SOLUTIONS TO

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Most sports and recreational
 turfs are subjected to traffic
 stresses. A hidden but very impor-
tant component of traffic stress is
 soil compaction, which is defined
 as the pressing together of soil
 particles into more dense mass.
 Soil compaction tends to be
 greater in the upper 50 to 75 mm
 of the root zone profile. Proneness
to soil compaction tends to be
 greater (a) in finer textured soils
 such as clays, particularly in com-
 parison to sands in the medium
 particle size range, (b) at higher
 soil water contents, and (c) with a
 higher amount of canopy biomass
to function as a cushion to traffic
 stress pressures.

Traffic stress pressure
 aspects
 Another aspect affecting soil com-
 paction is the intensity and fre-
 quency of pressure applied during
 traffic stress. Basically, pressure
 is calculated based on the weight of
 the pedestrian or vehicle divided
 by the surface area actually in
 contact with the turf-soil surface.
 Consequently, to minimise soil
 compaction it is desirable to have
 as great a contact surface area as
 possible relative to the amount of
 weight being applied. For exam-
 ple, a footballer with studs or flat-
 cleated shoes has a majority of the
 weight applied on the base of the
 cleats, in contrast to a flat to
 wafer-shaped tennis shoe where
 the pressure is applied broadly
 across the full base surface area.
 This results in a 25- fold greater
 intensity of traffic pressure where
 stud/cleated shoes are used. For
 the same reason, a golf shoe with
 the traditional hubs or shoulder

with spikes results in much higher
pressure stress in comparison to
spiked shoes with either inverted
metal bases flat
with the sole or else
nonspiked shoes.

In terms of the
frequency at which
traffic pressure is
applied, obviously
the more frequently
that pressure
stresses are applied,
the greater the
potential for
increased soil com-
paction problems.
There are a diver-
sity of traffic con-
trol techniques that
 can be used to
 encourage broader
distribution of traf-
 fic across turfed
areas. In the case of
sports fields, it may
 necessitate develop-
ing a greater num-
ber of sports fields
so that use can be
reduced on any one field by rota-
tion of play to allow turf rest and
recovery periods.

Effects of soil compaction
 The pressing together of soil parti-
cles into a more dense soil mass
as a result of traffic pressure
causes a number of problems in
maintaining a healthy, dense turf.
The first negative event resulting
from soil compaction is the loss of
macro-pore space and associated
soil aeration. Turfgrass roots and
beneficial soil micro-organisms
require oxygen for respiration to
support vital life processes. The
loss of soil aeration results in (a)
the inability of oxygen to move
from the above external atmo-
sphere into the root zone environ-
ment and, (b) the blockage in
outward movement of excessive
carbon dioxide and anaerobic
gases that are potentially toxic to
the turfgrass root system and ben-
eficial micro-organisms. The loss
of porosity in the root zone also
significantly reduces the water
infiltration and percolation rates
and therefore increases the
amount of precipitation lost by
surface runoff. The lack of oxygen
and presence of potentially toxic
anaerobic gases and chemicals
result in functional restrictions
of the turfgrass root system, and
eventually root dieback, which in
turn is reflected in reduced turf-
grass health and eventually actual
thinning of the above ground
canopy.

Correcting soil compaction
 problems
 Problems develop on extensive
turf areas that can only be man-
gaged through corrective measures
such as turf cultivation. By defini-
tion, turf cultivation refers to
mechanical methods of selectively
tilling an established turf without
destroying the sod characteristics.
The goal of this practice is to
enhance exchange of air and
water between the soil and the
above atmosphere. Since soil com-
paction is most severe in the
upper 50 to 75 mm, it is important
that turf cultivation operations
penetrate at least 80mm, and
preferably 100mm deep.

A key principle in implementa-
tion of turf cultivation operations
is that they be used only as
needed to correct a developing
soil compaction problem. In other
words, it should not be used as a
routine cultural practice, as there are negative aspects as well as positive benefits. Deep turf cultivation may never be needed on high-sand root zones constructed of the proper particle size analysis, whereas turf cultivation may be needed as frequently as monthly during the playing season on intensively trafficked, fine-textured clay soils. Symptoms used in diagnosis of soil compaction problems requiring turf cultivation include (a) a more impervious, hard soil mass as indicated by increasing difficulty in pushing a soil probe or cup cutter into the profile, (b) a reduction in the amount of water penetrating into the soil per unit of irrigation time, (c) reduced rooting depth and root number, and (d) actual thinning of the turf canopy. Turf cultivation is best accomplished when the soil is relatively moist to ensure maximum penetration and at a time of the year when moisture and temperature conditions will ensure rapid turf recovery over the openings, but when the seed germination and invasion of problem weedy species are minimised. Coring

Coring is a form of turf cultivation involving a hollow tine to remove soil cores and leave a hole in the turf-soil profile. There are devices that produce an opening and lift out soil by means of drilling. Coring generally has been preferred over the years in terms of beneficial responses. There is the option of either (a) removing the soil cores, if of an undesirable soil texture, followed by topdressing with an improved root zone mix, or (b) returning the soil cores, if of an acceptable turf texture, during which they are broken up and matted across the turf surface where they serve as a topdressing to enhance thatch decomposition. Most traditional coring machines penetrate 85 to 100mm deep. The more recent innovative development of deep tine coring units with the capability of penetrating 200 to 300mm deep has proven very beneficial in many situations. However, this does not mean that this deep penetration unit will replace the more traditional coring devices. Both approaches have a place in the culture of intensively maintained turfgrasses for sports and recreation uses.

Slicing

A form of turf cultivation involving a deep vertical cutting action that provides soil openings and loosening, but without removal of soil, is termed slicing. It typically involves V-shaped knives mounted in a circular arrangement. The penetration is 16 AD REF

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15 → depth depends on the weight applied to the slicing knives. Slicing does not cause as much disruption of the turf surface as coring but, by the same token, it is not as effective in enhancing soil water and air interchange. However, it is used effectively where a soil compaction problem has started to develop in the upper 50 to 75mm that cannot be corrected by coring, because it would be objectionable to the users during periods of intense play, or when high level competitions are scheduled.

Injection displacement
A recent innovation in turf cultivation involves the development of high pressure pulses of water or air that create openings in the soil profile to varying depths up to more than 200mm. The water injection displacement unit has created a great deal of interest, and is an innovative mechanical procedure involving sophisticated mechanical engineering approaches. They are advantageous on greens in that turf cultivation is achieved with minimal surface disruption. However, in the process of soil displacement, the soil must be moved somewhere and there is the question of just how much localised soil compaction or differential displacement of certain soil particles may occur under continued use. Time and further research will answer these questions. In the meantime, turf cultivation by water injection displacement is another tool which the turf manager has available to choose, depending on the particular circumstances under which the soil compaction problem develops.

Spiking
Turf cultivation involving shallow perforations of the turf surface by solid tines or blades is termed spiking. Because the penetration is only 20 to 30mm, spiking does not correct a major soil compaction problem. Rather spiking is used to break up an impermeable organic/compacted surface layer. It can prove particularly effective on high-sand root zones of the proper particle size distribution when the profile as a whole has an adequate infiltration rate and all that is needed is to break up the impermeable surface layer.

Preventing soil compaction
The preferred approach to solving soil compaction problems is a preventive basis. This typically involves root zone modification which tends to be relatively costly and thus is restricted to moderate to small areas such as sports fields, putting greens, and tees. The objectives of root zone modification are to select a particle size distribution that will have minimal compaction tendency, and maximum air and water exchange with the upper atmosphere. Construction starts with the proper subsurface drainage system. A 300 to 350mm deep root zone is placed over a gravel or crushed stone drain-bed of 100mm in depth. The best long-term performance has involved placement of a 50-60mm coarse sand layer above the drain-bed to create a perched hydration zone. This minimises soil drought stresses typical of sand root zones that do not possess a perched hydration zone. Construction systems such as the older Texas-USGA Method or the more recently published 1993 USGA guidelines are found to be the most effective (see References).

It is essential that the high-sand root zone contains a fully decomposed organic matter component to ensure proper buffering in terms of nutrient availability and protection against excessive leaching and allied environmental quality concerns. Note: the gravel, sand or organic matter materials being assessed for use in the root zone modification must be chosen based on established, detailed physical soil analysis, following the procedures outlined in the USGA guidelines.

Mesh system
A recent innovative development, one that has been researched since 1985, is use of the randomly oriented interlocking mesh element system. High-sand root zones have many advantages but they do tend to be less stable. There are a number of types of fibres available of a two-dimen-
A professional nature that contribute to
stabilisation of sands. However, only the three-dimensional interlocking mesh element system offers not only maximum soil stabilisation and root anchorage for reduced divoting, enhanced rate of divert turf recovery and lateral cleat tear, but also increased (a) soil water infiltration, (b) soil moisture retention, and (c) aeration, with resultant enhanced rooting and overall turfgrass health. These beneficial responses are attributed to a unique internal self-cultivation effect due to a flexing action of the three-dimensional, interlocking mesh elements randomly distributed through the upper 150mm of the root zone profile at a rate of 5kg/m³. The three-dimensional, interlocking mesh system with unique internal flexing also provides (a) a less hard surface, (b) a more uniform ball bounce, and (c) a superior load-bearing capacity. Based on eight years of detailed research, plus a number of successful real-world constructions installed with the proper subsurface drainage systems, the mesh element system has demonstrated great promise for use on sports fields, horse race tracks, golf tees, cart paths, and intensively trafficked areas requiring high load-bearing capacities.

References

Editor’s note: the interlocking mesh elements described are available world-wide as Netlon Advanced Turf. Further information concerning this process may be obtained by telephoning 0294 262431.