**Figure 3.** The RPR in traffic wear trial. RPR (right) and non-RPR (left).

to intense traffic wear reduced the population to approximately 3,000 initial selections. From these initial 3,000 selections only five populations of RPR were discovered. This type of selection not only translates into better traffic tolerance, but also positive recovery potential from traffic damage because of its stoloniferous habit. Our studies have shown that just because a ryegrass is stoloniferous, does not mean it can recover from an intense traffic event. What we found out was that only the stoloniferous varieties that were developed for traffic tolerance were able to recuperate from an intense traffic event. Though other ryegrass varieties can have some unintended traffic tolerances, they could not recover from the wear and actually have a negative recuperating potential (i.e. they don't recover.). This means that after the traffic simulation was completed, varieties were then studied for their ability to recuperate from the intense traffic wear, the varieties not developed for traffic tolerance actually continued to decline and did not recuperate from the traffic damage. Whereas, those developed under intense traffic selections protocols (i.e. RPR) did recuperate and in fact increased in coverage (Figure 3). As the turf canopy is opened up by traffic, RPR begins to produce stolons to fill in the open areas. This was first reported from research performed at The Ohio State University.

So, is RPR for sports fields? Yes, it was developed from day one for sports fields. RPR has been since day one mostly used on sports fields and golf courses with tremendous success. A lot of sports turf managers are sending feedback as to how much they like the performance and the wear tolerance of the RPR.

For more information visit barusa.com.•

A power screen for mixing of the soil and sand materials

*Photo: ENVision-The Hough Group Limited*

# Preparation of a Sand: Soil Mix – Procedure and Pitfalls

**R.W. Sheard, Professor of Soil Science (retired), University of Guelph**

The construction of Category 1, 2 and 3 athletic fields, as outlined in the Sports Turf Association's *Athletic Field Construction Manual*, calls for a certain percentage of silt plus clay in the root zone. The site where the field is to be constructed may have an excellent top soil which the architect is reluctant to discard preferring to mix the existing top soil with sand to achieve the requirements of the category of field that is to be built.

Several points are necessary to consider in making the use of the in situ soil a success.

The first point is the sand and soil cannot be adequately mixed on site. Attempting to mix by layering the sand on the surface and rototilling it throughout the 30 cm depth of root zone will not be successful because the depth is beyond that workable by a rototiller and the sand will continue to be concentrated near the surface. The appropriate procedure is to strip the top soil off the site and stock pile it prior to mixing with the sand. The selected sand and appropriate volume of sand are then blended together by passing over a power screen. Stripping the top soil and the necessary sub soil allows the final grade to be established and the drainage system correctly installed.

The second point is the mixing must be based on particle size analysis of the sand and soil by an accredited laboratory. Standard dry sieve analysis must be done on the sand source and the particle size distribution should fall within the specifications as outlined in the *Manual*. The soil sample, however, must be analyzed by the standard procedure for soil texture which provides estimates of the percentage sand, silt and clay in the soil. During this

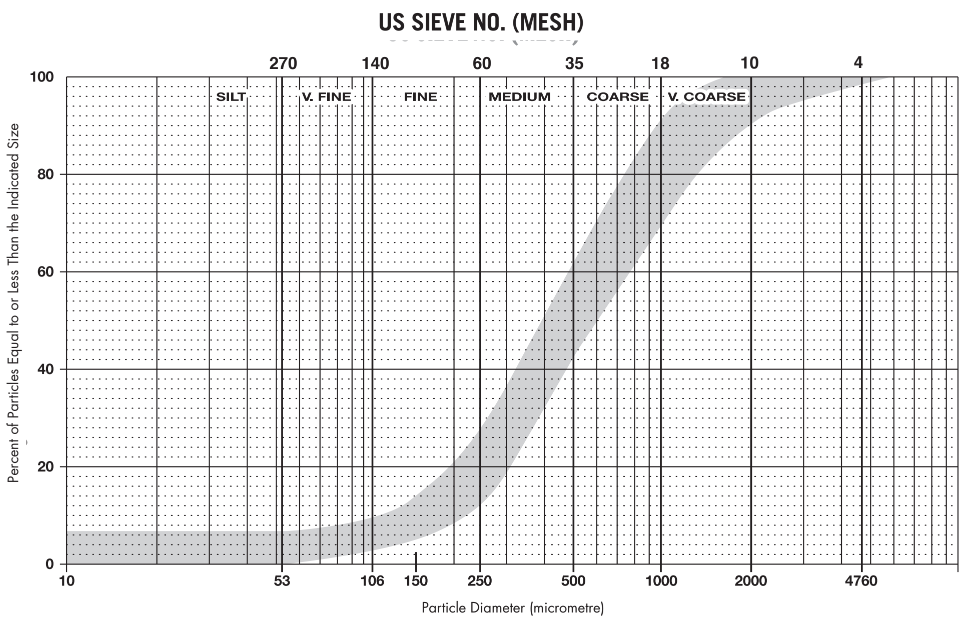



**Table 1.** The particle size distribution envelope for the root zone mix of a Category 1 athletic field. *Athletic Field Construction Manual*, Sports Turf Association, 2012.

procedure the aggregation or soil structure is destroyed so that all the individual soil particles are estimated. The use of the dry sieve analysis on the soil sample would result in high estimates of fine and very fine sand as the soil aggregates would appear in these size fractions. This is particularly true for soils which are well aggregated due to a high organic matter and/or clay content.

The laboratory should also be requested to do sieve analysis on the sand fraction in the soil using the same mesh sizes as used in the dry sieve analysis of the sand. The size distribution of the sand fraction in the soil should conform to that for the sand portion of the mix. Soils which are a fine sandy loam or a course sandy loam texture can result in poorly performing mixes if the sand in the soil makes up a large proportion of the total sand component of the final mix.

The third point is the volume of sand and of soil must be based on calculations using the data obtained from the laboratory analysis. The calculations use an iterative procedure which means repeating the calculations until the desired result is obtained.

The following example illustrates the iterative procedure.

Assume the soil sample has 77.4% sand and 27.6% silt plus clay and that the sand has 2.5% silt plus clay. In order to meet the requirements for a Category 2 field and to maximize available water assume the final mix should contain 20% silt plus clay and 80% sand.

For the first iteration assume a 1000 g trial mix is made containing 250 g of sand and 750 g of soil. The mix would have the following distribution of particles from the two sources.

- In the sand there would be 250 x .025 = 6.25 g silt + clay and 243.75 g of sand.
- In the soil there would be 750 x .276 = 207 g silt + clay and 543 g of sand.
- This would provide a mix with 213.25 g of silt + clay and 786.75 g of sand or 21.3 % silt + clay and 78.6% sand.

For the second iteration assume a 1000 g trial mix is to be made having 275 g of sand and 725 g of soil.

- In the sand there would be 275 x .025 = 6.87 g silt + clay and 268.13 g of sand.
- In the soil there would be 725 x .276 = 200.1 g silt + clay and 524.9 g of sand.
- This would provide a mix with 206.8 g of silt + clay and 793.0 g of sand or 20.6 % silt + clay and 79.3 % sand.

Realistically further iteration would be unnecessary.

In practice, the measuring of the two components to place in the mix is done by volume, not by weight. Therefore it is necessary to convert the above weights to volume which is done by multiplying the weight by the dry density of the material. The dry density of the stockpiled sand can be assumed to be 1.75 g/cm$^3$ and that of the non-compacted soil in a stock pile to be 1.1 g/cm$^3$. The volume of sand to use in a unit of mix would be 275/1.75 = 157 cm$^3$ and the volume of soil would be 725/1.1 = 659 cm$^3$. The volume ratio for the sand/soil mix would be 157:659 or approximately 1 part of sand to 4 parts of soil. The assumption of the densities of the two materials as they would appear in a stock pile is why further iteration calculations would be unnecessary.

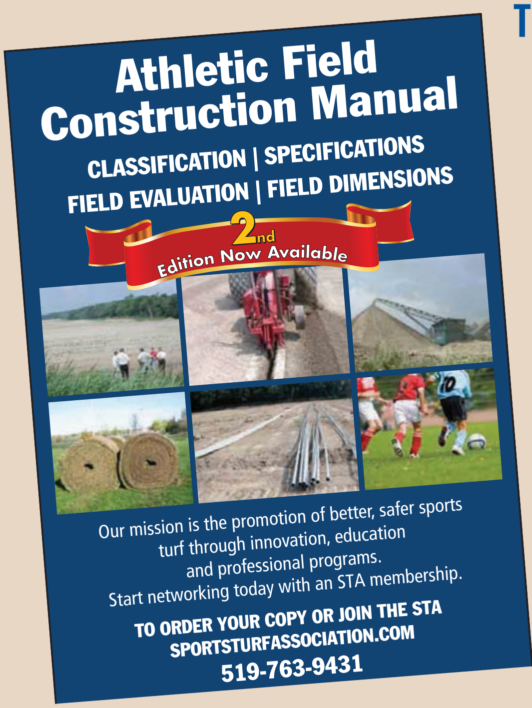


It is interesting to note that most of the sand in the mix comes from the soil. This is why the particle size distribution of the sand fraction of the soil is a critical laboratory requirement.

The preferred procedure for mixing is with a front end loader and a power screen. Four buckets of soil followed by one bucket of sand would be passed over the screen. The power screen also has the advantage of removing stones and other debris which may be present in the soil from the site.

The architect should verify the particle size distribution of the mix by making a small trial mix of four pails of soil and one pail of sand. A sample from this trial mix is sent to the laboratory for regular particle size distribution of sand, silt and clay. The laboratory should be requested to do sieve analysis on the sand portion. This analysis is critical to determine if the sand in the soil approximates the particle size distribution required of the sand sample.

Some inexpensive laboratory analysis, a few simple calculations, power screen mixing of the determined ratio of sand and soil, and a root zone mix which conforms to the specifications of the STA's *Athletic Field Construction Manual* is ready to be spread on the field.•




## The Sports Turf Association Publishes Second Edition of the

# Athletic Field Construction Manual

**GUELPH, ON.** The Sports Turf Association announces the publication of the second edition of its popular *Athletic Field Construction Manual*, a staple reference for those in the sports turf industry.

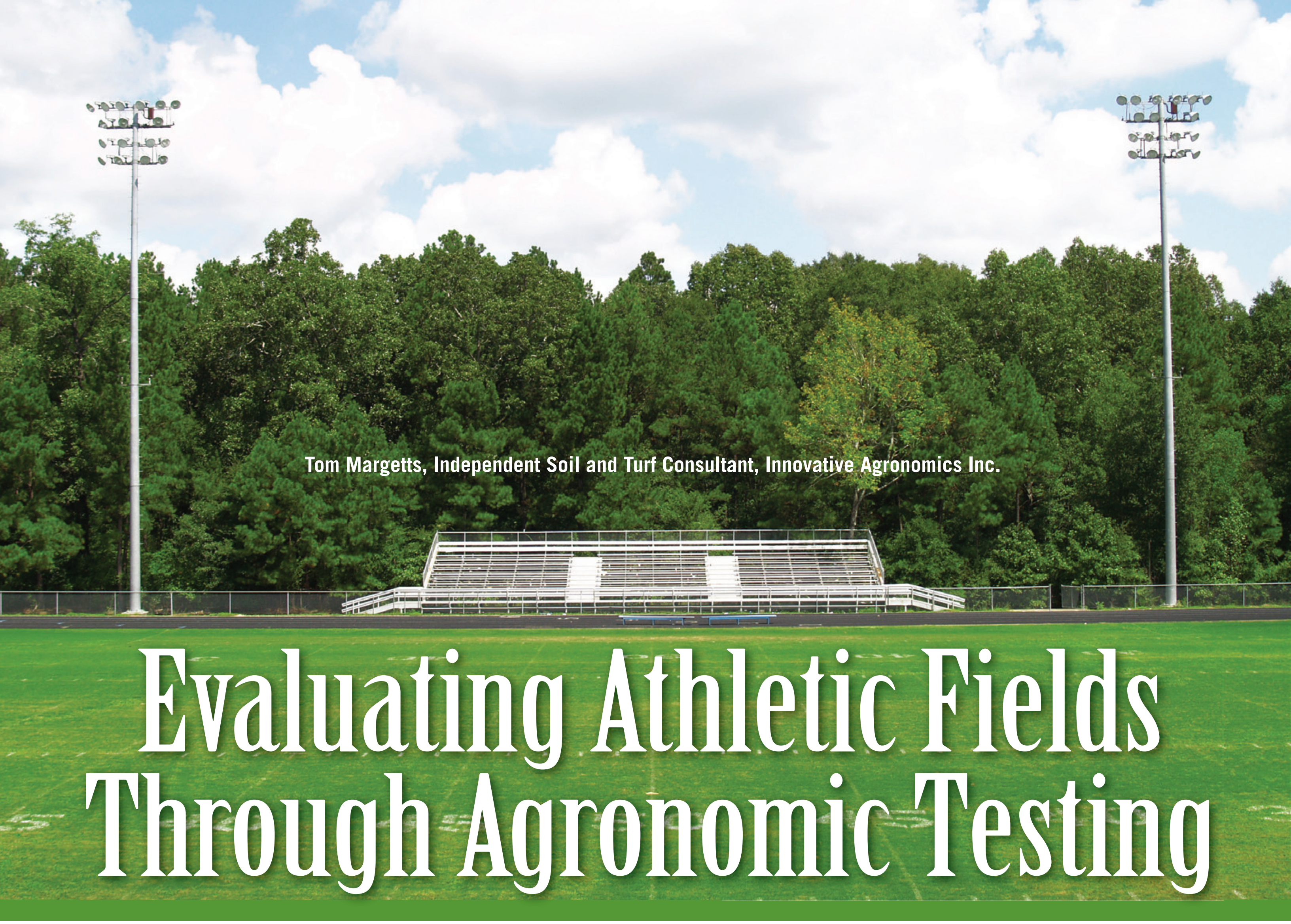
The manual, written by Dr. R.W. Sheard in conjunction with an editorial committee of professionals, brings uniformity to the construction of grass athletic fields.

"The reputation of the first edition published in 2008 has led to its approaching out-of-print status", said Dr. Sheard. "Rather than simply reprinting, we took advantage of the opportunity to make subtle revisions to this edition".

The opening pages have been restructured to improve readability. Classifications based on the root zone material for categories three and four have been more adequately defined, as have the tolerances for grade control and depth of the stone layer and root zone material. Additional changes are of only a clarifying nature.

The second edition of the *Athletic Field Construction Manual* is now available for purchase in both print and electronic PDF format.

Visit www.sportsturfassociation.com to order your copy today!



Tom Margetts, Independent Soil and Turf Consultant, Innovative Agronomics Inc.

# Evaluating Athletic Fields Through Agronomic Testing

## You Can't Manage What You Don't Measure

Rushing an athletic field project without a true understanding of your goals and objectives can often times end in a disappointing result.

Too often athletic field construction is treated in this way. We meticulously generate and review tender documents and review contractor proposals without really considering the destination or how this new field will fit into our program.

Many fields already exist in the turf manager's inventory. Few inventories contain the necessary information to allow them to be placed in a realistic classification system. Such an inventory system should permit an evaluation of how each field fits into an overall use program.

There are many challenges when it comes to field turf management and "hours of use" is definitely at the forefront. The physical components (sand, silt, clay) of an athletic field root zone are directly related to its ability

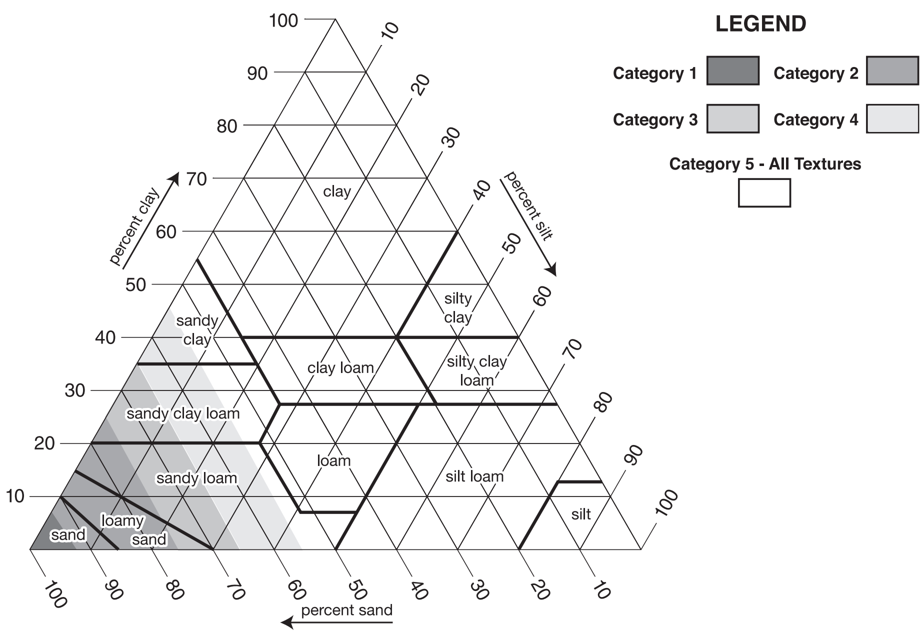



**Figure 1.** Use of the textural triangle to assign root zone soils to the field categories based on the particle size of the soil. *Athletic Field Construction Manual*, Sports Turf Association, 2012.

to withstand traffic and determine to a large degree its tolerable "hours of use".

The following discussion is geared towards information which can be gathered from existing fields for greater understanding of how to get the most out of the athletic fields you currently manage. "You can't manage what you don't measure" and now is the time to evaluate athletic fields to get a true understanding of what is realistic and what isn't. Agronomic testing strategies from an accredited laboratory can provide accurate information and allow making of the decisions required.

There are many components that go into an athletic field evaluation and placing the field in the appropriate category as defined in the Sport Turf Association's *Athletic Field Construction Manual* (Figure 1). Many of these can be determined and supported through independent laboratory testing and professional interpretation.

## Physical Soil Testing

Understanding the physical components of the athletic field root zone will allow putting a program in place specific to the field's potential and limitations. Physical testing is a laboratory audit to determine the size of the particles that make up the root zone and the ratio in which they are found (Figure 2). The determination of sand, silt and clay with total silt plus clay can be related back to the field's:

- ability to tolerate traffic
- level of maintenance required
- recovery from rain events and inclement weather
- drainage capabilities
- potential for compaction
- ultimately determine tolerable "hours of use"

Each physical particle of the root zone has a size related to it. The ratio in which the different sized particles are found is

Brookside Laboratories, Inc.

**** PHYSICAL ANALYSIS REPORT ****

File Number : 53747
** Date of Analysis **
Start Date : 6/3/2010
Completed : 6/7/2010

Submitted By: Innovative Agronomics Inc. Reviewed by:

Lab Number 0578
Sample Description

1

| Particle Size Analysis | | | USGA Specs |
|---|---|---|---|
| Clay <.002mm | % | 5.3 | <= 3.0% |
| Silt .002mm - .05mm | % | 27.9 | <= 5.0% |
| Sand .05mm - 2.00mm | % | 65.3 | |
| Gravel > 2.0mm | % | 1.5 | |
| Org Mat (360 deg C ash) | | 4.51 | |

Sand Fractions

| Sieve Size # | mm | | % Retained | |
|---|---|---|---|---|
| 10 | 2.0 | Fine Gravel | 1.5 | 2.0mm <= 3.0% |
| 18 | 1.0 | Very Coarse Sand | 3.4 | 2.0mm + 1.0mm <= 10% |
| 35 | .500 | Coarse Sand | 7.9 | |
| 60 | .250 | Medium Sand | 18.4 | 0.5mm + 0.25mm >= 60% |
| 100 | .150 | Fine Sand | 15.4 | 0.15mm <= 20% |
| 140 | .106 | Very Fine Sand | 8.6 | 0.106mm + 0.053mm <= 5.0% |
| 270 | .053 | Very Fine Sand | 11.6 | |

**Figure 2**. Laboratory Physical Analysis Report

| CATEGORY | PERMITTED DAYS | PERMITTED HR/DAY | PERMITTED HR/SEASON | CONSECUTIVE DAYS OF USE |
|---|---|---|---|---|
| 1* | 90 | 5 | 450 | 2 |
| 2 | 110 | 5 | 550 | 3 |
| 3 | 140 | 5 | 700 | 4 |
| 4 | 180 | 2.5 | 450 | 4 |
| 5 | 180 | 2.5 | 450 | 5 |

**Figure 3.** A guideline for the permitting hours of the five categories of athletic fields. *Athletic Field Construction Manual*, Sports Turf Association, 2012.

directly related to the amount of pore space the root zone has. All root zones are made up of a percentage of capillary (micro) pores and non capillary (macro) pores. Sand based fields (Category 1) will have a high percentage of non capillary pores which allows them to be free draining, resist compaction and have a low nutrient holding capacity. This almost always translates into higher maintenance. Soil based root zones will have a higher percentage of capillary pore space that will hold water for a longer period and provide a more nutrient rich environment for turf growth.

Basically, every aspect of a turf management program should be connected to the physical makeup of the root zone. It requires knowledge of a field's ability to tolerate inclement weather in relation to drainage, how prone it is to compaction and its porosity. Physical testing and interpretation can provide these answers and can save both time and money in your turf programs.

BASICALLY, EVERY ASPECT OF A TURF MANAGEMENT PROGRAM SHOULD BE CONNECTED TO THE PHYSICAL MAKEUP OF THE ROOT ZONE.

## Hours of Use

The physical components of the root zone are directly related to tolerable "hours of use". Most municipal athletic

lb/A

**BROOKSIDE LABORATORIES, INC.** 54581-5

**SOIL AUDIT AND INVENTORY REPORT**

Name ______ City ______ State ______

Independent Consultant Innovative Agronomics Inc. Date 5/19/2011

| Sample Location | | | | |
|---|---|---|---|---|
| Sample Identification | QUAD 1 d 6 in FIELD 1 | QUAD 1 d 6 in FIELD 3 | QUAD 2 d 6 in FIELD 1 | QUAD 2 d 6 in FIELD 3 |
| Lab Number | 0517-1 | 0518-1 | 0519-1 | 0520-1 |
| Total Exchange Capacity (ME/100 g) | 14.04 | 15.68 | 15.36 | 14.10 |
| pH ($H_2O$ 1:1) | a 8.0 | a 7.9 | a 8.1 | a 8.1 |
| Organic Matter (humus) % | 1.47 | 1.95 | 1.66 | 1.73 |
| Estimated Nitrogen Release lb/A | 49 | 59 | 53 | 55 |
| ANIONS: SOLUBLE SULFUR* ppm | 27 | 33 | 36 | 27 |
| PHOSPHORUS: MEHLICH III lb/A P as $P_2O_5$ | | | | |
| PHOSPHORUS: MEHLICH III ppm of P | | | | |
| PHOSPHORUS: BRAY II lb/A P as $P_2O_5$ | | | | |
| PHOSPHORUS: BRAY II ppm of P | | | | |
| PHOSPHORUS: OLSEN lb/A P as $P_2O_5$ | 23 | 23 | 9 | 18 |
| PHOSPHORUS: OLSEN ppm of P | 5 | 5 | 2 | 4 |
| EXCHANGEABLE CATIONS: CALCIUM* lb/A | 4620 | 5014 | 4960 | 4464 |
| CALCIUM* ppm | 2310 | 2507 | 2480 | 2232 |
| MAGNESIUM* lb/A | 400 | 518 | 490 | 490 |
| MAGNESIUM* ppm | 200 | 259 | 245 | 245 |
| POTASSIUM* lb/A | 140 | 166 | 158 | 162 |
| POTASSIUM* ppm | 70 | 83 | 79 | 81 |
| SODIUM* lb/A | 76 | 104 | 94 | 102 |
| SODIUM* ppm | 38 | 52 | 47 | 51 |
| **BASE SATURATION PERCENT** | | | | |
| Calcium % | 82.26 | 79.94 | 80.73 | 79.15 |
| Magnesium % | 11.87 | 13.76 | 13.29 | 14.48 |
| Potassium % | 1.28 | 1.36 | 1.32 | 1.47 |
| Sodium % | 1.18 | 1.44 | 1.33 | 1.57 |
| Other Bases % | 3.40 | 3.50 | 3.30 | 3.30 |
| Hydrogen % | 0.00 | 0.00 | 0.00 | 0.00 |
| **EXTRACTABLE MINORS** | | | | |
| Boron (ppm) | 0.44 | 0.56 | 0.49 | 0.82 |
| Iron** (ppm) | 20 | 32 | 23 | 23 |
| Manganese** (ppm) | < 1 | < 1 | < 1 | < 1 |
| Copper** (ppm) | 1.29 | 1.58 | 1.36 | 1.37 |
| Zinc** (ppm) | 0.70 | 0.73 | 0.63 | 0.57 |
| Aluminum (ppm) | | | | |
| OTHER TESTS: Soluble Salts (mmhos/cm) | | | | |
| Chlorides (ppm) | | | | |

* Ammonium Acetate Extractable (pH of 8.1)
** DTPA Extractable

d - specific depth    a - alkaline soil

**Figure 4.** Laboratory Soil Audit and Inventory Report.

fields experience high usage, potentially beyond their tolerance in relation to the maintenance program. Categorizing the athletic fields becomes very powerful information to deal with pressure from user groups, operating and capital replacement budgets. It provides the turf manager a tool to justify budget requests or defend how the conditioning matches quality.

For example, compare a sand based vs soil based root zone. *The Athletic Field Construction Manual* offers guidelines that indicate a Category 1 (sand based) field will tolerate 450 hours of use per season. The Category 3 (soil based) field will tolerate 700 hours of use per season (Figure 3).

This is where understanding the tolerable use is very important. Category 1 athletic fields are basically really big golf greens built to very tight specifications. They are designed to host a selected number of high level sporting events and be "game ready" quickly after inclement weather. They have a high amount of non capillary (macro) pores and can become unstable if the root matrix (tensile strength) is lost from the turf surface. This is not a situation a municipal turf manager needs to deal with in the middle of a busy season, without high inputs and resources.

Category 3 (soil based) athletic fields are the "work horse" of the bunch and have a better, well rounded soil structure. The Category 3 field has a good balance of capillary and non capillary pores for water holding capacity and adequate drainage. They will require less intensive maintenance and have the ability to withstand abuse under good preventative maintenance. However a soil based athletic field can be quickly destroyed if play or maintenance is allowed within a short period of time after heavy rainfall.

## Root Zone Layering

Physical soil testing can also target layering issues within the root zone. Layering can result from inconsistent materials or on-site blending during the construction phase. Every time a layer is introduced in the root zone there is a reduction in the efficiency in which the soil drains and exchanges oxygen from the surface. Layering problems are also created as a result of improper topdressing material selection. The topdressing material should be compatible with the physical components of the root zone. Test the upper and lower portion of the root zone if layering is suspected and test the topdressing material as well. With professional interpretation this laboratory data can be brought together to determine the best corrective measures and topdressing program moving forward.

Incompatibility of sod is another source of root zone layering. This can occur from sodding during construction or ongoing repairs and renovations during the season. Sod with a finer soil component than the material below can create an unfavourable interface that holds water, promotes shallow rooting and creates a slippery, unsafe playing surface. Conduct physical soil testing to determine the sand, silt, clay and particle size analysis on your sod layer and compare it to the root zone material under it. You may be very surprised!

EXCESSIVE SOIL COMPACTION, POOR INFILTRATION AND OXYGEN CAN LIMIT THE BEST TURF PROGRAMS.

## Nutritional Soil Testing

Proper soil chemistry is an important part of the success of a turf program. Independent nutritional soil testing can determine elements that are deficient such as phosphorus, magnesium, and potassium. They can also determine excessive values and strategies for reducing fertilizer inputs (Figure 4).

A soil test will not accurately measure nitrogen. Nitrogen is a very important component to turf growth rate and resiliency. Understanding the demand and reviewing past maintenance records will determine if Nitrogen rates are adequate. Testing frequency can vary; a client once said "If you are surprised by your soil test results, you likely aren't testing enough".

The Total Exchange Capacity (T.E.C.) of the root zone is a measurement of the root zone's ability to hold nutrients. This information will be found on most nutritional soil test results. Soil based root zones typically have a much different T.E.C. than sand based root zones. This information can assist the turf manager in determining how the elements should be applied in order to get the most out of the fertilizer program.

## Compaction Testing

Excessive soil compaction, poor infiltration and oxygen exchange can limit the best turf programs. Athletic fields get used and they get used a lot! Research suggests that a root zone in excess of 300 psi taken from a penetrometer (compaction meter) will hinder root development. Aeration and cultural practices are extremely important in an athletic field program. Understand the root zone compaction at the surface and different interval depths. Subsurface compaction layers can go unrecognized without an evaluation with this type of equipment. The physical components of the root zone will be either resilient or prone to compaction. Over compaction from maintenance or use shortly after a rain event "squeezes" the soil particles together, destroys the soil structure and reduces the size and amount of pore space. As a result there is a loss in the balance of air and water creating a poor environment for root health. The result will be weak turf and the remedy will need to be deep tine aeration.

## Summary

"You can't manage what you don't measure", so collect the information and make the necessary changes to your cultural management. Fit the information for each field into one of the categories described in the *Athletic Field Construction Manual* and establish a file of the data for each field. From this information establish the tolerable "hours of use", the maintenance required and the potential problems of drainage and compaction. •

OTS HIGHLIGHT

Presented February, 2012
Guelph, Ontario.

Figure 1. A broadcast application of granules containing *Phoma macrostoma* on research demonstration plots in Saskatoon.

# *Phoma macrostoma*: An Update on the New Turfgrass Bioherbicide

K.L. Bailey, Agriculture & Agri-Food Canada, Saskatoon, SK
and S. Falk, The Scotts Company, Marysville, OH

For several years, the fungus *Phoma macrostoma* has undergone extensive evaluation by Agriculture & Agri-Food Canada and The Scotts Company to see if a bioherbicide could be developed to control broadleaved weeds in turfgrass. In 2009, the Summer issue of *Sports Turf Manager* reported on its discovery as a potential bioherbicide, and some of the research demonstrating its efficacy and crop safety.

Last June (2011), the Pest Management Regulatory Agency approved a conditional registration for *Phoma macrostoma* to be used domestically and commercially for control and/or suppression of weeds such as dandelion, scentless chamomile, English daisy, white clover, black medic, Canada thistle, chickweed, broadleaf plantain, and ragweed. The bioherbicide may be used safely on a variety of turf types such as Kentucky bluegrass, bent grass, perennial or annual ryegrasses, fescues, bromegrasses, timothy, and Bermuda grass.

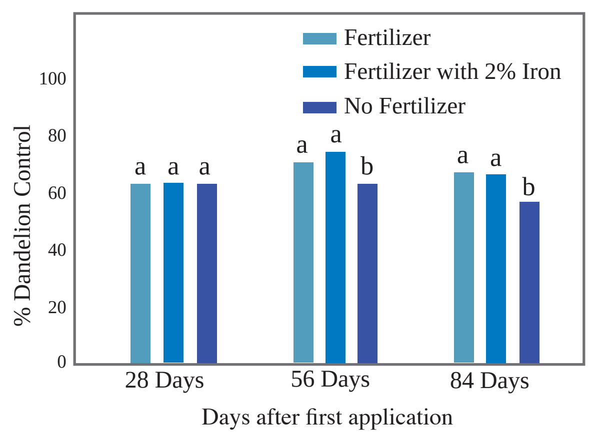
CONTINUING RESEARCH HAS EXPANDED OUR KNOWLEDGE OF HOW THE BIOHERBICIDE WILL PERFORM IN THE FIELD.

The fungus is formulated into granules which may be applied to either newly-seeded or well-established lawns from a ready-to-use applicator for spot treatments or by broadcasting the granules as either pre-emergent or post-emergent applications. The product may be applied anytime from spring through fall, but it works best when the mean day time air temperature is hovering above 20°C (15-30°C range) and the soil is relatively moist. The product does not need to be "watered-in" but some precipitation or irrigation (up to 1-3 inches) within 24-72 hours after application would be beneficial particularly if the soil is not friable or moist.

Continuing research has expanded our knowledge of how the bioherbicide will perform in the field. Studies have shown that extreme moisture events around application will reduce the level of weed control attained, especially on sandy soils. The bioherbicide may be applied at the same time as commercial granular fertilizers which may result in a 10-15% enhancement in weed control.

Currently, *Phoma macrostoma* is undergoing scale-up development to be able to efficiently produce commercial quantities, thus a commercial launch is still a few years away. •

**Figure 2.** Granules of *Phoma macrostoma* were applied at the 1X rate with or without commercial fertilizer granules at Marysville, Ohio. The use of fertilizers with the bioherbicide improved weed control later in the season. (Different lower case letter show significant difference among treatments using an LSD test at P= 0.05.)

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***Editor's Note: The referenced article in the Summer 2009 issue of Sports Turf Manager may be accessed online at www.sportsturfmanager.com/Publications/SportsTurfManager/Archive.***