PennState
College of Agricultural Sciences

How to Measure and Manage Surface Hardness on Natural Turf Athletic Fields

Penn State's Center for Sports Surface Research

Managing surface hardness on natural turf athletic fields requires both routine testing and proper field maintenance. Approximately 15% of concussions in football and soccer result from the head impacting the playing surface[1]. Head injury risk can be reduced by ensuring playing surfaces meet industry-established Gmax thresholds and receive routine maintenance. Surface hardness on natural turf fields is best managed in the off-season; however, in-season maintenance practices can also provide temporary Gmax reductions without sacrificing playability when properly performed.

Measuring Surface Hardness

- Surface hardness is measured by determining the 'Gmax' of the playing surface. Gmax is a numerical value representing the hardness of the surface, with higher values indicating a harder surface.

- The Clegg Impact Soil Tester is the device most commonly used to measure Gmax on natural turf fields. This instrument can be purchased and used by field owners or testing can be contracted to a field testing agency.

- The NFL requires the Clegg Impact Soil Tester be used to measure Gmax prior to every game. All areas within the field of play must be below 100 Gmax. If any area of the field is above 100, steps must be taken to reduce surface hardness and the field must be re-tested.

- Gmax should be tested at various locations across the field, with special attention being paid high-use locations, such as mid-field areas and goalmouths. At a minimum, testing should occur yearly. However, Gmax of natural turf fields can vary greatly over a relatively short period of time. Changes in soil water content and the amount of field usage (and resulting soil compaction), each have significant influence on Gmax. Frequent Gmax testing allows hardness levels to be tracked over time, which helps identify areas of concern before the 100 Gmax threshold is reached.

Managing Surface Hardness

- *Off-season* – Hollow-tine core cultivation (aerification) reduces soil compaction – a significant contributor to high Gmax. Large diameter hollow tines (up to 3/4") at close spacing (1 to 2") have the greatest effect. Field managers typically combine core cultivation, fertilization, and seeding. It is critical to allow for enough recovery time following this practice before the field used.

- *Off-season* - A quality compost can be spread across the field prior to core cultivation. This typically produces a further reduction in surface hardness. Spread compost to a 1/4" depth and core cultivate to mix the compost with the surface layer. Compost should be tested prior to use to determine its quality. Compost should not be added to engineered sand-based rootzones. For more information, see the 'Resources' section of our website: ssrc.psu.edu.

- *In-season* – Less aggressive aerification procedures using small diameter solid tines (such as needle-tines) can provide temporary Gmax reductions without reducing surface stability. However, care must be taken as aggressive procedures will de-stabilize the surface, creating potential safety and playability concerns.

- *In-season* – Dry soil conditions can produce high Gmax levels. Proper soil moisture should be maintained.

- *In-season/Off-season* – Re-sodding provides fresh turf and soil – and a softer surface. In-season re-sodding requires "thick-cut" sod (up to 1.75") for stability. Thinner sod can be used in the off-season given there is sufficient time for rooting prior to field use.

Additional information can be found on our website: ssrc.psu.edu.

[1]Meehan WP III, d'Hemecourt P, Comstock RD. 2010. High school concussions in the 2008-2009 academic year: mechanism, symptoms, and management. Am J Sports Med. Dec;38(12):2405-9.