**UNDERSTANDING TURF MANAGEMENT**
**The Thirteenth in a series by**
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# SOIL COMPACTION

A major problem facing every manager of intensively used sports fields is compaction. While surface wear from intensive use will visibly remove above ground vegetation, simultaneously a non-visible problem may be occurring below the surface in the form of compaction.

The combined wear and compaction creates a double restriction on root development of the grass plant. Removal of top growth reduces photosynthesis, thus the food required for root growth. Compaction reduces the porosity of the soil, restricting normal exchange of oxygen and carbon dioxide and other potentially toxic gases. Under very compacted conditions root elongation may even be impeded. The total effect on root growth is thus much greater than would be expected through removal of top growth only.

Compaction occurs when the soil particles moved into closer fitting arrangements. Water is the lubricant which facilitates the movement. Thus play under wet conditions when the soil is near saturation is more likely to lead to compaction than when the soil is dry. Drainage to remove excess water rapidly from the root zone is the one step which may be taken to assist in long term correction of a compaction problem.

The clay content of the soil is another very important factor. While sand and silt particles may be spherical or angular in shape, clay particles tend to be flat; hence they are often referred to as clay plates. These plates easily slide over each other and tend to become layered under pressure at high moisture contents. As the layered arrangement becomes more prevalent, porosity decreases. In addition the much smaller clay particles tend to slide into the pores between the larger sand and silt particles, intensifying the reduction in porosity.

If you have ever observed a road being constructed you would have seen the water truck spraying on water, followed by the various types of rollers. The contractor is attempting to maximize compaction by providing heavy traffic at a high moisture content.

But a compacted roadbed is obviously not the media for growing grass.

Thus compaction results from traffic, whether it comes from the players foot or from the machines used in construction or maintenance. Most sports fields are seriously compacted at the end of the construction process; and to a significant depth. The size of the equipment used in moving the root zone into place, combined with the repetitive trips by the motor grader establishing the finished grade, invariably result in a compacted system before the turf is ever seeded or sodded.

Often the contractor is under time restraints. Thus some, or all of the work may be conducted with large machines under excessively wet conditions. The primary business of most earth moving contactors is in road construction; they just following their normal practices when they get a relatively small contract for a playing field.

It is important that the sports turf manager realizes that compaction may exist before the field is sodded and he should endeavour to correct the problem first. Deep tillage with heavy duty aerifiers or even the use of a farm-type chisel plough, operated in several directions will assist in reducing the compaction. For maximum effect the trick is to do the remedial aerification or tillage when the soil is somewhat less than field capacity; that is - *dry*.

Compaction is the cumulative effect of frequency and intensity of pressure applied to the soil surface. Pressure is the weight of the pedestrian or vehicle divide by the surface area actually in contact with the soil. The area of contact should be as large as possible; thus the use of turf tires or flotation tires on turf maintenance equipment.

James Beard provides some interesting numbers in his book 'Turfgrass, Science & Culture' on the effect of the athletes' footwear on the pressure applied to the soil surface. A comparison is made of a 220-lb person wearing football shoes versus wearing regular street shoes. A street shoe contains approximately 32 sq. inches of effective surface area, thus in walking the 220-lb person would exert a pressure of 6.25 lb/sq. inch. In contrast, a football shoe has seven, 0.9-cm diameter cleats, providing an effective surface area of 1.3 sq. inches in contact with the soil surface. Thus the static pressure exerted by the 220-lb person increases to 150 lb/sq. inch under his running foot.

Compaction due to the athlete or to turf maintenance equipment is generally confined to the upper three inches. In many cases it may be a zone of one inch or less.

The remedy for compaction of existing turf is turf cultivation, often called aerification. The principle types of cultivation for the relief of compaction are coring, slicing, and spiking.

The three cultivation machines may be divided into two distinctly different systems based on their physical operation. Coring is the practice by which hollow tines or spoons are used to extract cores of soil to a depth of two to three inches. On the other hand, slicing is a procedure in which a solid knife, mounted on a rotating drum, is sliced into the top two to three inches of soil. Spiking is a similar procedure in which a solid spike or prong is forced into the soil up to six inches and withdrawn. The spike may be vibrated to a degree to cause some shattering effect to

the surrounding soil.

The two systems are distinctly different in operation because they involve two different principles. Coring involves the removal of an intact core of soil which is deposited on the surface or removed from site. It results in a minimum disturbance of the surrounding soil (Fig. 1). Compaction is alleviated by breaking up the removed cores and matting them back into the holes, or removing the cores from site and backfilling the holes with a suitable topdressing material. The procedure is best performed when the soil moisture is at field capacity to reduce the force required to penetrate the compacted soil and to assist in removing intact cores. Following two or three hours of drying of the cores on a sunny day, they may be easily broken and matted or vertical mowed back into the surface. On a clay soil, allowing the cores to completely dry may result in nearly rock-like objects which cannot be broken until the next rain or irrigation.

Slicing and spiking involve forcing a knife or prong into the soil and opening a slit or hole. The soil existing in the volume occupied by the slit or hole must be forced sideways or upward, thus increasing the density of the soil in the immediate vicinity of the slice or hole (Fig. 1). Relief of compaction occurs when there is a vibration effect associated with the penetration of the knife or prong which shatters the compacted zone. To maximize the vibration effect, the cultivation should be done under relatively dry conditions, which in turn requires more force to permit penetration of the knife or prong.

Slicing and spiking are generally less disruptive of the turf surface and are less labour intensive than coring. They are used, therefore, as a routine operation for entire fields whereas coring is restricted to high traffic areas where overseeding is to be done or the root zone is to be modified by the addition of a topdressing material.

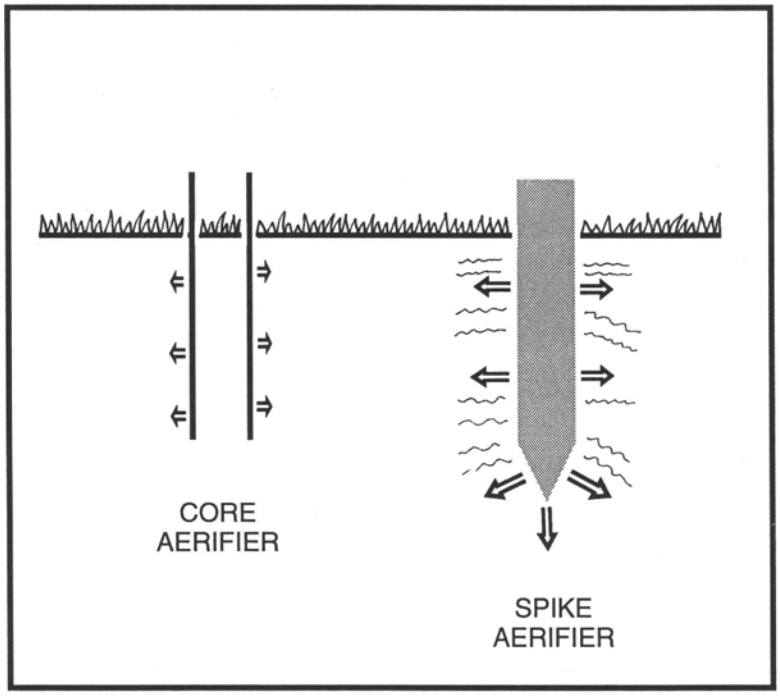
Coring is a practice which should be integrated with overseeding as loose soil is provided to aid in covering of the seed and improvement of germination. At the same time it must be realized that weed seeds are also encouraged to germinate, a factor which applies to all types of turf cultivation which disturb the dense canopy of turf. Scheduling turf cultivation to seasons when annual weed germination is not a significant factor, such as early fall, can reduce the problem.

The total removal of a compacted zone by coring will take a number of years. A 0.75 inch diam. core, on two-inch centres, will remove 11 sq. inches of surface area per square foot per operation. Assuming that the machine may be driven in each operation so that no recoring of the same hole occurs, it would take a minimum of 13 operations to remove the compacted layer.

It is generally recommended that cultivation not be performed when the turf is under heat or moisture stress. The other factors, such as irrigation,nitrogen fertilization and correct mowing height, which contribute to vigorous turf, should be in operation before cultivation occurs. Nevertheless, the need for relatively dry conditions to optimize the shattering effect of spiking should not be overlooked.

One of the principle reasons for the construction of all sand rooting zones for turf is to avoid the problems of compaction. Sands, selected according to the USGA specifications, do not compact to any significant degree beyond that which exists at the completion of construction. While the resulting porosity of all sand rooting zone may be ten percentage points less than that of a normal soil, one is assured that it will remain constant, as will the relationship between micro and macro porosity, even under a high level of use. The same can not be said for fields built with clay soils where the macro porosity will be reduced by compaction.

**Figure 1:** An illustration of coring versus spiking. The lenght of arrows represent the relative amount of compression of displaced soil into the surrounding soil. The wavy lines indicate the zone of shattering.




**Weather Retort**

*If it is bright and sunny after two cold and rainy days, it is probably Monday.*

*- Hugh B. Brous, Jr.*