Root Zone Properties For Athletic Fields

by Dr. James R. Crum and Dr. John N. Rogers, III—Michigan State University

In athletic field design, construction and maintenance, there is an increasing focus on the agronomic issues that will dictate the playability and safety of the field. The important agronomic properties to be considered are surface and internal drainage, soil porosity, soil strength, soil water holding capacity, and soil cation exchange capacity. For successful design, construction and maintenance, it is necessary to understand how each contributes to the functioning of the athletic field.

Drainage

For lasting field quality in widely variable climatic conditions, the removal of excess and the addition of supplemental water used for plant growth must be addressed.

The soil, in most cases, is considered a three-phase system of solids, water and air. The solids are made up of organic and inorganic particles ranging from microscopic to quite large in size. In the arrangement of these solid particles, void spaces, or pores, of varying sizes surround them. When the soil pores are filled with water there is very little oxygen in the soil and plants begin to die because of the anaerobic conditions.

A thick root system is the result of a well-managed field.

Athletic fields are constructed with slopes away from the center portion of the field to provide surface drainage for excess surface water. Slopes for athletic fields should be between 0.5 to 1.0 percent to effectively move water while maintaining a relatively level playing surface.

If excess water does enter the soil, provisions need to be made to allow the water to flow quickly through and away from the field. The rate at which water flows through the soil is controlled by the sizes of the pores through which it flows. Just as one large pipe can handle more water than many small pipes, large soil pores allow much faster drainage than do many small pores. Therefore, providing and maintaining large pores in the soil is extremely important. High sand content soils contain, and are the best at maintaining, large pores.

Soil strength

In general, if the native soil at the facility will not maintain adequate macropores for rapid air and water movement within the root zone, the soil needs to be amended or replaced. High sand content materials now are generally selected for use as an amendment or as a root zone because of their ability to maintain the large pores for water and air movement. Because these sandy materials have less cohesion, they can be somewhat unstable if care is not taken in the selection of the material. In most cases, amendment materials have been added to provide the necessary soil strength. Our work suggests that high sand content root zones can be manufactured to have adequate soil strength with precise selection of the content material for the desired particle-size distribution and, when it can be controlled, particle shape. In general, the wider the distribution of different sizes, and the more angular the sand particles, the greater will be the strength. However, too wide a distribution can disrupt water flow.

Soil water holding capacity

High sand content root zones offer the advantage of drainage, but this will normally mean a limit to the water held in the soil that the turfgrass plants can utilize. Layering larger-sized particles below smaller-sized particles increases the storage of plant-available water in the upper layer of soil. This principle, used in USGA specification golf putting greens, also can be used in athletic fields. But, care must be practiced to insure the desired effect.

Amendments also can be added to the sandy material to increase their water holding capacity by increasing the amount of smaller-sized pores that store the plant available water. As long as the amount of larger-sized macropores remains high enough to provide the desired air and water movement, the amendments are beneficial. Problems can occur when the amount of macropores decrease with time, causing a decrease in drainage rate.

Primary athletic field construction types

Both native and layered root zone system athletic fields have advantages and disadvantages. Each type has worked brilliantly or failed miserably depending on their adherence to the soil criteria listed above.

Native

Native soil fields, for the most part, retain the soil native to that location. The obvious advantage of native soil is lower construction cost. Disadvantages include the possibility of poor soil, variability and the degree of native slope.

Turfgrass roots respond to nutrients, water, oxygen and temperature. Native soils high in silt and clay have smaller pores than sandy soils, thus they do not drain as well. In general, they will have shallower roots than sand-based soils because the oxygen level is relatively low deeper in the soil profile.

In some situations, native soils can be improved to meet the objectives of the athletic field by adding amendments. Common natural amendments used to improve athletic fields are sand, soil, peat or porous inorganic minerals. Sand and porous inorganic minerals are added to increase the amount of macroporosity within the soil and increase the rate of drainage.

To develop relatively high quality native soil fields, core aeration and a sand topdressing program may be used to create consistency across the field and to achieve improvement in the internal drainage and the water and oxygen balance.

Layered

While USGA root zone metods and specifications are used in athletic field design and construction, care in selection of root zone materials is needed to address the greater strength necessary for athletic fields. Also, the growth habits of the grasses used for putting greens and athletic fields are different and therefore will not react the same in similar sand-based systems.

USGA specification greens are layered with larger-sized pores below smaller-sized pores. While this increases the amount of plant available water storage in the upper part of the soil it may, in some

cases, cause problems by not allowing rapid enough drainage, or maintaining higher water contents than desired at certain times of the year. For this reason, some putting greens are constructed without the layer of larger-sized pores below the root zone.

Examination of the root zone after drainage ceases in layered systems shows that water content increases with depth. Building on this principle, we've constructed a sloping putting green with decreased thickness of the root zone material above the pea stone at the highest points of the slope and increased thickness of the root zone material at the lowest points of the slope. This variation in depth produces a root zone with higher water contents nearer the soil surface highest level and decreases the water contents near the surface at the lowest level. Theoretically, on a sloping athletic field with the layered system, the same principle might be employed, utilizing a thinner root zone at the center of the field and a thicker (and dryer) root zone on the edges.

In sand profile fields, soil, peat and porous minerals are added to increase the strength and/or water holding capacity of the system. It is very important to have the soil and amendments tested by a reputable laboratory to determine the exact amount to be added to the soil for the desired effect.

Dr. James R. Crum and Dr. John N. (Trey) Rogers, III are members of the Crop and Soil Sciences Department at Michigan State University. .Both were instrumental in the indoor turfgrass research project for World Cup , 1994.