CULTIVATION FOR SURFACE PROBLEMS

Robert N. Carrow
University of Georgia

SURFACE CHARACTERISTICS

The characteristics of an athletic field or golf green, depend on the turfgrass, physical conditions in the soil, and proper contouring for water drainage. From the viewpoint of the athlete or golfer, a **good sports** turf should have these **characteristics:**

- **Firm —** for good footing and stability. Neither too hard or soft.
- **Stable Surface —** does not deteriorate and become uneven or unstable.
- **Resilient** — to cushion falls and reduce injury.
- **Dense Turf —** for ball roll or bounce, resiliency, wear tolerance.
- **Uniform —** even surface for footing and ball bounce.
- **Persistent Turf —** season long turf.
- **Deep Rooted —** resist divots and tears, maintains stability of surface.
- **Wear Tolerant —** to withstand wear as pressure, abrasion, tearing.
- **Compaction Resistant —** to resist soil compaction.

BASICS OF SURFACE CULTIVATION

Oftentimes, soil physical conditions in the surface 3 inch zone have a dramatic influence on these athletic field or golf green characteristics. Surface cultivation operations can aid in maintaining adequate physical conditions, basically by providing one or more of the following attributes:

a. Create temporary "**macropores**" (>0.12 mm diameter) that:

  - Enhance water infiltration and percolation.
  - Enhance gas exchange (O_2, CO_2) into and out of the soil.
  - Become root channels.

b. Loosen the surface soil. On fine-textured sites, the soil may be naturally hard or become hard by compaction. Even coarse-textured soils exhibit surface hardness under some conditions such as a wide particle-size distribution or lack of organic matter.

c. Provide a means to add amendments to the surface for integration into cultivation holes or by direct injection.

PROBLEM IDENTIFICATION

The first step in determining whether surface cultivation will be beneficial is to assess whether the **primary problem** is within the surface 3 inch zone or caused by conditions outside the zone. For example, an excessively wet surface may be due to (a) a high natural water table, especially in prolonged wet weather, (b) a perched water table caused by a layer below 3 inches depth that impedes drainage, (c) a runoff or seepage area from adjacent grounds of higher elevation, or (d) insufficient surface drainage, especially "pot-hole" depressions that collect extra surface water. Surface cultivation may aid in some of these situations but other approaches will be more important such as surface/subsurface drainage, deep cultivation, and leveling depressions.

Field problem situations that require cultivation include one or more of the following:

a. Layers in the surface 0 to 3 inch zone. Fine-textured (high in silt/clay) fields can exhibit layers caused by:

- Compacted zone at the surface.
- Layer of different texture or composition in the 0 to 3 inch area, especially if the interface is distinct.
- Sodic affected zone.
- Excess clay/silt causing low infiltration even without compaction.
- Algae at the surface.
- Caliche layer occurring naturally or from high carbonate irrigation water.

Coarse-textured (i.e., sand) fields can demonstrate layers caused by such conditions as:

- Fine-textured layer from sod, topdressing, water deposition, wind deposition.
- High organic matter layer (mat).
- Sodic-induced zone.
- Calcite-affected zone from high bicarbonates and carbonates causing sealing/cementing of pores.
- Algae at the surface.

All of these layer situations in fine or coarse-textured soils would restrict water movement and gas exchange. Most would also limit rooting by increasing soil strength.

b. Hard sands. Sometimes sand athletic fields have hard surfaces caused by low organic matter content or too wide of particle size distribution. Such sands are susceptible to compaction. Cultivation aids in loosening the soil on a temporary basis.

c. Hydrophobic sands. Water repellant sands can cause localized dry spot (LDS) in the surface 1 to 4 inches of high sand soils. Cultivation alone is not sufficient to correct LDS but, when in conjunction with wetting agent application, can help alleviate this problem. Wetting agents can be injected into the soil surface by some high pressure water injection units. Sometimes an apparent LDS is not caused by hydrophobic conditions but are the result of poor irrigation coverage or a shallow root system or soil.

d. Sloped areas causing excess runoff. Surface cultivation can improve water infiltration on sloped sites where excessive runoff results in droughted turf. At times a semi-hydrophobic thatch on a sloped area magnifies the problem and requires a wetting agent plus cultivation.

e. For injection of materials. At times, a surface cultivation operation is conducted primarily as a means of injecting a chemical or physical amendment such as an insecticide, nematocide, fertilizer, wetting agent, sand, or sand substitute.

EQUIPMENT CHOICES

Factors to consider when choosing between equipment options are:

1. What is the specific problem(s)?
2. Depth of the problem within the soil profile.
3. Whether sand or some liquid or granular amendment will be surface applied or injected.
4. The degree of turfgrass surface disruption that can be tolerated.

5. The degree of turfgrass root injury expected and how serious a problem this may be at that time of year.
6. Expected longevity of results.
7. Time constraints.
8. Cost constraints.
9. Equipment availability by purchase or contract.

Expected longevity of results (item 6, above) is based primarily on common sense. For example:

- Larger, deeper, more frequent holes should last longer.
- When soil is removed and replaced by sand, the hole will last longer than if not filled or no soil is removed.
- Holes in expanding clays do not last as long as in non-expanding clays, such as kaolinite.
- The deeper part of a hole may last longer than the surface portion.
- Holes last longer under less traffic.
- When a device makes a penetration hole plus has loosening action between holes, it will have greater initial effectiveness.
- When more compaction is alleviated at the bottom of tine penetration or between holes than created, effectiveness will increase.

Turfgrass cultivation equipment is listed and categorized in Table 1. Those units that have injection capabilities are denoted in the right hand columns. Also, the optimum moisture condition for effective cultivation operation is identified.

PRACTICAL GUIDELINES

Unsuccessful cultivation programs are most often the result of improper problem identification or selecting the wrong cultivation technique. Each type of cultivation equipment can be used for certain problems, but no piece of equipment can deal with all soil physical problem situations. The turf manager must understand what a particular cultivation technique can do and what it cannot accomplish. Turfgrass cultivation manufacturers should promote their products based on what type of problems they can resolve.

Frequency of cultivation should be carefully determined. Some problems, such as a subsurface layer from an old mineral sod, may be alleviated permanently with one or two cultivation operations. Other problems will reoccur, such as reformation of a surface compacted layer from continuous traffic. Thus, frequency depends on how often cultivation must be done to correct the problem(s) on a continuous basis. If more than one problem requiring cultivation as a solution is present, a "program" is developed for each problem — some programs may involve only one or two cultivation applications, while others may require a continuous program.

Timing of each cultivation operation within a program must be chosen. The three most important considerations are: a) is the soil moisture appropriate for the particular cultivation operation, b) is the condition of the turfgrass sufficient to allow cultivation, and c) are climatic conditions favorable for the turf to recover from any temporary injury?

Lastly, as with any program, the turf manager must evaluate the effectiveness of the program — are the desired results achieved? Benefits may be improved infiltration/percolation, better root growth, enhanced turf quality and growth, elimination of poor aeration and black layer, etc.

In conclusion, the development of an effective cultivation program requires that the turf manager have a) intimate knowledge of the specific soil physical and chemical problems on a site, and b) detailed understanding of the advantages and disadvantages of each type of cultivation technique.

Table 1. ***Comparison of Different Turfgrass Cultivation Methods***[X].

Cultivation Procedure	Comments Tine dia.	Depth of Penetration (inch)	Soil Moisture for Best Effectiveness[Y]	Deep Cultivation Method (>6" depth)	Direct Injection Possible
1. **Coring with hollow tine, spoon, screw devices.**					
a. Tractor-drawn units with spoons or tines that enter the soil at an angle. Some units are motorized.	Several types Interchangeable spoons, hollow tines, slicing blades. ½ - ¾"	3-6	FC	—	—
b. Drum-type Hollow tine	Several types	2-3	FC	—	—
c. Verti-Drain, Soil Reliever	Hollow tine	10-12	FC-DFC	Yes	—
d. Vertically operated tines Many types, HT	Most common form of cultivation 1/2 - 7/8 " dia.	3-5	FC	—	—
e. Deep-Drill Aerofier	Screw device				
- Floyd McKay	½ - ¾" dia.	5-10	FC	Yes	Yes - Granulars
- Green Care	¾ - 2"dia	16	FC	Yes	
2. **Coring by solid tine devices.**					
a. Verti-Drain, Soil Reliever	½ - 1" dia.	12-16	DFC	Yes	—
b. Shatter-core vertically operated tines.	½ - ¾" dia.	3-5	DFC	—	—
c. Units where tines enter the soil with a rotary pattern (Aera-Vator).	½" dia.	3 ¼	FC-DFC	—	—
d. Small diameter solid tine often as a quad tine.	¼" dia.	2-3	FC	—	—
3. **Slicing** - Solid tines or blades, are not power driven. Many types. tines into the soil.	Blades pulled through the soil or the weight of the unit pushes				
a. Straight-line tines	Most common.	3-7	FC	Some units	—
b. Straight-line blades (Verti-Slicer) (Verti-Groover)	Thin width blades.	2-6	FC	Yes	Yes - Granulars
c. Offset tines (Aerway Slicer)	Larger width blades, ¼ - ½"	6-8	DFC	Yes	—
4. **Spiking**. Blades are not power driven (i.e. do not cut through the soil but penetrate by machine weight)	Small spikes or knife-like blades. Units may be pull type or motorized drive (Spikeaire).	¼ - 2	FC	—	—

Table 1. (Continued)

Cultivation Procedure	Comments	Depth of Penetration	Soil Moisture for Best Effectiveness[Y]	Deep Cultivation Method (>6" depth)	Direct Injection Possible
	Tine dia.	**(inch)**			
5. **Subaerification**.					
a. Yeager-Twose, Turf Conditioner	Blades vibrate side-ways.	2-8	DFC	Yes	Yes-Granulars
b. Green Care, Shatter Master	Blades vibrate front to back.	4-12	DFC	Yes	—
6. **High Pressure Water Injection.** *Toro Hydro-Jet *Other Units	Uses high pressure water action.	4-20	FC	Yes	Yes - Liquids (some); some units inject granulars.
7. **Air Pressure**.					
a. Terra Lift probe.	1", one	6-36	FC-DFC	Yes	Yes- Granulars
b. Aerragreen	½", 4 probes ½", 1 probe	6-12 36	FC-DFC	Yes	Yes - Uses polystyrene beads
8. **Grooving.**[Z] Power driven blades that cut through the soil and thatch layer	Used for renovation and not for routine cultivation.	1-5	FC-DFC	—	—
9. **Forking**. spot treatment cultivation method.	The "original"	6	FC	Yes	—

[W] Conversions: ¼" = 6.3 mm; ½" = 12.5 mm; 4" = 4 inch = 10 cm; .6" = 6 inch = 15.2 cm.

[X] After Carrow, R. N. Golf Course Management Vol. 58, 1990. Commercial examples are to illustrate particular types of cultivation units and does not imply an endorsement.

[Y] FC = field capacity' DFC = drier than field capacity.

[Z] Grooving causes severe injury to the turf and is not generally used as a true cultivation method but is used to "open up" the turf in renovation.