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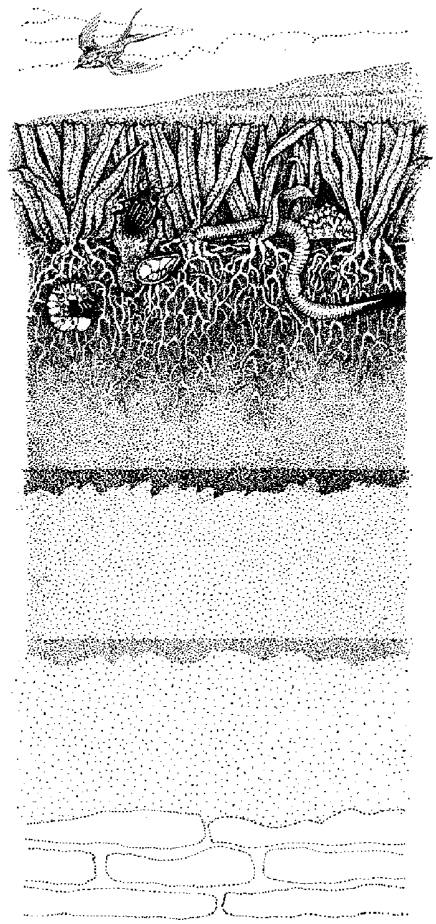

The Art and Science of Turfgrass Soil Management

Fall is often a season when turfgrass managers have the time and opportunity to consider doing some important soil management techniques. Soil management includes the modification of both the chemical and physical properties of soil. Because turf problems related to soils are often considered "hidden" due to their below-ground nature, they are often misdiagnosed, ignored or forgotten. ■

Turfgrass symptoms of soil problems include the following:

- shallow but extensive root system
- little or no roots below 4"
- little or no top growth
- off-color, very chlorotic tissue
- easily wilted
- low density with weeds
- poor response to fertilization and soil-applied pesticides
- prolonged wet soil that limits recreational uses
- water easily runs off the turf surface.

Some sites may have all of the above symptoms while others may have just a few. Some symptoms may take a long time to show (like root growth) while other symptoms are quickly visible (top growth). Many other factors can cause the symptoms described above, making a definitive diagnosis nearly impossible. Thus, soil management often is considered an art more than a science. Turfgrass managers must understand and utilize more scientific principles to improve the art of soil management.

Managing Soil Physical Conditions

Most turfgrass sites have been disturbed, or at least changed from their natural state, as the result of construction where the natural order and state of soil layers (profile) has been rearranged by the bulldozer. Often construction debris may be buried in the disturbed soil, further affecting the ability of turfgrass plants to survive.

There are many sites, like residential lawns, where no soil physical management practices are used; whereas, there are sites like golf greens or intensively management sports fields that use every available soil physical management tool. The soil physical management tool box contains methods such as:

- Cultivation; coring, slicing, spiking, grooving, water and air injection, drilling, solid tine cultivation

- Amendments, either of a physical, chemical and biological nature

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Soil Management

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For maximum positive impact, cultivation tine spacing should be no greater than 2 inches on center, which can be accomplished by narrow tine spacing units or multiple passes.

Cultivation

Turfgrass managers understand the agronomic need for cultivation, but the users of many of the sites are not so understanding. There is nothing that raises more flack from golfers than core cultivating the greens. The reasons for cultivation include: increasing infiltration and percolation of water and other materials (nutrients, pesticides) through soil; removal of unwanted layers; aiding in overseeding; as part of a thatch management program; and improving the health and vigor of the site. Improving infiltration occurs when the cultivation hole extends from the turf surface to below the zone of restriction. The zone of restriction is a layer of soil that is very dense and has a very slow rate of water movement through it. The zone of restriction caused by normal use of a site (maintenance equipment, carts and foot traffic) is usually contained in the surface few inches of soil. Shallow forms of cultivation like hollow and solid tine aerifiers are effective in improving the soil physical conditions on sites with this shallow restrictive zone. On sites with deeper zones of restriction, usually created during construction from heavy earth moving equipment, deeper forms of cultivation are needed which include the solid or hollow tine deep aerifiers, water injection and deep drilling. If the depth of restriction is deeper than the depth of cultivation there may be very little improvement in the soil physical condition.

All types of cultivation only have a positive influence on a small zone of soil surrounding the cultivation hole. A dye movement study conducted by Dr. Panayiotis Nektarios while a graduate student at Cornell revealed that most forms of cultivation studied positively influence the 0.5 to 1 inch of soil surrounding the cultivation hole. Water injection cultivation had a larger zone of influence up to 2 inches of soil at the bottom of the hole. Thus, for maximum positive impact, cultivation tine spacing should be no greater than 2 inches on center, which can be accomplished by narrow tine spacing units or multiple passes.

The reasons the fall is an ideal time for cultivation are: to alleviate the compaction caused during this year's growing season, take advantage of the cooler soil temperatures so as to promote root growth, enhance fall overseeding, and to improve the general health and vigor of the turfgrass. On areas with large reserves of annual bluegrass seed, core cultivation is often delayed until mid to late fall to discourage annual bluegrass seed germination/encroachment.

Amendments

Amendments come in various forms as either physical, chemical or biological types. Some amendments, such as organic matter, can influence all three areas. Others, like sand, may influence one, the physical properties. The physical properties altered include water movement through soils, moisture holding capacity, compaction resistance, and aeration. Chemical properties include nutrient holding capacity (cation exchange capacity), nutrient source and pH. Biological properties include the general microbial population, disease antagonistic organism activity, and microbes important in nitrogen transformations and pesticide degradation.

The most common amendments are: sand, soil, calcine clay, calcine diatomite, and organic matter sources. There are several new amendments, most notably the natural zeolites like clinoptilolite. Table 1 summarizes amendments, properties and uses.

A major concern of any amendment is how stable it is to breaking down, especially if used to amend sand. If the amendments to sand break down into very fine particles, the highly pervious nature (well drained) of sand could be destroyed and the site made less usable, especially during rainy periods. Amendments can break down into smaller particles in several ways, by microbial decomposition, chemical decomposition and physical forces like weathering and traffic.

We have been studying the stability of amendments to some of the above breakdown forces, weathering and traffic (impact and abrasion). There currently is no accepted method of assessing the stability of amendments. We choose to use several suggested ASTM methods used to assess aggregate stability. One method involves simulating weather by wetting samples in a saturated sulfate salt solution (magnesium sulfate) then overdrying. We found all of the routinely used soil amendments (calcine clay, calcine diatomite and sand, as well as 6 sources of clinoptilolite) were stable to weathering. We are currently assessing their stability to traffic forces and maintenance practices (abrasion and impact) using the LA Abrasion test method. The initial data suggests that all of the amendments tested do break down to some degree, but further analysis is needed to determine if the breakdown is excessive enough to destroy the well drained nature of sand based turf areas.

Amendments can be used to partially amend soils (topdressing or shallow incorporation into the root zone) or complete incorporation into the

Source	Amendment of	Properties Improved Physical	Chemical	Biological	Degradation Forces*
Sand	soil	yes	no	no	C, T
Calcine Clay	sand soil	yes	yes	no	W, T
Calcine Diatomite	sand soil	yes	no	no	W, T
Natural Zeolites	sand soil	yes	yes	no	W, T, C
Organic Matter	sand soil	yes	yes	yes	B
Soil	sand	yes	yes	yes	

Table 1. Sources of soil amendments, the properties they influence and the forces involved in degrading amendments.

* Forces involved in degrading amendments include C=Chemical, T=Traffic, W=Weathering and B=Biological.

root zone. The factors involved in choosing one over the other involves: the time one can wait for positive results (topdressing is long term while complete root zone modification is very quick fix), cost and which amendment is used.

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- **shallow but extensive root system**
- **little or no roots below 4"**
- **little or no top growth**
- **off-color, very chlorotic tissue**
- **easily wilted**
- **low density with weeds**
- **poor response to fertilization and soil-applied pesticides**
- **prolonged wet soil that limits recreational uses**
- **water easily runs off the turf surface**

Amendments come in various forms as either physical, chemical or biological types. Properties altered include:

Physical properties
- ***water movement into/through soils***
- ***moisture holding capacity***
- ***compaction resistance***
- ***aeration***

Chemical properties
- ***nutrient holding capacity (cation exchange capacity)***
- ***nutrient source***
- ***pH***

Biological properties
- ***general microbial population***
- ***disease antagonistic organism activity***
- ***microbes important in nitrogen transformations and pesticide degradation***