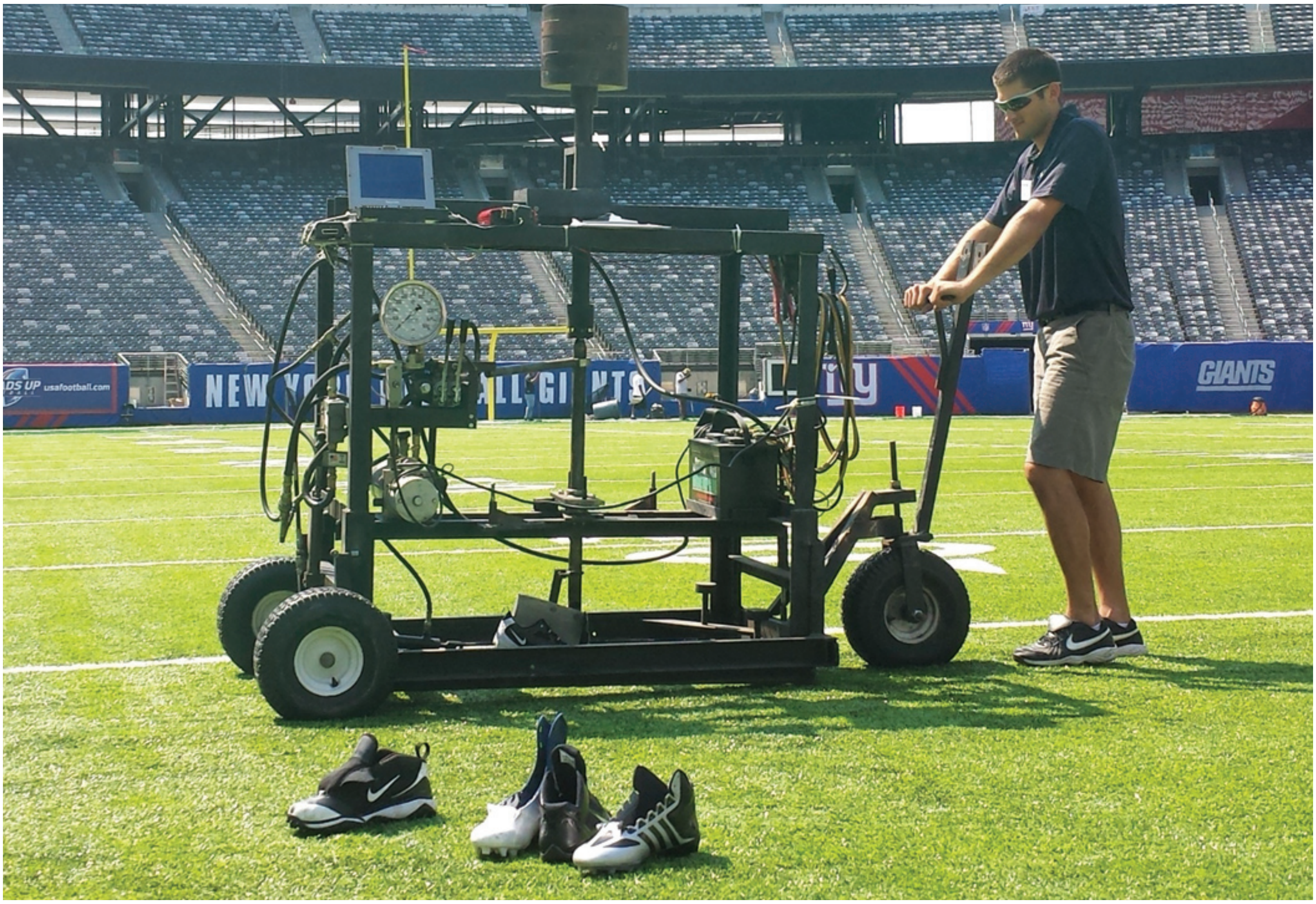

UPDATE ON FIELD SAFETY TESTING

▲ **Penn State's Pennfoot** machine measures both rotational and linear (translational) traction. Rotational traction is more related to injury risk while linear is more related to performance. For rotational traction, Pennfoot measures the amount of force required to rotate the shoe in the turf.

As another football season looms on the horizon, coaches are finalizing game plans they hope will bring them season-long success on the field. Sports turf managers are no different but instead of wins, success means providing playing field conditions that maximize both playability and safety.

The current heightened focus on athlete safety has increased the scrutiny of all potential contributors to athlete injury, including the playing surface. In fact, all NFL fields are now tested and certified before every game using a set of "recommended practices." These recommended practices include tests such as field hardness (Gmax), soil moisture, infill depth, and visual inspections, depending on the surface type.

Much of the increased concern for athlete safety is due to a heightened awareness of the issues surrounding concussions. Research indicates that most concussions are the result of violent athlete to athlete collisions. However, this same research indicates that approximately 10-15% of concussions in American football are caused by the head hitting the surface. Consequently, the hardness of the playing surface can affect injury risk.

By routinely monitoring field hardness levels, management practices can be implemented well before the surface exceeds hardness thresholds. For example, surface hardness of NFL fields is tested with the Clegg Impact Tester. The

» We have measured **Gmax values well over 250 Gmax** (Clegg) on dry, compacted fields. As a reminder, the **NFL threshold is 100 Gmax**.

Clegg quantifies surface hardness by measuring how quickly a vertically-dropped weight stops when it hits the surface. In the NFL, all fields, both natural and synthetic, must be below 100 Gmax in all locations when tested with the Clegg. If hardness levels begin to approach 100, steps are taken to lower these values. Practices that lower Gmax of a surface include topdressing crumb rubber onto synthetic turf fields or needle-tine aerification on natural turf fields.

The Clegg model used in the NFL is equipped with a 2.25 kg missile and is calibrated from 0 to 150 G. A standard Clegg is calibrated from 1 to 1000. The 0 to 150 G calibration of the NFL model has better accuracy over the range of Gmax values typical of natural and synthetic athletic fields. (The NFL Clegg model can be purchased from turf-tec.com for approximately $4,000.)

▲ **Many field managers** are now using a Clegg hammer to regularly measure Gmax on their own.

▲ **The Center for Sports Surface Research** recently measured rotational traction of 30 commercially available shoes on Kentucky bluegrass, bermudagrass, and FieldTurf Revolution. The difference among playing surfaces was minimal compared to the large differences found among shoes.

THE F355

Another device traditionally used to measure surface hardness of synthetic turf fields is the F355. Named after the American Society for Testing and Materials (ASTM) standard that describes its specifications, the F355 quantifies surface hardness using the same principle as the Clegg. However, the drop heights and mass of the weights differ between the devices and the generated Gmax values are not interchangeable. For instance, 100 G as measured with the Clegg is not the same as 100 G measured with the F355. While the NFL uses a limit of 100 G with the Clegg, according to ASTM, a field should not exceed 200 G when measured with the F355.

In the past, the F355 has been used to measure Gmax levels on synthetic turf while the Clegg has traditionally been used on natural turf. However, because both devices use the same principle to measure surface hardness, either can be used, regardless of surface type. A recent ASTM subcommittee round-robin testing event at Penn State confirmed the high correlation between the Clegg and the F355. The round-robin testing included seven testing agencies and 15 surfaces. The full report is available on our website, ssrc.psu.edu.

Regardless of the device used, routine field testing benefits all athletes who use the field and demonstrates a commitment to field safety. Arguments can be made for either device, however, if fields are not being tested, no advantage is gained. Many field managers are now using the much less expensive Clegg adopted by the NFL, which provides a more affordable option for sports complexes that wish to be proactive and regularly measure Gmax on their own.

No surface hardness discussion is complete without addressing the reasons why fields get harder over time. Field hardness on natural turf fields is largely determined by soil water content and compaction. Dry conditions produce a harder field than wet conditions. A dry field combined with a high level of soil compaction produces an even harder surface. Obviously, lack of turf cover can also contribute to higher Gmax values. We have measured Gmax values well over 250 Gmax (Clegg) on dry, compacted fields. As a reminder, the NFL threshold is 100 Gmax.

Not surprisingly, water management and core cultivation are key practices to reduce surface hardness levels. However, core cultivation during the season is not recommended. As a result, in-season techniques to reduce hardness are a bit more tricky. NFL field managers have been experimenting with in-season needle-tine aeration and deep-tine units set to penetrate only a few inches to slightly raise the surface. These techniques have been fairly successful for short-term reductions in surface hardness without sacrificing playability, but care should be taken. If in-season cultivation becomes too aggressive, the surface playability may suffer due to reduced footing.

SYNTHETIC TURF

On synthetic turf, contrary to popular belief, compaction is not a major cause of increased surface hardness. Infill particles are usually very uniform in size. This uniformity limits compaction potential and after an initial, post-installation settling-in period, compaction is minimal.

Instead, what we call "walk-off" crumb rubber is frequently the main contributor to elevated surface hardness levels. The crumb-rubber infill is what provides the cushioning. The small amounts of rubber particles being removed from the field in shoes, on equipment, etc. add up over time. As the crumb rubber layer thins, surface hardness increases. This is especially true in high-use areas. (See article on page XX of this issue for maintaining crumb rubber levels.)

Consequently, infill depth should be measured at numerous locations across the field regularly and compared to your turf manufacturer's recommended infill depth range. Infill should be added when levels drop below the recommended range. Often, the entire field will not require additional infill. For instance, if the field is used for lacrosse, perhaps only the goal mouths will require a few buckets of rubber. In these situations, rubber can be hand-applied and worked in with stiff-bristled push brooms. Large scale additions of rubber often require repeated light applications of crumb rubber using a topdresser followed by grooming with a drag broom.

Recently, head injuries have received a lot of attention; however, lower extremity injuries can often sideline athletes for longer periods of time. Sometimes the playing field is mentioned as a possible reason for a knee or ankle injury. Often times the type of surface is mentioned as a culprit if the surface is synthetic. If the field is natural turf, the condition of the surface is sometimes blamed.

Another, possibly more important factor, is being recognized as a significant contributor to lower extremity injury. That contributor is the shoe. Remember, the traction between a shoe and the surface is affected by both the shoe and the surface. The aggressive cleat patterns found on many of today's most popular athletic footwear are producing traction levels much higher than we have seen in the past.

A certain level of traction is needed to run, change direction, and perform other maneuvers necessary for sports. However, high levels of what is called "rotational traction" have been indicated in increased knee and ankle injuries. High rotational traction means that the shoe is resistant to rotating within the turf as a player pivots. In essence, the shoe sticks while the leg rotates. If the shoe sticks, ligaments and tendons are put under additional stress, which may lead to increased injury risk.

We recently measured rotational traction of 30 commercially available shoes on Kentucky bluegrass, bermudagrass, and FieldTurf Revolution. The difference among playing surfaces was minimal compared to the large differences found among shoes. Although there is not enough research to set safe and unsafe traction thresholds, our data suggest rotational traction, and therefore injury risk, varies greatly among cleat patterns.

Additionally, cleat pattern appears to play a much greater role than the playing surfaces tested. The database with rotational traction information for each shoe on each of the three surfaces can be found on ssrc.psu.edu. We plan to update this database each year with traction data from newly released cleat patterns. A related study that included multiple shoes on various surfaces has recently been published in the April 2014 edition of *Applied Turfgrass Science*, a peer-reviewed scientific journal. The study can be found on the journal's website, www.agronomy.org/publications/ats.

As we all know, injuries are an unfortunate part of sports. However, a proactive approach to field safety can help minimize injury risk. Routine surface hardness testing, adding crumb rubber when infill levels drop, educating trainers and parents about the importance of shoe selection are all things that we can do to provide the safest field possible. Because at the end of the day, the safety of the athletes using our fields is our number one goal. ■

Tom Serensits is manager of Penn State's Center for Sports Surface Research; Dr. Andy McNitt is professor of soil science – turfgrass, and director of the Sports Surface Research Center, as well as coordinator for Penn State's turfgrass science undergraduate program.

Advice on MAINTAINING THE INFILL on your synthetic field

We asked some turf managers and equipment manufacturers for advice on maintaining the infill on synthetic turf fields. Our panel includes: Darian Daily, Sports Field Manager, Cincinnati Bengals; Jon Dewitt, CSFM, Athletic Field Manager, Georgia Tech; Paul Hollis, Executive Vice President, Redexim North America; Tom Lober, Director of New Business Development, Noland Sports Turf; Abby McNeal, CSFM, Director of Turf Management, Wake Forest University; Jason Mueller, Grounds Manager, Kirkwood (MO) School District; Ronn Ponath, President/Owner, Kromer Company; Doug Vescio, CEO/President, Vescio's SportsFields; Will Wolverton, Manager, Wiedenmann North America; and John Wright, Director of Fields, Seattle Seahawks.

HOW OFTEN DO YOU RECOMMEND ADDING INFILL MATERIAL?

Daily: Only when needed. I would suggest getting an infill depth measuring device and monitoring the infill depth throughout the year. In my experience, your infill depth will drop after the first year of installation due to the field "settling in," which is normal. Once you get your infill depth back to the manufacturer's recommended

▼ **Verti-Brush at work**. Courtesy of Redexim North America.

depth (each company's recommendations are different), monitor the field and when your average infill depth gets below recommended threshold, call your manufacturer for their recommendation. If it is recommended to install more infill, have a professional infill installer apply the infill. One thing I have learned, you don't need to apply much rubber to bring your numbers back into spec. Installers have methods of getting the infill down into the system for a safe and playable field more quickly.

Hollis: The infill material provides a cushioning effect; the more infill, the more cushioning. Playing surface hardness levels, or Gmax ratings, are almost always associated with low infill levels. It is not that the infill material is compacting like the soil does on natural turf fields. Instead, the infill is actually being removed or displaced on fields over time, in a variety of ways. The result is less infill in the field and increased surface hardness. In order to prevent this, infill levels should be measured regularly and compared to the infill depth recommendations provided by the field manufacturer. When infill levels drop below the manufacturer's recommended range, additional rubber should be added.

Courtesy of Kromer Company

Mueller: Our field is about 4 years old, and we monitor it regularly with an infill depth gauge. We have not had noticed a decrease in our infill depth, and the depth is consistent throughout the field. This is probably due to our regular grooming schedule. Also, our turf is Astroturf 3Di, and has a thatch layer incorporated into the fibers that reduces the movement of the infill.

McNeal: As often as the field needs it per your observation and manufacturer's recommendation. Sports turf managers have to be diligent about monitoring the infill levels as the field is used; higher use fields may require more frequent additions of rubber infill mix. On our baseball field we add material in our higher traffic areas (batters boxes and base areas) almost every other day during our season. If we do not monitor these areas closely then we can have fiber wear sooner then anticipated.

Lober: The end user should have a system to chart the areas that tend to have infill movement due to high activity. For example the penalty kick line in soccer gets used heavily during practice where several kids will line up and go one after another. Corner kicks, goal mouth areas for soccer and lacrosse, and extra-point kicks for football are also critical areas. The growing application of turf for baseball fields makes sliding into second, third and home the areas that get infill movement more than any other application.

How do you check the infill depth? This is easy and can be done by using a depth meter that can be purchased for as much as $250 or there are other companies that make depth testers for rubber track surfaces that are around $20. These tools are reasonably accurate because testing a rubber track surface requires a fine tolerance.

The infill should be ~1/2"-3/4" below the tips of the blade so a 2-1/2" system should have a minimum of 1-3/4" of infill. Not sure what height system you have? Go along the edge of the field and pull a bundle of blades and measure them. Charting the areas that require regular maintenance is something that should be done often but adding large amounts of infill should generally not be necessary for the first 3-5 years. Spreading bags of rubber and brushing the field to distribute it should be done by professional turf installers but can be done by facility maintenance staff if they are up to handling the task of moving and spreading supersacks of rubber. For example each pound of rubber equals about 1/2" of infill per square foot. If an 80,000 square foot field is low by an average of 1/4" then it would take approximately 1/2 pound of rubber per square foot or 40,000 pounds, which is 20 supersacks. I generally don't recommend trying to put more then 6-10 sacks of rubber in at any one time unless the field is extremely low and requires more infill. A good practice would be to add 3-4 bags in years 4, 6 & 8.

Dewitt: Never have had to; on my old rug the fibers were completely worn away and existing crumb was right on the surface! My new rug doesn't get used a whole lot and it's indoors so I haven't had to add anything since it was installed in summer 2010.

Vescio: First and foremost the field should be filled to appropriate levels (according to specifications). The field should be checked in its entirety at least once per year. Typically a Gmax report will indicate the levels of infill. Through the Gmax report or at a minimum a yearly check will help establish the need for additional infill. More attention will be needed in small yet high traffic areas such as a soccer goal or football place kicking. These areas should be checked before use for tears, wear, and low infill.

Ponath: This depends upon several factors. With fields that have not had regular maintenance the infilling is usually done when the field shows a lack of infill and matted and entwined fibers and becomes less safe and playable. This is typically an after the fact approach and also has safety issues. Consequently more infill is needed immediately.

WHAT IS THE MOST EFFICIENT WAY TO RE-DISTRIBUTE OR EVEN OUT THE INFILL?

Wolverton: Grooming the field is the most common and practical way to re-distribute the infill. This should be performed frequently based on the recommendations of the manufacturer. Other methods help such as using a sweeper that brings some of the infill material into the sweeper, separates the infill from the debris, and evenly redistributes the infill back on to the playing surface.

Wright: Brush/tine groom multiple directions; add fill using top-dresser best suited for quantity to be distributed/time-frame available; integrate added fill into system using Lay-Mor type front mounted brush.

Daily: I have seen a regular topdresser used to distribute the rubber evenly. In most cases a GreensGroomer or Sweep-n-Fill type brooms are used to work the infill in. In extreme cases, I have seen a Lay-Mor power broom being used. I would not recommend the use of a Lay-Mor unless it is use by a professional installer. A Lay-Mor will destroy a field VERY quickly if not used correctly.

Ponath: Regular conditioning grooming and finish grooming, which is a two-step process using specific tools designed for synthetic fields will redistribute the infill, decompact the fibers, and remove metal objects in one pass. The finish grooming process helps in reducing the static electricity and helps the infill to position it to support the fibers so that they stand up properly. This improves the appearance and extends the life of the fibers. This also means that less infill will be needed.

Hollis: Brush the infill into the turf by lightly agitating the fibers back and forth using a simple stiff drag brush.

Vescio: The size of the area to refill will determine the method and the type of equipment. In large areas topdressing with a drop spreader

Synthetic turf infill tester from Redexim.

or broadcast spreader is the easiest and most commonly used equipment.

In small areas such as a soccer goal or football place kicking, softball and baseball wear areas such as plate and pitching areas, as well as the sliding areas, redistribution of infill can be done by hand or a small push spreader. Careful consideration should be taken in these areas to simply not dump infill but to apply evenly.

Prior to any re-infill I would recommend the following steps:

Cleaning and removing any debris. There is equipment that is available on the market for so called "deep cleaning" that allows removal of the existing debris to a depth of 1/4" or so. At the very least a tag along sweeper should be used to remove foreign particles.

After the "cleaning" and before adding additional infill brooming or sweeping the field with typical field groomer should be done to help the turf fibers stand up. In some cases a "power sweeper" may be necessary to aid in standing the fibers. This should be done by the synthetic turf provider or contractor.

In smaller high traffic areas such as soccer goal or football place kicking, softball and baseball wear areas such as plate and pitching areas, as well as the sliding areas standing up the fibers can be done with a medium to soft push broom or a hand held gas powered brush.

Make sure that the environmental conditions are good for installing the infill. Dry and non-windy days are best.

Mueller: We use a John Deere Gator to pull a Redexim Verti-Groom. Between gym classes, band practice, soccer or football practice and games, and nightly rentals our field can see up to 10 hours of play in one day. To reduce compaction and to keep the infill evenly distributed we groom as often as once per week during periods of heavy use.

Dewitt: Don't let it get too bad on you in the first place. If you have some really bad pockets from drills or kickers repeatedly using the same area use a power broom to heavily work those spots; otherwise a simple GreensGroomer drag behind brush has been sufficient for us. We drag about once per week and do a heavy cleaning/brooming annually.

McNeal: If it is a smaller area then we use a push broom to level out the infill or a metal tine leaf rake turned over. If it is a larger area we will use a drag over the area then the groomer and possibly the drag again. The drag is made from left over turf stapled around a wooden frame (for weight).

Lober: A push broom is the most common way but the rubber tends to fly up in the air and land back in the same spot so I recommend a two man process of push broom and blower which works very well for small areas. They can also use a small power broom. Other than that the proper use of the drag brush is the best way to make sure the field has a consistent level of infill.

WHAT STEPS SHOULD BE TAKEN TO PROLONG THE LIFE OF A FIELD, E.G., REDUCING FIBER WEAR, ETC.?

Daily: We constantly drag and groom our field to keep the fibers standing up. We monitor our infill depths to insure the proper amount of infill is in the system to help the fibers stay standing up. Lastly we have the Coaches constantly moving around just as we do for our natural grass fields. It's not much, put just enough to spread the wear out.

Hollis: Regularly scheduled maintenance consisting of: brushing or grooming the fibers, adding infill when needed, raking the existing infill that has settled to loosen the infill and prevent compaction, as well as, an annual deep cleaning should be considered when trying to extend the life of a synthetic playing field.

Mueller: We communicate with our athletic director to rotate use of the field for PE classes and practices. This is especially important for reoccurring drills, or where home plate is thrown down for PE softball. We try to match or grooming schedule to coincide with the amount of play. Our groomer has nylon brushes, and metal tines. We limit the use and the depth of the metal tines to reduce wear on the turf. We sweep our field with a Redexim Verti-Top 3 - 4 times per year. This is scheduled to coincide with periods of heavier debris; fall leaves, spring pollen, female sports (hair in turf). This debris could mix with the infill causing drainage and compaction issues.

McNeal: We groom it before each event. Monitor weekly and remove any debris (trash, leaves, etc.) off of the field. Yearly I have an outside contractor perform a deeper more through clean, Gmax testing, and independent evaluation. This allows me to see if we have missed something with our field checks. I try to communicate to our coaches the importance of moving drills and activities around to reduce "wear patterns" with some coaches I have success with others not so much. We monitor each field and adjust our program as needed, just like a natural grass field.

Lober: A very good way to prolong the life of the field is to properly decompact the field and groom it with a machine that has vacuum filtration capacity. This keeps the field from compacting and reduces the amount of dirt and debris that will settle to the bottom of the turf and reduce the drain rate. When the field does not drain properly water tends to puddle and then more dirt and debris will travel to the low spots and cause more compaction that compounds the issue. In the first 2 years of a field it is not necessary but after that a regular annual maintenance from an STC approved system should be the recommendation.

▲ **Francis Field**, Washington University in St. Louis. Courtesy of Byrne & Jones Sports.

I have been doing turf maintenance with the SMG Sportchamp for 6 years now and recommend that in years 3, 4 & 5 a standard groom should be performed, after that a deep clean groom should be performed once or twice a year from year 6 on. The benefits of this are that the field is cleaned and dirt is removed to allow for proper drainage and reduced compaction. This makes the field safer by reducing the Gmax rating and also helps remove debris from the infill which can then be a better product to reuse when the field is replaced around years 10-12.

The best way to reduce fiber wear is to keep the infill up to the proper height. Having a good understanding of the difference between slit-film and mono-filament is also important. Excessive brushing of slit-film can cause it to become wire fine and abrasive. Excessive brushing of mono-filament can cause blade release and reduce the tuft bind later in the life of the field.

Wright: Treat the surface as if it is natural turf by limiting vehicle traffic except when necessary; require vehicles to have turf-type tires; use protective flooring/plywood when non-turf friendly vehicle traffic is necessary; and prohibit food, drink and glassware on unprotected turf.

Use flooring protection system for non-sporting events and events with high volume/concentration of foot traffic. Always use an impervious layer of some sort (visqueen) beneath protection systems when hosting dirt shows, i.e. Supercross, Monster Jam, sod-overs.

Vescio: Education; it is critical that the client understands the limitations of the synthetic turf and the intent for which the turf was installed.

Provide the client with guidelines for usage (do's and the don'ts).

Rotation of areas; try to avoid practicing repetitive drills or usage in the same areas.

Wearing footwear that is recommended for the synthetic turf.

Inspecting infill levels monthly. Note: High traffic areas should be monitored weekly or after heavy usage and these areas should be replenished more frequently as needed depending on the use.)

While maintenance logs may not help prolong the life of the field, they may help the client if a wear or warranty issue should arise. Furthermore it will provide vital information for the synthetic turf manufacturer and contractor for what future clients can expect. Just like a vehicle warranty use and years don't always equate to longevity.

Site visits by the contractor to the client's site to help with evaluations and use as well as checking maintenance logs.

There is some specialty equipment in the market place available that will remove the existing infill material while producing very little disturbance and fibulation to the existing fibers. The existing infill can then be reintroduced, redistributed back evenly over the field along with additional infill needed to replenish the field. This may also help relieve compaction and lower Gmax levels.

Maintaining proper infill heights

Ponath: Maintaining the life of the field also means that less infill will be needed. If the tools and processes I've mentioned previously are used then the results are safer fields, playable fields and attractive fields. The final benefit is that these best practices also prolong the life of the synthetic turf which provides for a better return on investment. The frequency of this process is determined by the hours of usage on the field. The type of field whether for a specific sport or a professional, amateur, or general purpose will require different frequencies and intensities. Other factors such as sun and shade, weather, indoor and outdoor must be also considered.

Wolverton: Routine maintenance which consists of grooming and sweeping. It is important to redistribute the infill and stand your fibers vertically to reduce the breakage of fibers when they are lying down. Another important practice is to maintain proper drainage by cleaning your field periodically to remove dirt and debris. ■

Countera-*SALT*: successfully managing salinity

We have discussed in past issues of *SportsTurf* understanding salinity measurements and causes of salinity. This final article recaps what salinity and specifically sodium (Na) does to plants and soils, and discusses how to beat back the a-SALT with general management.

Low levels of salts, including Na, are not dangerous to most turfgrasses. If salt levels accumulate in the rootzone to high enough concentrations, it is difficult for turfgrasses to uptake water. This is because solutes (salts dissolved in water) *like* water, and want to hold on to it. Think of the result as a tug-of-war game, where water is the rope: on one end are the turfgrass roots, on the other end are solutes. The more solutes present, the more muscle at the salt end of the water rope. Furthermore, like many organisms, turfgrasses try to achieve a balance between the salt levels inside and outside their cells. Thus, a turfgrass grown in salt affected soil or irrigated with saline water must exert more energy to extract water from the soil. This results in a type of water/drought stress. Turfgrasses spend more energy trying to simply survive, instead of using the water for routine metabolic processes.

Certain solutes [especially sodium (Na), chloride (Cl), bicarbonates (HCO_3) and boron (B)] that are passively taken up with water can concentrate within the turfgrass and result in ion toxicity. Ion toxicities are most evident in roots and leaves since they are the main points of entry for water to enter the plant. Certain turfgrasses are more tolerant than others. For example, in general, warm-season grasses such as bermudagrass and seashore paspalum are more tolerant than cool-season grasses like bentgrass. How? Many warm-season grasses have salt glands that secrete salts from leaves (pretty cool, right?).

When Na is the specific salt in either water or soil, plant uptake of Na increases and Na can begin to block uptake of and displace calcium (Ca), magnesium (Mg), ammonium (NH_4^+) and potassium (K) within plant cells. When salinity (definition in next section) levels in water are very low, supplemental Ca, Mg, and K may be needed for plant nutrition.

SALTS AND SOILS STRUCTURE

Salinity is when acid-base pairs form from K, Ca, Mg, sulfate (SO_4), HCO_3, Cl and Na. Fine soil particles (silt and clay) and organic matter flocculate (bind together) into aggregates in the presence of Ca and Mg ions from these pairs. Calcium and Mg dominated salinity improves soil porosity, increases soil stability, and creates an optimum environment for root penetration and growth. This trend holds true with high salinity too. Thus, simply because salinity is high does mean a negative change in soil structure.

However, if Na is the dominant ion contributing to the water salinity, it will displace Ca and Mg in soils (those primarily clay based, or with organic matter). Due to its single charge, Na does not "bridge" soil particles together. In fact, it has the quite opposite effect. The large ionic swarm and its appetite for water result in dispersion or spreading of soils. This results in individual soil particles plugging pore spaces and a reduction in total soil porosity. Sodium affected soils compact easily when dry too. The end result? Poor water infiltration, air movement and root penetration. The reason only fine textured soils and soils with considerable organic matter are affected is because they have many negative binding sites (AKA cation exchange capacity) with which salts can react. For this reason, the structure of sand based rootzones with low cation exchange capacity will minimally be affected by Na.

If irrigating with a water source with very low salinity (pure water), ions that are present on the cation exchange site will leave the soil colloid and dissolve into soil solution. When this happens, there are fewer bridges keeping soil colloids aggregated. The end result of pure water application to soils is dispersion of aggregates and loss of pore spaces, very similar to changes in soil structure resulting from high concentration of Na. Soils compact easily and the loss of pore space results in poor water infiltration, air movement, and root penetration. In this scenario too, soil texture and the amount of organic matter present are important factors determining the extent of damage that can occur. The finer the texture and more organic matter present (thus greater CEC), the greater potential for dispersion. Coarse sands with low CECs are less affected.

MANAGEMENT OPTIONS

Both proactive and reactive management strategies can help you navigate any salt tempest. Monitoring both the salinity of your water source (EC) and the total dissolved salts (Ca, Mg, Cl, Na) within your soil are necessary to determine how to effectively manage a salinity issue, or prevent one from starting. If after you begin monitoring your water and soil, you determine that soil EC levels remain too high, whether due to water source, storm event, or excessive fertilization, there are a few steps you can take to manage the problem and reduce the risk of turfgrass damage. It is important to keep in mind that native soils will many times be different in texture and CEC than constructed rootzones, so make sure to sample all areas separately.

Grow salt tolerant grasses. If the irrigation water supply is salty and investing in alternative treatment/dilution methods is not viable, consider growing only salt tolerant species.

Apply a leaching requirement or reclamation requirement. In a nutshell, increase your irrigation volume to make sure that water (and salts with it) is always draining past the rootzone. A leaching requirement is used when there is not a problem, but you are concerned that you may start to have one (due to changing water quality, drought, etc.). A reclamation requirement is used when there is already a build up of salt within the soil. There are many ways to calculate these requirements, contact the authors if you need to determine one.

Monitor soluble salt levels in the soil. By monitoring soluble salt levels consistently you can adjust irrigation volumes to help compensate for higher salt levels, or decrease irrigation rates when salts have been flushed from the soil. Monitoring soluble salt levels also will determine if there is Na problem. Increasing Ca and Mg in soils or saline water can reduce Na-induced particle dispersion, and some of the more noticeable detrimental plant effects. (See

May 2012 issue about how to monitor; you can find article, “Is your turf under A-salt?” at www.sportsturfonline.com.)

Adjust fertilizer source and/or reduce fertilization rates. If irrigation water contains excess soluble salts, send a water sample to a soil-testing lab for an irrigation water analysis. This analysis will help to determine the ions that are readily available from the water source. Using this data, the nutrients supplied by the fertilizer can be reduced to account for those readily available from irrigation water. If adjusting fertilizer nutrient levels is not an option, simply lower the rate at which the turfgrass is fertilized (if possible) to reduce excess salt presence in substrate/soil. Especially for soluble fertilizers, since they directly contribute to higher salt levels, applying a lower rate with more frequency may also assist in ensuring that the soil is not overloaded with salt at any given time.

Apply an amendment. This is done ONLY when either (a) the water source is pure, or (b) Na has been identified as the main salt constituent. The most common amendment used is gypsum. It can be applied in a granular form or injected in line into the irrigation water. Gypsum replaces Na with Ca. Other Ca sources work as well. If adequate Ca is available in the soil, applying acid to reduce the soil pH and release the Ca may be effective. Look for a future article focusing on amendments. Contact the authors if you need assistance on determining options.

Blend “salty” with clean water. Whatever the source of high EC in water, if there is another source (whether municipal, pond, well, etc.) that can be used to dilute the “salty” water, use it to decrease the salt levels and reduce plant stress attributed to high substrate EC. For most turfgrasses, the target is to reduce to ≤ 2 dS m-1. Contact the authors for additional help.

Change to a different water source entirely. If EC readings of current water are so high that it is not feasible to continue using a particular source, find an alternative source.

Install a reverse osmosis system. If no alternative or mixing source of water is available and growing turfgrasses at this particular location is critical, a reverse osmosis system may be the most viable method for producing quality water that can be used for irrigation purposes. These systems have improved greatly in the last few years; however, they tend to be expensive and the wastewater, a salt-rich brine, must be disposed of. With most reverse osmosis systems, once the water has been cleansed (desalinated), Ca and Mg are added back and or the water is blended with rain fed/storm water so the water is not too pure.

The salinity reduction strategies above can help reduce and/or alleviate salt stress, but keep in mind that each strategy is only as effective as the monitoring data from which you make your management decisions. ■

Dara M. Park, Ph.D. is an assistant professor, turfgrass, soil & water quality at Clemson University. Dr. White is the nursery extension specialist at Clemson.