

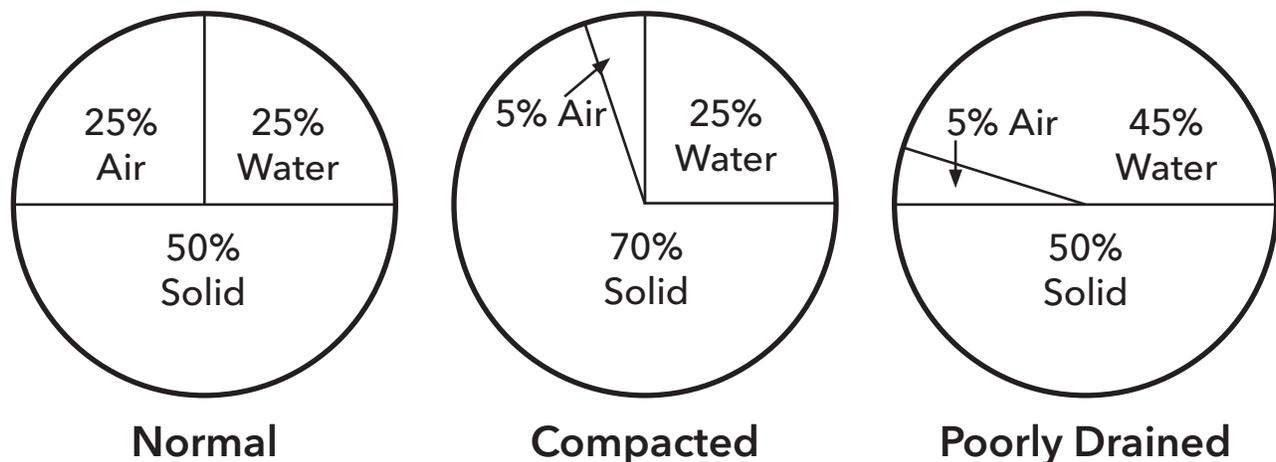
SOIL OXYGEN...THE FORGOTTEN NUTRIENT

By Dr. Charles H. Darrah, Consulting Turfgrass Agronomist

We all know that to grow healthy, vigorous sports turf we need to apply fertilizers. Fertilizers most often contain nitrogen, phosphorus and potassium. Sometimes it is necessary to apply secondary and micro-nutrients like calcium, magnesium, iron, manganese, zinc and others. These elements are often called the fertilizer nutrients. Levels of these nutrients can be determined by laboratory soil testing and nutrient amendments made as indicated by the test results.

However, what is often forgotten are the three most important elements for plant growth CARBON, HYDROGEN and OXYGEN. Carbon and oxygen are taken up by the leaves for photosynthesis in the form of carbon dioxide (CO_2). Plants take up hydrogen and oxygen as water (H_2O). What is rarely understood is that plant roots also need oxygen (O_2) for growth and nutrient uptake. Roots take up oxygen and give off carbon dioxide just as animals do when breathing. So, where does oxygen come from? It comes from the soil air, which originates from the air above it. Soils must be able to "breathe" in and hold enough oxygen in the soil air for roots to grow and function properly. The figure below shows what is commonly the case for soil air in sports turf soils:

Soil Volumetric Proportions



The first figure (NORMAL) shows the make-up of a volume of soil that is "ideal" for plant growth. Soil solids (minerals and organic matter) occupy about 50% of the normal soil volume. The remaining 50% of the volume of a normal soil is open pore space. Ideally, about half of the pore space is filled with air and the other half with water. This pore space provides the ideal amounts of oxygen and water for healthy turf growth.

The second figure (COMPACTED) shows a very common situation in sports turf. Compaction causes these soils to have fewer and smaller pore spaces. These pores do not allow air and water to easily move into and out of the soil. Compaction from play is the main cause of soil compaction in sports turf. Over-use, use of wet fields and heavy maintenance equipment are also contributing factors. Some new fields are over compacted from the start by poor construction techniques. Clayey soils and wet soils compact more easily than sandy or drier soils. One event on a clayey, wet soil may effectively seal the soil surface, especially in areas of high play.

The third figure (POORLY DRAINED) shows another very common problem in sports turf soils. Poorly drained soils can result from excessive rainfall or irrigation or they can simply be in low-lying areas of the field. Clayey soils usually have poorer drainage than sandy soils, although it is not uncommon to find sandy soils that drain poorly. Field areas that collect rainfall or are over irrigated will typically be poorly drained. Compacted soils tend to drain poorly. And, since moist soils are more prone to compaction than drier soils, poor drainage can lead to increased compaction.

It is important to recognize that both of these common soil problems cause LOW SOIL AIR. Turf roots will not grow into soils that lack air. Turf roots in a compacted soil will be near the surface where there is still some soil air. It is not uncommon for sod laid on top of a highly compacted soil to have very few roots growing into the soil below. Turf may not grow at all in highly compacted soils such as in goal mouths. Shallow rooted weedy plants usually take over in these areas or they simply remain bare.

Often, turf will not respond to fertilizer applications, especially nitrogen, when there is a lack of soil air. This is because there are fewer roots to absorb the nutrients. Lack of oxygen also prevents roots from making the energy needed for nutrient uptake. In addition, soil microorganisms need oxygen to recycle some of the important soil nutrients needed by the plants.

Corrective steps are often difficult. In highly compacted situations, frequent, deep aeration is the only corrective method, short of complete soil tillage. If the compacted layer is near the surface then effective aeration can be achieved using different types of aeration equipment. In some situations, soil modification with sand or organic matter prior to turf establishment can reduce the potential for soil compaction.

Improving soil drainage can also be difficult. Installing sub-surface drainage may not be very effective, especially in poorly drained clayey soils. In some situations, soils with improved internal drainage characteristics may be needed. On the other hand, improving drainage problems might be as easy as reestablishing the crown or adjusting irrigation rate and/or frequency.

It is important to remember that deep, vigorous root systems are the key to healthy turf. The nutrient most likely limiting in sports turfs for a deep, vigorous root system is OXYGEN contained in the soil air. Probing the soil and observing for difficulty of penetration or excessive soil wetness provides the best indication that soil oxygen is the missing nutrient.