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Turfgrass Traffic and Compaction: Problems and Solutions

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Heavy traffic often causes significant damage to turfgrasses. On recreational and sports turf, as well as cemeteries and backyard lawns, foot traffic is the main culprit; on commercial and ornamental turf sites, including golf course fairways and home front yards, injury comes primarily from vehicular traffic. The genetic ability of turfgrasses to tolerate traffic is known as *wear tolerance*. This term describes the ability of a turfgrass to withstand weight or pressure that crushes leaves, stems, and crowns of the plant. Table 1 ranks common turfgrasses based on their relative resistance to wear.

Foot and vehicular traffic, especially on wet soils, can also cause *soil displacement*. This term refers to the scuffing or tearing of plant parts within soft wet soil and indicates greatly increased damage to the turfgrass crown and the upper regions of the root system.

On sports fields and golf course tees and fairways, *turf removal,* or divots, is an additional consequence of traffic. Severe damage occurs when entire pieces of the turf are torn or chopped loose and displaced. To tolerate soil displacement and divot removal, a turfgrass must have strong recuperative powers. Tables 2 and 3 rank common turfgrasses based on their relative recuperative potential under moderate and severe wear, respectively.

Table 1. Relative resistance to wear among California turfgrasses

High	Zoysiagrass
	Kikuyugrass
	Hybrid bermudagrass
	Tall fescue
	Common bermudagrass
	Perennial ryegrass
	Kentucky bluegrass
	Hard fescue
	Red fescue
	St. Augustinegrass
	Highland bentgrass
	Colonial bentgrass
	Creeping bentgrass
Low	Dichondra

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Although less visible, another effect of traffic that is potentially more damaging and longer lasting is the *compaction* of the soil on which the grass grows. Although compaction may not immediately kill the plant, it restricts growth and predisposes turfgrasses to a variety of other stresses and injuries. Eventually, by restricting growth of both roots and shoots, compaction can cause the death of turf plants. Knowledge of how compaction affects the soil's physical and biological properties, as well as the turfgrass plant itself, is essential in order to efficiently deal with its effects.

Table 2. Relative recovery from moderate wear among California turfgrasses

Fast	Hybrid bermudagrass
↑	Kikuyugrass
↕	Common bermudagrass
↕	Tall fescue
↕	Perennial ryegrass
↕	St. Augustinegrass
↕	Kentucky bluegrass
↕	Dichondra
↕	Highland bentgrass
↕	Hard fescue
↕	Red fescue
↕	Zoysiagrass
Slow ↓	Colonial bentgrass

Table 3. Relative recovery from severe injury among California turfgrasses

Complete	Hybrid bermudagrass
↑	Kikuyugrass
↕	Common bermudagrass
↕	Zoysiagrass
↕	Creeping bentgrass
↕	Highland bentgrass
↕	Kentucky bentgrass
↕	Dichondra
↕	St. Augustinegrass
↕	Tall fescue*
↕	Perennial ryegrass*
↕	Hard fescue*
↕	Red fescue*
Partial ↓	Colonial bentgrass*

*These grasses can become bunchy.

GENERAL PROBLEMS ASSOCIATED WITH COMPACTION

Bulk Density

Bulk density is increased in compacted soils. As bulk density increases, large, noncapillary pores in the soil are destroyed, while smaller, capillary pore space increases.

Water-Holding Capacity

Although the water-holding capacity of soil generally increases as compaction increases, water infiltration and percolation into and through the soil are reduced. Decreased water infiltration makes proper irrigation difficult. Standing water on the soil surface and excessive runoff on slopes contribute to inefficient water use. Standing water due to lack of infiltration on compacted soils not only increases water loss due to evaporation, but also enhances the incidence of turf disease.

Drainage

Lack of water percolation, especially on fine texture (clay) soils leads to poor soil drainage. Compacted soils may be drier in summer due to poor drainage. Because they are drier, they generally heat up more rapidly, leading to wilting, drought, and injuries caused by high temperatures.

Compacted soils may absorb and hold more water in winter due to poor drainage, then warm up more slowly in spring than noncompacted soils. This may be important in areas planted to warm-season grasses (e.g., bermudagrass) that require high soil temperatures to come out of dormancy and green up.

Oxygen Diffusion Rate

The oxygen diffusion rate (ODR) in compacted soils is severely reduced, thereby lowering oxygen levels in the root zone where respiration is required for root growth and development. Without efficient respiration, nutrient uptake by roots is curtailed and the turf plant suffers from nutrient deficiencies. Furthermore, microorganism activity decreases because of insufficient oxygen in compacted soils and the availability of nutrients (e.g., nitrogen and sulfur) may be curtailed. This is of special importance where organic and slow-release fertilizers (e.g., ureaformaldehyde) are used. Decreased microorganism activity can also result in slow thatch decomposition and thus increased thatch build up.Water absorption by roots is also reduced at limited oxygen levels.

Root Growth

In highly compacted soils, turfgrass root growth may be completely stopped or greatly reduced.

Turf Establishment

Turfgrass establishment, whether by seeding, sodding, or other vegetative methods is hindered.

Wear Tolerance

Wear tolerance decreases.

Recuperative Potential

Recuperative potential decreases.

TURFGRASS SYMPTOMS OF SOIL COMPACTION

- Turfgrass develops shallow roots.
- Roots are generally thicker and shorter than in noncompacted soils.
- Shoot growth declines.
- Tiller, rhizome, stolon, and leaf growth drop in size, volume, and number.
- Grass stand gradually thins as compaction increases.
- Turfgrass stand lacks green color (a general yellowing) due to unavailability of adequate nitrogen, sulfur, etc.
- Often turf is invaded by compaction-adapted weeds (e.g., knotweed, crabgrass, annual bluegrass, goosegrass, clover).

PREVENTION AND CORRECTION OF COMPACTION

- Avoid repeated traffic over the same site. On sports fields, if possible, move field boundaries occasionally to prevent concentrated traffic on specific locations.
- Reduce traffic by the establishing pathways of concrete, asphalt, and so on.
- Channel traffic with the use of proper landscape or hardscape designs and placement of trees and shrubs.
- Use maintenance vehicles with pneumatic tires.
- Change mowing patterns often to reduce the operation of mowers on the same route.
- Where traffic is unavoidable, increase the height of cut to increase wearability and root depth.
- Minimize traffic when soil is wet or near field capacity.
- On golf courses, build large greens, and properly and frequently rotate cup placement.
- Also on golf courses, build wide tees and alternately use one half of each tee to place markers.
- Develop a soil medium that is resistant to compaction. Sands and loamy sands are least likely to compact, while high silt and clay content soils are easily compacted. Partial soil modification with organic amendments may decrease compactibility of turf soil. This effect, however, is often short term and not effective in sites under heavy traffic. Note that the addition of sand to clay soils may actually increase their compactibility and destroy soil structure due to the development of cementing conditions. Very little data supports the addition of chemical amendments (for example, gypsum) to correct compaction problems.
- Given heavy traffic and use, for example, on athletic fields, complete soil modification or the replacement of existing soil with a noncompactable root zone material is often the only way to reduce, or even prevent, compaction. Examples of complete modification of athletic grounds are the University of California's sand golf green, bowling greens, and athletic fields, the Prescription Athletic Turf system, and the USGA (United States Golf Association) golf greens.
- Incorporate one or more cultivation practices (e.g., coring, grooving, slicing, or spiking) into the turf management routine when turf is grown on compactable soils. Of these practices, coring, which can be done with either hollow or solid

tines of various lengths and spacing, is considered the most effective with the longest lasting effect. All forms of cultivation should be practiced when turfgrass is growing vigorously and can recover from injuries: for cool-season grasses this period coincides with early to mid-spring or late summer to mid-fall; for warm-season grasses, cultivation is practical during the nondormant season. Cultivation practices damage soil structure if done when the soil is too wet and may be ineffective if the soil is too dry. Although the frequency of aerification is determined primarily by the magnitude of the traffic and the severity of compaction (the poorer the soil condition, the more frequently it should be aerified), a heavily trafficked turf stand can benefit from 2 to 4 aerifications per year. Aerification should be avoided, however, during high temperature periods, when soil is too wet in winter, and during periods of peak annual weed seed (e.g., annual bluegrass) germination (or, if done when weed seed is prevalent, apply a pre-emergent herbicide immediately after aerification).

- No single practice can completely correct compaction problems, and several must be combined for a successful maintenance program.

In summary, turfgrass managers and homeowners must realize that soil compaction is the hidden enemy of turfgrass. Correcting a compaction problem after it has already developed is often a difficult and prolonged process.

The best approach to dealing with soil compaction is to anticipate its eventual occurrence and to develop a turfgrass maintenance program in which compaction reduction procedures are detailed. Such a maintenance program should begin while the turfgrass is growing healthy and vigorously, so it can recover quickly from any cultivation activity.

FOR MORE INFORMATION

You'll find more information on many aspects of turfgrass management in these titles and in other publications, videos, slide sets, and CDs from UC ANR:

Turfgrass Pests, Publication 4053
Managing Turfgrasses during Drought, Publication 21499
Turfgrass Selection for the Home Landscape, Publication 8035

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