. For example, insect parasitic nematodes are now registered to control cranefly larvae (leather jackets) in turf and BT (Bacillus thuringiensis) which is a caterpillar disease, can be used to control sod webworms. There are also many native insects and mites present in healthy soil that prey on these pests.

Most people do not realize how important beneficial fungi and bacteria are in suppressing fungal diseases in turf. Native micro-organisms can be conserved by reducing fungicide use; they can also be added to turf by topdressing with compost, which is rich in micro-organisms. Studies have shown that monthly applications of compost and sand topdressing have been effective in suppressing diseases such as dollar spot, brown patch, grey snow mould, and red thread.

Competitive control might be considered a type of biological control because it involves overseeding with highly competitive grasses to prevent weeds from growing. Some managers overseed with turf-type perennial ryegrass at least once a year, in some cases up to four times a year, to maintain the integrity of heavily used turf. This is cheaper than re-sodding a field and minimizes the amount of time the turf is out of operation.

Chemical Control

Under an IPM program of turf management, it is possible to reduce and even eliminate pesticide use without sacrificing the desired quality and performance of turf. If monitoring determines that it is necessary to use pesticides, reduce the impact on non-target organisms by choosing the least toxic products and by applying them in spot treatments. Take advantage of the most efficient application equipment, such as the lance or wipe-on type of applicators, to further reduce the amount of chemical needed to accomplish the desired level of control.

Evaluation

Evaluation is the final, but very important, component of an IPM program. This is the stage for analyzing results, deciding on improvements and recording costs and benefits. Generally IPM programs cost more than conventional practices for the first few years, but they become less expensive than conventional management in later years. Therefore, good records are important for tracking the long-term results and benefits from an IPM program.

[Reproduced from *Turf Line News*, Vol. 116, June/July, 1993. Dr. Gilkeson was scheduled to speak at the Ontario Turfgrass Symposium in January, 1997, however, government budget controls prevented her from attending]

COMING EVENTS

January 7, 8, 9, 1997
Ontario Turfgrass Symposium
Venue: Constellation Hotel, Toronto
Contact: Office of Open Learning,
Room 160, Johnston Hall,
University of Guelph,
Guelph, ON.
(519) 767-5000

February 7 and 8, 1997
Niagara Parks Alumni Assoc. Educational Conference,
Venue: Ameri-Cana Conference Centre,
Contact: Michael Scmahl
(905) 687- 3307 or
Russ Nutley,
(905) 627-3783

February 23 - 26, 1997
WCTA Annual Conference,
Venue: Plaza of Nations, Vancouver, B.C.,
Contact: Bob Wick,
(604) 467-2564
FAX: (604) 467-0500

MOEE Land Classes 1 & 3 Licence Preparation Courses
February 15 & 16, 1997 - Guelph
March 8 & 9, 1997 - London
March 13 & 14, 1997 - Toronto
March 29 & 30, 1997 - Guelph
April 12 & 13, 1997 - London

Turf Pest Identification Clinics
March 26, 1997 - London
April 2, 1997 - Toronto
CONTACT: Turfecs
23 Mallard Court,
Guelph, ON. N1C 1B5
Toll-free 1-888-TURFECS or
(519) 767-1611

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Best Wishes for A Happy New Year
1997