Best Management Practices:

Avoid Soil Compaction

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Why shouldn't we work the soil when it's wet? Why shouldn't the marching band and the drill team practice on athletic fields, even when they're dry? Why should we avoid tight turns and spinning wheels with our turf maintenance equipment? Because we want to avoid soil compaction, a natural process that – taken to the extreme - eventually results in the formation of sedimentary rock. Soil doesn't have to be as hard as rock to be too compacted for the healthy growth of turfgrasses.

Wet soils are easily compacted because the excess moisture they contain minimizes the friction between particles and allows them to shift into close-packing arrangement. Like working wet soils, frequent pedestrian traffic and heavy machinery also destroy soil structure, a term that refers to the arrangement of clusters or aggregates of soil particles. Aggregates can be shaped like blocks, plates laminated together, clods, prisms, or crumbs. Aggregates of soil particles form over a period of years, or more slowly if organic matter is deficient. The action of soil microorganisms on organic matter releases gels or gums that hold the particles together. Excessive force can overcome the organic matter bonds that hold particles into desirable soil structure (aggregates). For example, pick-up trucks with standard tires concentrate their weight on relatively small surface area, and therefore exert larges forces (high psi) on the soil surface.

When soil particles are squeezed together due to shear force (such as from spinning wheels) or static weight on the soil surface, some of the air space between the particles is eliminated and reduced in size. Ideally, air space in soil should be about 25% of the total volume. For example, imagine a volume of soil one foot wide, one foot long, and one foot deep. One quarter of that volume (equivalent to 6"x 6"x 6") should be air. As the amount of air is reduced because soil particles are packed tightly together, the soil environment becomes unfavorable for root growth, and eventually for the entire turfgrass plant.

The soil can become so compressed that grass roots can't penetrate the surrounding soil, affecting their rate of growth, length, orientation, and branch patterns. Besides the physical aspects of a compacted soil, the lack of air space often means that air diffusion is limited and roots are suffocated. This inhibition of air diffusion is exacerbated by poor drainage in compacted soil.

Compaction significantly reduces the speed with which water passes through the soil, in part because of the reduction in total pore-space, but in particular because of reduced pore size between the tightly packed particles. In the smaller pores, water molecules are attached to nearby soil particles through capillary action, effectively reducing the gravitational pull on the water molecule. That is why compacted soil is usually poorly drained.

The plants' normal life processes that allow water and nutrient uptake cannot occur in root tissue when the surrounding soil is excessively wet. Instead, other life processes predominate, specifically, those

that can occur in an environment containing little or no oxygen. Organic acids and alcohols build up in the soil, often giving it a characteristic fermented odor. Symptoms observed in plants growing under conditions of soil compaction include: *yellowing, stunting, poor vigor, swollen short roots with few root hairs, susceptibility to disease.*

Qualitative assessments of compaction involve the measurement of bulk density, which is the mass of dry soil in a known volume (as it occurs in place). The equipment to extract a specific volume of soil is expensive and can be easily damaged when sampling in stony soil. Getting a volume sample in a soil that is stony or one that contains buried debris can be difficult. For example, when the sampling tool is removed from the ground, the excavated soil may not be an accurate volume because of a hole left by a rock that remained in the ground. Any rock in the path of the sampling tool also interferes with obtaining an accurate sample. Interpretation of bulk density values will depend on other factors, such as soil texture and comparison to uncompacted sites of the same soil type. Penetrometers, which measure the resistance of the soil to a probe pushed

into the ground, are sometimes used to compare "soil strength", but these instruments also can be difficult to use and the results difficult to interpret.

Soil compaction can be difficult to measure, but its effects are easy to see and experience. Simply put, it's difficult to dig in areas of compacted soil. Digging holes for planting, or even to gather soil samples for testing, can be a time-consuming and laborious process. One useful technique is to compare the difficulty of digging in two areas: the problem area and a second area with a similar type of soil that you are certain is not compacted. Ponded water remaining on the field long after a rainfall is another visible sign of compaction. Plants often exhibit signs of the stress that they are experiencing under these conditions - as mentioned previously – but the symptoms could be misinterpreted as nutrient deficiencies, disease, poor turf varieties, or other causes.

People without some experience working with soil often don't believe it, but even raindrops or overhead irrigation can cause compaction if the water falls on bare soil. The force of the falling drops of water shatters the soil aggregates. The particles from the surface aggregates disperse and fill up smaller pore spaces in the surrounding soil, forming a crust. The dry crust is a barrier to the infiltration of water and emergence of crop seedlings. Further consequences of reduced infiltration include greater water runoff, loss of seed & fertilizer amendments, and increased potential for soil erosion. Mulching bare areas in the landscape will minimize crust formation and subsequent negative effects.

Alleviation of soil compaction is not a simple matter. While routine aerification can alleviate surface compaction and allow air and water infiltration, it may lead to deeper compaction. Best management practices for sports fields, therefore, include the rule: Avoid soil compaction. Protect bare surfaces with mulch (etc.); limit unnecessary traffic; use only equipment with turf-type tires; stay off the field when it's wet; and make gradual turns with maintenance equipment, never spinning the wheels. Prevention of compaction will relieve you, and your sports fields, of multiple sources of stress.

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