CUTT

Program Spotlight

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Proper Management Prevents Compaction

Soil compaction is defined as the pressing together of soil particles, resulting in a more dense soil mass with less pore space. The size and organization of soil particles is a determining factor when considering the amount of compaction that might occur. Finer particle silt and clays are more easily pressed together, but improper sand based mixtures with an array of particle sizes and shapes can be equally susceptible when a heavy load is applied. Ultimately, it is vital to understand the consequences of compaction, as many of the cause are unavoidable.

Soil Under Foot

Researchers have investigated the difference in compaction associated with vehicular or foot traffic. Regarding foot traffic, the speed of the traffic event and the weight per unit of contact area are important factors in assessing the overall compaction. For example, a crew member running on a putting surface exerts 38 times more compaction than if they were walking. In addition, a street shoe with a larger surface area has 25 times less compacting force than a cleated shoe with a smaller surface area. What types of shoes are the crew members wearing on the putting greens when they are walk-mowing?

Vehicular traffic involves the vertical force of a moving tire, sheer stress from slippage and vibration. Studies have shown that large, wide tires increase the depth of soil compaction as compared to lighter vehicles with narrow tires. Starting and stopping that creates slippage increases the compaction, yet increasing speed from 1 to 3 miles per hour without slippage decreased compaction 50% in the top two inches of soil.

Squeezing the Plant

A turfgrass surface significantly absorbs and dissipates the force of compaction and yet the effect of compaction on turf growth is difficult to diagnose. Still, the compaction of the soil will ultimately influence the health of the turf by reducing soil aeration, altering plant and soil moisture relationships, or soil temperature. Obviously, there are significant effects on root growth, but shoot growth is also influenced as nutrient and water uptake is altered. Physiologically, there are several studies that reveal how compaction reduces energy reserves, increases canopy temperature and increases disease incidence.

The most critical of all consequences to compaction is the reduction in soil oxygen level. Interestingly, the distribution of rooting is one

Severely compacted areas are not able to sustain healthy turf.

of the most critical factors. Under compacted soil conditions, roots appear to be confined to the surface. In fact, Bob Carrow at the University of Georgia reported 20% more surface rooting when soil was compacted and significantly fewer deeper roots. He speculated that reduced oxygen levels were a factor, but more important was the energy the plant must expend to "squeeze" through the tighter soil matrix. Consequently, when compaction persists in the summer, plant energy levels are reduced 25 to 50%! This information is vital when considered with the recent research conducted at Kansas State that reports severe declines in energy are the cause of bentgrass summer decline.

Poa Paradox

The lack of oxygen in compacted soils often translates to increased water holding. Several studies have seen increased root and shoot growth as a result of improved moisture relations. In addition, turfgrass water use, measured as evaporation from the soil and transpirational water loss from the plant (evapotranspiration) decreases as compaction increases. Still, it is common to see turfgrass managers apply additional water to compacted sites. This might be due to low infiltration rates, thin turf that leaves the soil exposed and increases evaporation, and a perceived lack of growth that is often met with additional water.

Creeping bentgrass tolerates extremely saturated soil conditions. In most wet areas on northern courses, it is the predominant species. In fact, many park systems that flood areas for skating rinks, seed creeping bentgrass because it is the only plant that will survive under water and ice. When the soil is saturated with water, the soil pores are filled and little air is available. This is also true when the soil is compacted and smaller pores hold water and in general the soil lacks oxygen. Yet, in these compacted situations, annual bluegrass is more competitive and survives where creeping bentgrass will not. How can this be?

Air pores in the plant that connect the root to the shoot might be crushed in bentgrass on compacted sites and not in annual bluegrass. This "crushing" prevents bentgrass from oxygenating their roots from the surface. This could be an important consideration with regard to the new air injection systems, should they be capable of forcing oxygen into the rootzone and favoring bentgrass growth.

The Fix

Once the soil becomes compacted, there are limited short-term solutions that will provide relief. If the sand content can be increased from 70 to 90%, water infiltration will increase 20-fold. Once the sand becomes the major component of the rootzone, bridging between particles occurs and theoretically the sand creates larger pores and a rigid matrix resistant to compaction. However, this will take a decade or more with less than aggressive procedures. Remember, a core cultivation unit setup with 0.5 in. tines on 4 in. spacing at normal speed only affects 5-8% of the soil surface. Therefore, golfers who see superintendents "burying" the green with sand must realize how little is accomplished at each event. This argues further for building right and managing it properly to avoid compaction problems.

There has been a considerable amount of sports turf research conducted on synthetic fiber—for example, plastic fibers, ground up Nike sneakers, carpet fibers, and crumb rubber—inclusion in sand to improve stability and reduce compaction, while maintaining infiltration. Most of the work has explored various percentages of the material incorporated into the sand. While stability is important for putting greens, there is a wide range of specifications that can provide what is needed. However, tee areas or heavily trafficked practice greens might consider some of this technology to enhance surface stability, compaction resistance and improve a turf's conditions.

Taming the Tiger Effect

As with all challenges on the golf course, the first step is awareness and recognition of the problem. Compaction is often referred to as the hidden stress. Understanding the effects on rooting and overall turf health may explain why certain areas suffer more than others do. Short-term solutions such as core cultivation and soil amendment address only the symptoms of the problem: low soil aeration and poor infiltration. Long-term solutions are severely disruptive and might limit an already short golf season. Consequently, prevention is the best option.

Know your soils or sand, by having them physically analyzed in an attempt to understand their likelihood for compacting. Maintain a dense turf through proper management, rec-

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Broadleaf Weed Management

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carfentrazone-based products. Carfentrazone (also known as Quicksilver) has been produced and used for weed management in cereal crops in Europe and in combination with other herbicides for use along utility lines and rights of way. FMC is now marketing this product for use alone in warm and cool season turfgrasses for broadleaf weed management, and Riverdale is marketing it in combination with other products (including 2,4-D, MCPA, MCPP and dicamba).

Carfentrazone applications result in rapid weed control, with results often seen within hours after application. Complete control of certain perennials was noted in up to 7 days after application. Speed Zone and Power Zone are two new products which contain carfentrazone plus MCPA, MCPP, and dicamba or 2,4-D, MCPP and dicamba, respectively. Both of these products are marketed by Riverdale and enhance the spectrum of activity of carfentrazone for broadleaf weed management. These products excel in cool weather control so applications can be made in early spring and the products are rain-fast in as little as 3 hours after application.

Power Zone is particularly effective at controlling clover, dandelion, ground ivy, and spurge in turfgrass. Carfentrazone is remarkable in that it is particularly fast acting, non persistent in the soil, and apparently not associated with the development of any herbicide resistance to date. Upcoming formulations of carfentrazone may include combinations with newer chemistry such as clopyralid and fluroxapyr. We are currently working with both FMC and Dow to evaluate these product combinations for greatest efficacy. It has been reported that carfentrazone plus phenoxy-product combinations may exhibit additive or synergistic effects when combined in comparison to each product applied separately. We are currently evaluating these mixtures to determine if this is a possibility.

This fall I will be releasing a new website for weed management in turf and ornamentals which will contain articles, references, many photographs, and web-based publications which describe the latest in both chemical and alternative forms of weed management. Hopefully you will find this tool helpful to logically select an effective weed management program for your landscape setting.

Leslie A. Weston, Ph.D.

Table 1. Description of Broadleaf Postemergent Herbicides Now Available for Use in Turf in New York State.

Product	Mode of action	Soil persistence	Rapidity of control
2,4-D	growth regulator	limited	moderate
dicamba	growth regulator	moderate	moderate
triclopyr	growth regulator	moderate	rapid
clopyralid	growth regulator	long	rapid
metsulfuron	inhibitor of branched chain amino acids	long	moderate
chlorosulfuron	inhibitor of branched chain amino acids	long	moderate
carfentrazone	PPO inhibitor	none	very rapid

Preventing Compaction

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ognizing that a dense turf absorbs and dissipates much of the compactive forces. Most importantly, manage the traffic by regularly moving the cups and tee markers, and scatter golf cart traffic. Consider moving them more than once a day if heavy traffic is expected with non-tournament play. Communicate these issues with architects and golf professionals so that they understand the importance of dispersing traffic by providing large tee areas and copious amounts of cupping space. In the end, the Tiger Effect equals compaction that must be tamed!

Frank S. Rossi, Ph.D.

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