

# Right rootzone recipe maximizes performance

By Jason Henderson, Ph.D.



Photos courtesy of Michigan State Athletic Department.

**A**thletic field rootzones pose a very interesting challenge. They must provide an environment suitable for sustaining turfgrass growth and maintain a consistent, stable playing surface despite the rigors of athletic competition. This is not an easy proposition considering the intensity of traffic and that many athletic fields endure annually.

There are two primary rootzone construction types: native soil-based and sand-based. The ultimate success of any athletic field, regardless of construction type will depend on the quality of specifications for construction, skill of the athletic field manager, maintenance budget, and a cooperative coaching staff. However, many major problems can be eliminated before construction, starting with quality specifications that include a comprehensive grow-in plan, and selecting the right rootzone constituents.

## Native soil-based rootzone

Unfortunately, a preconceived notion exists that native soil fields perform poorly. This is simply not true. If the field is designed, constructed and managed properly it can perform very well. Some of the highest quality cool-season athletic fields in the country are constructed using native soil, but they were constructed correctly, aggressively managed, and the maintenance staff has convinced the coaches to constantly change traffic patterns.

The primary concern with native soils is their susceptibility to compaction. Native soils depend heavily on soil structure to develop the necessary amount of relatively large soils pores (macropores) to enable rapid



drainage and soil aeration. Soil structure can be quickly destroyed by manipulating the soil during construction.

Loamy sands, sandy loams, and loams are preferred soil textures for athletic field construction. These are considered coarse to medium textured soils, but they are still very prone to compaction. Tremendous care must be exercised when manipulating the soil to minimize compaction of both the topsoil and subsoil. A good way to minimize compaction is to use the smallest equipment necessary to get the job done.

Specify that low ground pressure rated track equipment or equipment with floatation tires is used for moving soil. Compaction levels of the topsoil and subsoil should be monitored throughout the construction process by submitting samples to a laboratory that is accredited through the American Association for Laboratory Accreditation (A2LA) for proper analysis.

A Proctor compaction test should be completed before construction to determine the optimum water content of the soil. The optimum

**IT IS HIGHLY RECOMMENDED THAT YOU USE AN A2LA ACCREDITED LABORATORY TO HAVE ALL COMPONENTS OF THE MIX EVALUATED AND TO DETERMINE THE OPTIMAL MIX RATIO.**

water content is the water content at which maximum bulk density is achieved given a particular compactive effort. This information can be used to specify limited soil disturbance while the water content is equal to or greater than optimal water content to prevent excessive compaction. This information can also be used to specify a reasonable permeability at 80-90% maximum proctor density to ensure suitable soil physical properties. These soils should also contain a considerable amount of organic matter (4-8% by weight) (Hummel pers. communication, McCoy 1998).

Native soils tend to be very hard when dry and very soft when wet. The organic matter helps to moderate soil moisture levels and reduce soil bulk density values.

It is extremely important that native soil fields are designed to have the ability to remove excess water from the playing surface. There are

two ways to remove excess water from the playing surface; surface drainage and rootzone permeability. Since the native soils will have a low root zone permeability it is critical that these fields are pitched to greater than or equal to 1.5%. The distance to a collection drain should be kept as short as possible to keep water accumulation to a minimum.

Subsurface drainage systems (i.e., 4-inch drain lines with gravel blanket) should not be installed into a native soil field without some type of drastic rootzone modification, unless the water table is high and will affect soil properties. Otherwise, subsurface drainage systems are ineffective for removing excess surface water from native soil fields.

By-Pass drainage systems such as a sand slit or XGD system installed at the proper spacing can be very effective as long as the drain trenches are backfilled to the soil surface with a material that has a higher permeability than the native soil that was removed.

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Undesirable soil textures can be modified using a coarse uniform sand and a coarse textured compost with a high organic matter content to achieve better physical properties. However, it is highly recommended that you work with an A2LA accredited laboratory to have all components of the mix evaluated and to determine the optimal mix ratio. When using a sand to amend a soil, using more sand is not always better and if you are not extremely careful you may produce a mix that is more suitable for a parking lot than an athletic field.

## Sand-based rootzone

Many newly constructed athletic fields today are built with a high sand content root zone. Why would we choose to grow a fairly needy plant in terms of nutrients and water, on a rootzone material that has a limited ability to retain nutrients and hold plant available water?

Sand, the largest of the three primary soil particles, is single-grained and maintains macroporosity once compacted (Bingaman and Kohnke, 1970). This permits rapid removal of excess water and allows sufficient gas exchange with the atmosphere. Despite the high permeability of sand root zones, sand-based fields should be pitched 0.5-1.0% to facilitate surface drainage.

The use of sand for rootzone construction started with the first United

water contents (5,9,13% by weight). The eight sand-soil mixtures were subjected to four different analyses: Standard Proctor Compaction Test (ASTM D698-00), California Bearing Ratio (ASTM D1883-94), saturated hydraulic conductivity, and pore size distribution.

The results of this research showed that it required 10% silt and clay combined to substantially increase the bearing capacity (soil strength) of the rootzone while still retaining adequate permeability (7.5 in./hr). The other important point to note is the effect water content at compaction had on the permeability of the rootzone. The higher the silt plus clay content of each mix, the greater the negative effect water content at compaction had on rootzone permeability. This indicates that if a rootzone contains an appreciable amount of silt plus clay (>5%) the rootzone should be compacted at (<5%) gravimetric water content.

These results pertain to mixes created using this sand and soil only. Optimal mix ratios for other sand and soil sources should always be determined by laboratory performance testing using an A2LA accredited laboratory.

Results from this research contributed to selecting the rootzone constituents for the playing surface conversion of Spartan Stadium in 2002, the main venue for football games on the campus of Michigan State

## THE HIGHER THE SILT PLUS CLAY CONTENT OF EACH MIX, THE GREATER THE NEGATIVE EFFECT WATER CONTENT AT COMPACTION HAD ON ROOTZONE PERMEABILITY.

States Golf Association (USGA) specifications for putting green construction published in 1960. By the mid-1960's the knowledge gained on behalf of the golf course industry began to transfer to athletic fields when Dr. Roy Goss began recommending high sand content rootzones for athletic fields (Goss, 1967). Since then, the USGA recommendations have been used as a guideline to construct many athletic fields. The USGA recommendations have been revised several times with the latest revision in 2004 to optimize putting green construction not athletic field construction and performance. The activities performed on a putting green obviously differ greatly from those on an athletic field and many athletic fields had very unstable playing surfaces.

In an effort to increase the stability of athletic fields, a laboratory study was initiated at Michigan State University in 1998 to determine the percentage of silt and clay that could be added to a sand to maximize stability while retaining adequate root zone permeability (Henderson et al. 2005). Previous work concluded that small additions of silt and clay to a sand quickly reduced permeability (Adams and Jones, 1979; Baker, 1985).

However, the amount of fine textured particles that must be added to sand to get a substantial increase in stability had not been determined. A well-graded sand was mixed with a sandy loam textured soil to produce eight different mixtures. Each mix was compacted at three

University. Thanks to Amy Fouty, CSFM, and her crew, Spartan Stadium received the STMA Field of the Year honors for the College and University Category in 2005.

For many years selecting the best components for an athletic field rootzone was complicated by the fact that there were no well-accepted specifications for particle size distribution or performance criteria for athletic field root zones. In January 2004, the American Society for Testing and Materials published ASTM F2396-04 *Standard Guide for Construction for High Performance Sand-Based Root Zones for Sports Fields*. This standard provides specifications for particle size distribution and performance criteria unique to athletic fields. The performance criteria include physical, chemical, and mechanical properties. This publication is a tremendous step toward building playing surfaces that are safer, more consistent, and more resilient.

The key to a high quality athletic field, regardless of construction type, starts with quality specifications, complete testing of materials before construction and a quality control testing program throughout the construction process. A complete list of A2LA accredited laboratories and proper sampling methods is at [www.usga.org](http://www.usga.org).

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