BY **PHIL BROWN AND DR. BERT MCCARTY**

Understanding and minimizing soil compaction

Soil compaction is becoming an ever more prevalent problem within the turf world. With the surge of athletic events and practice on a limited number of fields, unhealthy turf and playing conditions are emerging. Facilities wishing to attract additional revenue are facing the situation where the more customers they attract, the greater the traffic on the turf and thus, the greater the amount of soil compaction.

Soil compaction is the pressing together of soil particles, resulting in a more dense soil mass with less pore space. When the soil particles push together, they occupy a smaller space, thus, are considered compact.

Compaction occurs in areas receiving the most traffic. Athletic training fields are a high compaction risk due to the near daily usage and the evolution of larger and stronger participants. Other areas at risk are recreational fields open to almost unlimited play and practice. It is not just foot traffic causing compaction, but also vehicular traffic. Daily mowing, periodic topdressing, and fertilizing require heavy machinery to perform, thus, additional sources of compaction.

A marching band's practice field—talk about compaction!

Soil compaction can occur at any time, however it is most acute when the soil is wet. This is from the water in the soil acting as a lubricant, more easily allowing the soil particles to slide past each other with less resistance than when they are dry. This is amplified when soil high in silt or clay is used during construction. These soils remain wet longer following rain and the smaller size of these soil particles allows them to press closer together.

Problems caused

Compaction can also cause a number of soil problems, including an increase in bulk density, an increase in soil strength or firmness, a reduced aeration porosity, and an altered pore size distribution when soils are highly pressed together.

Bulk density is a measure of mass or weight per unit area. In compacted situations, due to the increase in number of soil particles in the area, the mass will increase. This also contributes to the reduction in aeration porosity, as the closer soil particles are to one another, less pore space exists. Sufficient pore space allows air, water, and other nutrients to enter the soil, a reduction in this eventually leads to poor turf. Non-uniform pore size distribution also can contribute to this, causing soil particles to move closer to one another, reducing pore space.

These physical changes can have detrimental effects on turfgrass growth such as decreased root growth, decreased shoot growth, reduced carbohydrate reserves, and decline in overall quality. Destruction of the soil structure also may occur. The resulting soil often becomes "hard as a brick" when dry and a "mud hole" when wet. The turf eventually thins, potholes develop, and the resulting hard surfaces can cause player injury.

Prevention

Constructing fields with sands that do not compact is the first step in preventing soil compaction. This involves replacing the existing soil with a pre-approved sand-based rootzone mix that balances good water management and compaction prevention. Unfortunately sand-based athletic fields are more expensive to build.

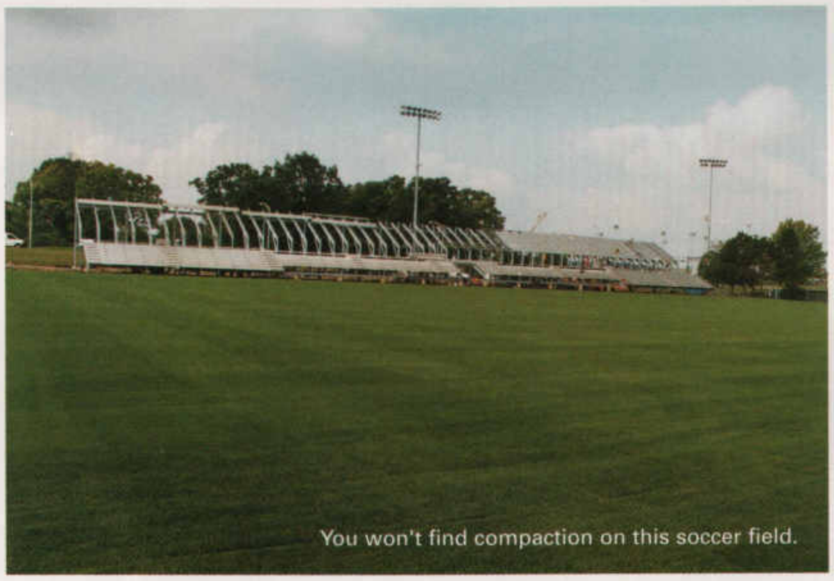
The most common way of reducing compaction of existing soil is through the use of soil cultivation techniques. Most of these techniques operate by physically altering the soil profile in some way, be it by removing parts of the soil or by altering the structure of the soil. A great deal of diversity exists among the cultivation techniques available.

The most popular method of reducing existing soil compaction is hollow tine aerification. Hollow tine aerifiers are hollow tubes 1/2 to 3/4-inch in diameter and 3 to 12-inches long, designed to pull plugs out of the soil, thus, reduce the amount of soil per unit area. They operate on the principle that if less soil is present then a lower mass per unit area (or bulk density) results. Note that hollow tine aerification can disrupt the surface considerably, the equipment can be expensive, and generally requires a medium sized tractor.

The disruption cause by hollow tines has increased the popularity of solid tine aerification. Solid tines are designed to enter the soil vertically and shatter (disrupt) the structure of the soil as they are retracted from it. Since solid tines do not pull out plugs of soil like hollow tines, they require very little clean up, saving on labor costs, and helping keep the playing surface smoother. However, there is a question over the effectiveness of solid tines since they do not remove any soil material and therefore might not be reducing the bulk density of the soil.

Adaptations to hollow and solid tine aerification include both deep tine aerification and spiking. Deep tine aerifiers are hollow and solid tine aerifiers able to penetrate to depths of up to 12 inches. Spiking is similar to solid tine aerification except the tines are thinner and shorter. Spiking is designed where the surface of the turf requires as little disturbance as possible.

The hydroject operates on a similar principle to solid tine aerification but instead of a tine, high-pressured jets of water are used. The water is pushed into the soil under pressures of 2000 psi enabling it to reach a depth of roughly 8 inches. The water not only aids in the relief of compaction but helps water penetrate to the lower parts of the soil profile, redistributes organic matter in the soil, and wet hydrophobic (excessively dry) soil.



You won't find compaction on this soccer field.

Another technique that operates in a similar way to the original solid and hollow tine aerifiers is "drill-n-fill." Drilling involves using a piece of machinery with drill bits attached to it. The bits are drilled into the ground, creating deep holes. As is the nature of a drill, some soil from the hole is brought up to the surface, lowering bulk density. This, however, is not in the same quantities as conventional hollow tine aerification. Some machines allow the hole to be filled with sand and tend to cause less surface disruption than conventional aerifiers. Unfortunately these machines are relatively slow when compared to other aerifiers but do not disrupt the surface as much as deep-tine aerification.

Other techniques use a horizontal motion. Slicing, for example, is using a rolling blade to cut slits into the soil. The slicer helps break up the soil surface, reducing surface compaction as it does so. Slicing also helps soil water and air exchange and slices algae and turfgrass runners. Slicing blades can be continuous or a series of teeth set on a rotating blade.

Similar to slicing is grooming. Grooming operates in a similar manner but the blades are attached to a walk-behind mower. The blades used in grooming are much smaller and thinner than those used in slicing as the technique is generally used in the prevention of mat and grain formation on turfgrass. The blades are powered to revolve against the direction of machine movement. Due to the shallow blades, grooming is unlikely to have a great deal of effect on deep compact areas but helps in alleviating or preventing compaction in the upper soil profile.

Supplements to the use of machinery include reducing or altering the traffic pattern on the turf, especially when the soil is excessively wet. On football and soccer fields concentrated practices should be performed or rotated on different parts of the field. Using only lightweight machinery and minimizing its use and practice when soils are saturated also help prevent soil compaction.

Soil compaction is a serious issue among the turfgrass community and one that has possible legal ramifications. It can cause the deterioration of turf quality and be a danger to participants. Take steps to relieve this problem or eventually undesirable turf and soil conditions will develop.

Phil Brown earned his Master's degree under Dr. McCarty at Clemson University and now is working on his Ph.D. in soil physics at Clemson. He can be reached at philipb@clemson.edu.