FIGURE 1:
PHOMA MACROSTOMA
ON CANADA THISTLE

PHOMA MACROSTOMA: A BIOHERBICIDE IN THE MAKING

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A 2009 OTS Highlight Article. A good stand of turfgrass provides numerous benefits that contribute to our quality of life. When weeds invade our lawns, parks and golf courses, they disrupt the vigour, uniformity and aesthetics of established grass. Weeds are also a major source of pollen, which contributes to allergies and other irritations. Integrated weed management systems emphasize prevention of weed problems by maintaining vigorously-growing lawns with a combination of biological, chemical, cultural, manual and mechanical methods. However, pesticide bans in some municipalities and provinces across Canada have reduced the options available for weed control.

Bioherbicides are an alternative weed control option to traditional herbicides that are permitted to be used where herbicide bans are in effect. Bioherbicides, often made from naturally-occurring fungi or bacteria found on plants or in soil, can suppress weed growth and development, or result in weed mortality. There are opportunities for commercial applicators, farmers and homeowners to use microorganisms for biological weed control in agriculture, forestry and turfgrass situations.

Presently, the number of bioherbicides commercially available in Canada is fairly limited. But innovative research by public institutions and industry partnerships for new product development will bring more biological control projects to fruition, such as the project between Agriculture & Agri-Food Canada and The Scotts Company to develop the naturally-occurring fungus *Phoma macrostoma* for broadleaved weed control in turfgrass.

Government scientists discovered *Phoma macrostoma* on Canada thistle plants growing in Alberta, Saskatchewan, Ontario, New Brunswick and Nova Scotia (Figure 1). The fungus only caused small, insignificant lesions when sprayed onto leaves, but when added to soil, emerging Canada thistle plants came up white. Host range studies were conducted to determine which weed and non-target plant species were susceptible to the fungus. Weeds such as Canada thistle, dandelion, scentless chamomile, white clover and chickweed emerged white and died when the fungus was pre-emergently placed in the soil. However, there was no bleaching or mortality on weeds like green foxtail or wild oats. Among the non-target plant species, broadleaf plants such as canola or lentil were affected, but monocot plants like wheat, barley, oat, millet, canaryseed and grasses were unaffected.

To test whether biological control would work in the field, methods were developed to grow *Phoma macrostoma* in the laboratory and formulate it as a granule or powder for broadcasting to the soil surface. Conceptually, the granules would either be applied together with grass seed to establish a weed-free lawn (Figure 2)

FIGURE 2A: UNTREATED

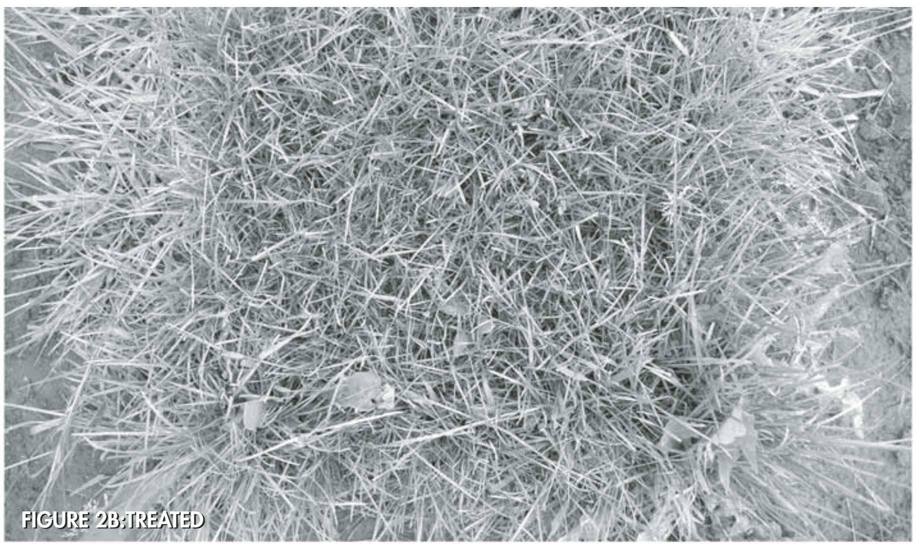

FIGURE 2B:TREATED

TABLE 1. DANDELION CONTROL (%) AT 28, 56 AND 84 DAYS AFTER APPLICATION (DAA) OF *PHOMA MACROSTOMA*, GUELPH, ON

Rate	% Dandelion Control at 28 DAA	% Dandelion Control at 56 DAA	% Dandelion Control at 84 DAA
1 x	83 ab	92 a	92 a
1/2 x	76 abc	72 ab	76 abc
1/4 x	51 cde	52 bc	52 bcd
1/8 x	48 de	26 cd	41 d
0 x	0 f	0 d	0 e

There are no significant differences among treatments followed by the same letter within a column. (P=0.05, Duncan's multiple range test)

or be broadcast over turfgrass and soil to prevent new weed emergence and kill previously established weeds. Field tests were conducted at several sites and over several years to determine efficacy and application parameters such as the lowest effective dose (Table 1), number of applications needed, timing of the application during the growing season, and weather conditions affecting efficacy.

It was also important to monitor the behaviour of the fungus in the environment to provide information on persistence, dispersion and survival for the assessment of environmental risk. Using

The bioherbicide has limited soil mobility. Research showed that its presence declined with time such that it was not detectable after one year.

genetic markers specific to the fungus, it was shown that *Phoma macrostoma* had limited mobility in the soil and its presence declined with time such that it was not detectable after one year. There were no persistent effects on susceptible crops such as peas the year following the first application.

As the research continues, it becomes more apparent why R&D partnerships are necessary for achieving success in biological control. There are five major categories for which sufficient information must be acquired in order to determine if an organism has potential to be an effective and safe bioherbicide. These categories are concerned with the characterization and biology of the organism, the interaction of the organism in the environment and associated environmental risks, the commercialization aspects of production and formulation, the toxicological safety towards human and animals, and the regulations that govern the research process and final product registration.

The partnership between Agriculture & Agri-Food Canada and The Scotts Company has addressed the biological, environmental and toxicological aspects with *Phoma macrostoma* for use in turfgrass, and are currently working on the final development and commercialization stages to bring this innovation to the marketplace. ♦

IMAGE 3

USING DRAIN TILE INSTALLATION & SAND TOPDRESSING TO DEVELOP A BUILT-UP SAND-CAPPED SYSTEM OVER TIME

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High school athletic fields constructed on native soil relatively high in silt and clay are incapable of providing adequate drainage during periods of heavy rainfall. This, in combination with heavy use, will result in turfgrass failure, reduced traction and stability, and compaction, which will only worsen infiltration and future turfgrass health and vigour. Current solutions to this dilemma include complete field renovation. However, these processes are very costly (all figures that follow are in USD) and render the athletic surface temporarily unusable.

For instance, renovation costs range from $600,000 to 1,000,000 for a synthetic field; $400,000 to 600,000 for a conventional sand-based athletic field with a 30 cm sand-based root zone over a 10 cm gravel layer and a subsurface drain tile system (Image 1, pg. 14); or $200,000 to 300,000 for a sand-capped system with a shallow (10-15 cm) sand-based root zone directly over the underlying native soil and a subsurface drain tile system (Image 2, pg. 15).

These staggering upfront prices are not an option for school systems with minimal budgets and high annual use requirements. A possible alternative to complete renovation is the installation of a subsurface drain tile system and subsequent sand topdressing applications, providing a built-up sand-capped system over time. A built-up sand-capped system, which can be done in four simple steps for $53,400-99,000 [price includes irrigation system installation ($15,000), 2-6 m drain tile spacing ($60,000-14,400, respectively), and 5 cm sand layer ($24,000 for labour and materials)], would provide high schools and other municipalities with a cost effective solution to impeded field playability that does not interrupt field use for an extended period of time.

Above (Image 3): Water Management Inc. cutting drain lines and installing drain tiles, Intramural Field, Michigan State University, East Lansing, Michigan, July 2008.


IMAGE 4


IMAGE 5

The concept behind the built-up sand-capped system is to combine the advantages of the sand cap system (drainage and sand root zone playing surface) while providing almost uninterrupted availability. The idea is to cut drains in the existing field running lengthwise, put drain tile in the lines, and back fill with pea stone and then sand, or coarse sand alone (Image 3, pg. 13 and Image 4 pictured above).

If the existing field does not already have irrigation, installation of an irrigation system prior to drain tile installation is necessary at this time as turfgrass grown on a sand-based system requires regular watering. It is also important to correct any low (wet) spots in the existing slope by leveling them with topsoil; soil removed during drain line installation would be appropriate for this task. Subsequent repair to any irrigation line damage is necessary.

An aggressive sand-based topdressing program would begin during the summer with a "specific high sand-based material" (approximately 90% well-graded sand sized particles). Sand topdressing would be coupled with an annual field renovation program (including reseeding, cultivation, etc.). During this period, it is also important to regularly clean and maintain irrigation heads to prevent sand from damaging the system. The topdressing stops in early August to allow settling prior to usage in the fall. During the first year, the sand may not reach the level necessary to prevent saturated surface conditions, particularly in low lying areas. However, the drain tiles will prevent standing water from developing, providing a system that is better than the original. The next spring, the topdressing process would begin again to add the rest of the material, further increasing drainage capacity. The end result is a well drained, stable, sand-based field for a fraction of the cost required for other renovation processes.

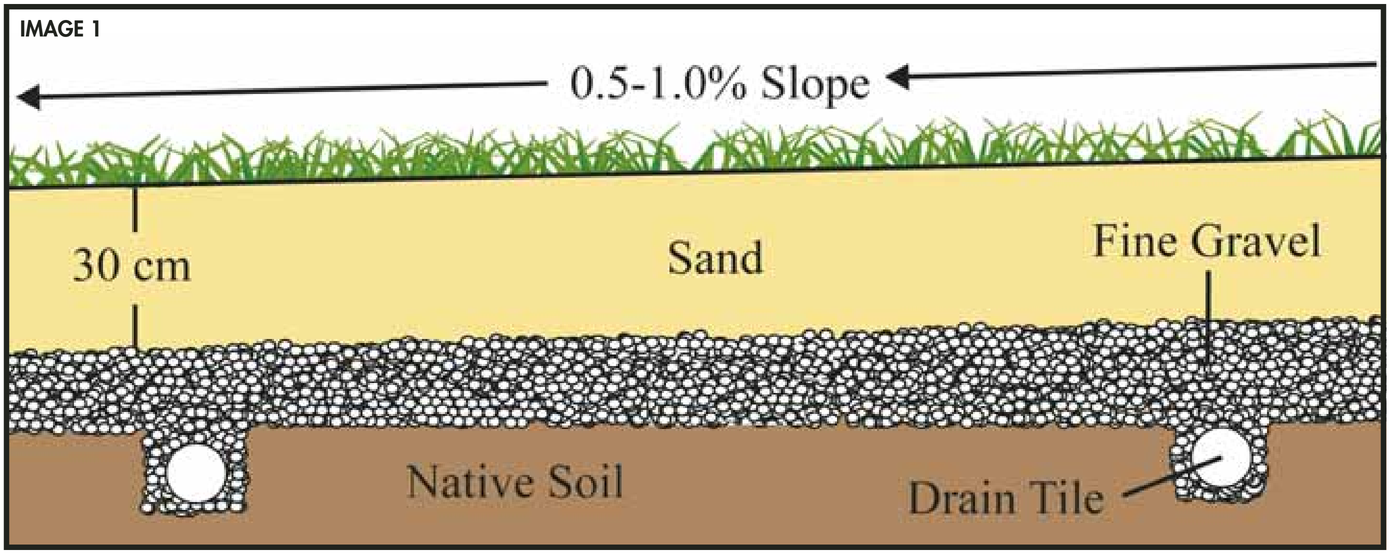
The built-up sand-capped system will not only reduce the annual repair costs required for a native soil field, but also reduce the initial cost of field renovation. To install the drainage and backfill a field with 2 m centres (would have approx. thirty 122 m x 10 cm drain lines @ $13-16/linear metre) would cost $48,000-60,000 installed, while a field with 4 m centres would cost $22,400-28,000, and 6 m centres would cost $14,400-18,000. Then

Below (Image 1): Conventional sand-based athletic field schematic.

Top Left (Image 4): Water Management Inc. backfilling lines with a sand-based root zone material, Intramural Field, Michigan State University, East Lansing, Michigan, July 2008.

Top Right (Image 5): Cady traffic simulator, designed at Michigan State University, East Lansing, Michigan, for simulation of athletic field traffic.

IMAGE 1



topdressing would begin on the field during the summer with each centimetre of material costing about $4,800 (120 tonnes of sand for $3,200 and $1,600 for labour).

However, a number of questions arise when considering the built-up sand-capped renovation procedure, such as what is the optimum topdressing regime capable of accumulating an adequate sand layer without being detrimental to turfgrass vigour and wear tolerance? Can athletic field use continue throughout the topdressing regime? And, what is the optimum drain tile spacing in combination with sand topdressing depth, accumulated over time, necessary to prevent prolonged saturated field conditions which would otherwise compromise stability?

A series of research projects were initiated in the spring of 2007 at the Hancock Turfgrass Research Center, Michigan State University, East Lansing, Michigan, to explore the feasibility of a built-up sand-capped system. Objectives of this research were threefold: 1) to evaluate the effects of cumulative sand topdressing rates on the fall wear tolerance of a cool-season turfgrass stand; 2) to determine the effects of traffic applied during the topdressing regime on the fall wear tolerance of a cool-season turfgrass stand; and 3) to establish drain tile spacing, in combination with sand topdressing, necessary to improve drainage characteristics, wear tolerance and surface stability of a cool-season turfgrass stand.

Below (Image 2): Sand-capped athletic field system schematic.

FIGURE 1: EFFECTS OF ANNUAL TOPDRESSING RATE ON COST (LABOUR AND MATERIALS) AND FIELD STABILITY.

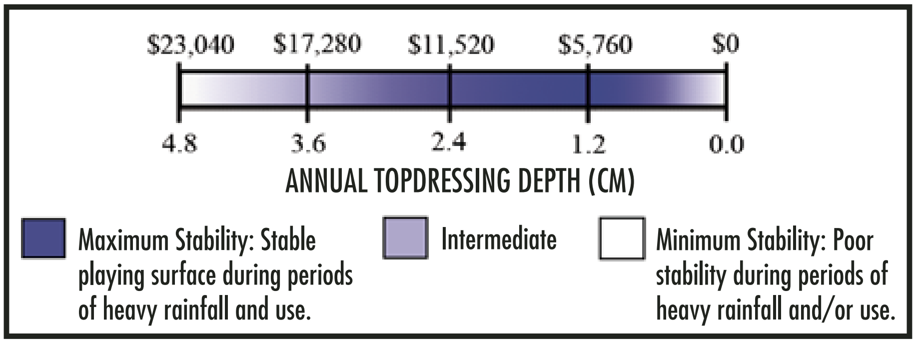
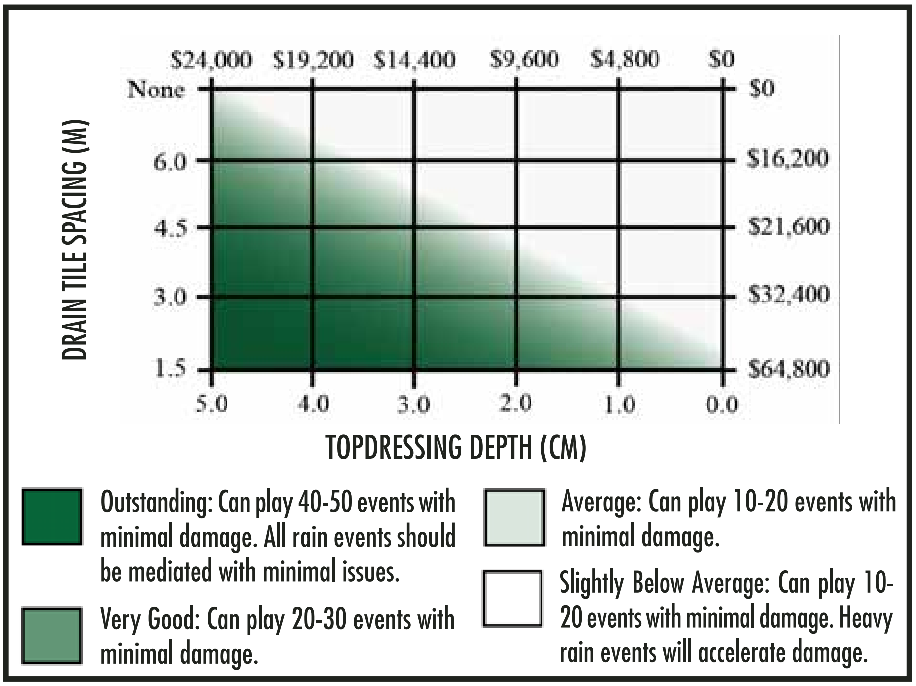
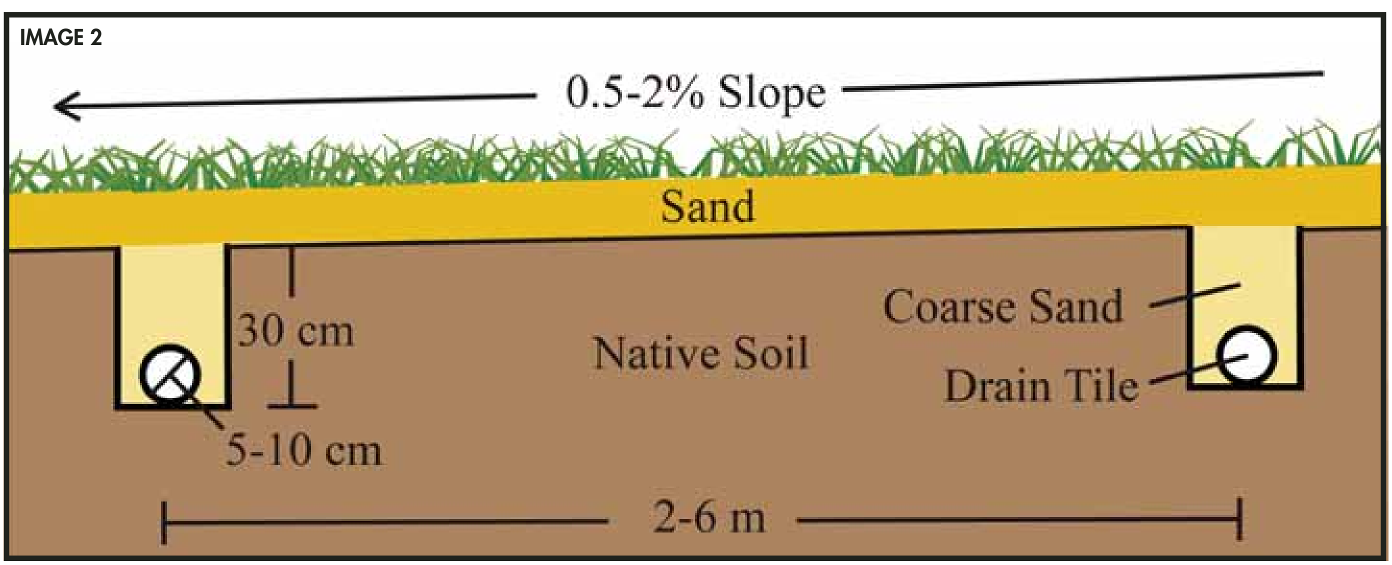


FIGURE 2: EFFECTS OF DRAIN TILE SPACING AND TOPDRESSING DEPTH ON THE COST OF INSTALLATION AND WEAR TOLERANCE.





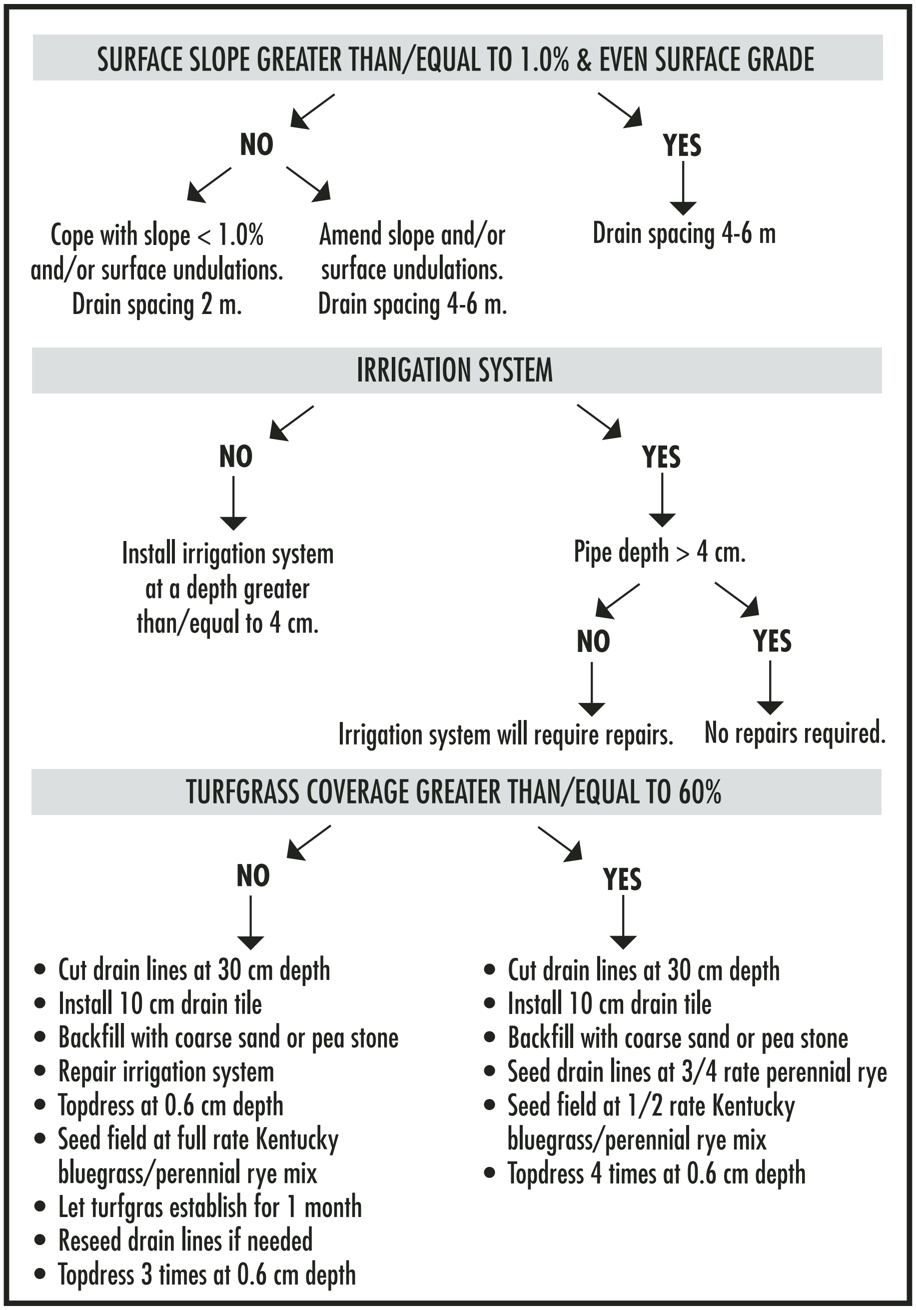
All research was conducted on a 90% *Poa pratensis* – 10% *Lolium perenne* mixture established from seed on a compacted sandy loam soil with a 1% surface slope in relation to drain tiles. The turfgrass established for these projects received summer sand topdressing applications applied over a five week period at a 0.6 cm depth per application, then simulated athletic field traffic was applied using the Cady traffic simulator in the subsequent fall for two consecutive seasons (Image 5, pg. 14).

Topdressing rate results obtained from this research suggest that when topdressing is used to develop a sand layer over an existing native soil athletic field, a conservative topdressing regime, 1.2 cm applied over a five week period in the summer, will provide field managers the greatest results, wear tolerance and surface stability in the subsequent fall (Figure 1, pg. 15). Results also suggest that if a spring re-establishment prior to the initiation of sand topdressing is required, restricting summer traffic will provide the best results in the subsequent fall.

Findings from this research also indicate that if spring re-establishment is not required, effects of summer traffic will be inconsequential to turfgrass wear tolerance and surface stability characteristics in the ensuing fall. As little as 1.2 cm of sand topdressing ($5,760) was shown to substantially reduce the surface moisture content of a native soil athletic field, implying that this cultural practice alone could substantially improve the drainage characteristics of a native soil athletic field.

Regarding drain tile spacing in combination with sand topdressing, results suggest that as topdressing is being accumulated from a 0.0 to 2.4 cm depth in the first year, the 2.0 m drain tile spacing will provide the greatest overall drainage, wear tolerance (ground cover) and surface stability (shear strength and surface hardness) characteristics. However, the 4.0 m drain spacing provides drainage and surface stability characteristics equivalent to the 2.0 m drain spacing. These findings indicate a drain tile spacing of 4 m, which will substantially reduce installation costs ($22,400-28,000), is adequate to provide sufficient drainage and stability when 2.4 cm of sand topdressing ($11,520) has been applied (Figure 2, pg. 15).

FIG. 3: RENOVATION FLOW CHART DESIGNED FOR MAKING RENOVATION DECISIONS BASED ON A VARIETY OF FIELD CONDITIONS, PRIOR TO INSTALLATION OF A BUILT-UP SAND-CAPPED SYSTEM.



As topdressing depths were accumulated from 2.4 to 4.8 cm in the second year, minimal wear tolerance and surface stability differences were observed, suggesting that the effects of drain tile spacing on wear tolerance and stability are minimal once 4.8 cm of topdressing has accumulated. These findings suggest that if 4.8 cm of sand topdressing ($23,040) has been accumulated and an adequate surface slope is available (greater than/equal to 1%), drain tile spacing can be increased to distances of 6 m or greater. Drain tile installation at 6 m spacing would cost approximately $14,400-18,000. It is important to note that substantial surface runoff was still collected from the control treatment after 4.8 cm of sand topdressing was accumulated, suggesting that drain tiles are still required for the removal of surface runoff from low lying areas (Figure 3, above). ♦

TOWN OF OAKVILLE

THERE'S A NEW GAME IN TOWN. KNOW THE LIMIT & WORK WITHIN IT!

PAM CHARBONNEAU, TURFGRASS SPECIALIST, OMAFRA

The title says it all. There are new limitations on how you manage your sports fields. Part of the struggle at the moment is knowing what can and can't be done. The second part of the struggle is to figure out ways to work within the new Pesticides Act and regulations and still maintain safe, healthy sports fields. This article is going to focus on what we can do to maintain healthy turf and also to make you aware of some of the research that began this summer that will address some of the knowledge gaps that we have when operating in an environment without pesticides. The focus of this article is on minimizing weeds in sports fields.

Turf Management Basics

We are now forced to focus on the basics of turf management to have sports fields with minimum weed cover. The tools that we have at our fingertips are not new. They are:

- turfgrass species selection
- turfgrass cultivar selection
- mowing
- fertilizing
- irrigating
- aerating
- overseeding

Turfgrass Species Selection

Most recommendations for sports fields in Ontario suggest 100% Kentucky bluegrass (sodded fields) or 80:20 mixtures of Kentucky bluegrass and perennial ryegrass. With sodded fields there is the opportunity to incorporate the more traffic tolerant perennial ryegrass species through an overseeding program. Without herbicides in our toolbox, do we need to investigate other turfgrass species to help us achieve sports fields with minimum invasion from weeds? Is it time to look at species like *Poa supina* or tall fescue for sports fields in Ontario?

Turfgrass Cultivar Selection

In this current climate of managing sports turf with a pesticide ban, knowledge is power. It isn't only important to select the correct species composition for your sports field, it is also important to select the best cultivars. A lot of work has been done by researchers at Rutgers University to characterize Kentucky bluegrass cultivars and there is a summary of the information in the *Sports Turf Manager* Vol. 22, No. 1 "Understanding Turfgrass Species for Use on Athletic Fields & Recreational Areas" by Paul Stevens. This information is very useful. The groups are divided according to growth type (compact, aggressive), colour, density and stress tolerance. There is not reliable information on traffic tolerance or resistance to broadleaf weed invasion. Currently all of the National Turfgrass Evaluation (NTEP) tests apply a broadleaf herbicide to establish weed free plots.

The Guelph Turfgrass Institute has a Kentucky bluegrass trial underway at the moment. It could be very valuable to look at how these cultivars resist broadleaf weed invasion and how they stand up to wear. Dr. Jordan and Dr. Lyons have a dwarf Kentucky bluegrass trial at the Guelph Turfgrass Institute that was established in 2008 that is looking at the effects of various mowing heights, wear, divot recovery and weed invasion. This information could prove to be very useful for turfgrass managers to help them select Kentucky bluegrass cultivars that will stand up to wear and will also resist weed invasion.

To my knowledge, this type of information is not available for perennial ryegrass cultivars. Similar to the Kentucky bluegrass trials, the NTEP ratings for perennial ryegrass look at quality, spring green up and resistance to some common diseases. In addition, it is more important than ever to consider using endophyte enhanced perennial ryegrass seed in your overseeding program to reduce the likelihood of losing your sports field to a turf insect pest. The good news is that NTEP has announced that for cool season turfgrass trials seeded in the fall of 2009, they will be testing for drought and traffic tolerance. For more information, visit their website at www.ntep.org.

Mowing

Mowing does have an impact on weed invasion in turf. This is particularly true for crabgrass invasion. Studies on tall fescue (Dernoeden et al., 1993) showed mowing at 3.5” (9 cm) gave 100% control of crabgrass plants. At 2.5” (6 cm) there was a 40% reduction of infestation of crabgrass. Studies have shown that at excessively low mowing heights there is an increase in invasion of dandelion and clover. A demonstration trial that was conducted over a five year period at the Guelph Turfgrass Institute showed an interaction between mowing height (4 and 8 cm) and year on broadleaf weed invasion, suggesting that there was an interaction between the amount of rainfall and timing of the rainfall on weed invasion at the different mowing heights. The suggestion is to mow as high as possible for the intended use of sports fields.

Fertilizing

Supplying turf with adequate nitrogen fertilizer has a big impact on weed invasion. Fertilizer applied in the spring to thin turf provided a 70% reduction in crabgrass control. In the demonstration trial mentioned earlier in this article, percent broadleaf weed coverage in the fertilized plots was reduced from 50% to between 5-10% over the five year study just by applying 2.0 kg of nitrogen (N) per 100 m^2 per year. Supplying sports fields with a balanced fertility program based on a