CULTIVATION PRACTICES FOR COMPACTED SOILS

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Compaction of soil results in many undesirable effects such as reduced soil aeration, water infiltration and percolation. These soil responses to compaction can reduce turf shoot and root growth which leads to lower turf quality and tolerance to environmental stresses.

Soil porosity can be divided into two major types of pores; macropores and micropores (also referred to as non-capillary and capillary pores, respectively). Macropores are the large soil pores which govern the rate of water infiltration and percolation and the soil aeration status. Additionally, macropores are the channels through which plant roots explore the soil. Micropores are responsible for the soil's water holding capability. In general, compaction of soil reduces the amount of macropores with a concomitant increase in micropores. Thus, soil compaction creates a chronically "wet" soil with poor aeration and conditions for root survival.

Cultivation is one cultural practice the turf manager can use to alleviate poor soil conditions associated with compaction. Cultivation attempts to create large soil voids and loosen the soil profile. The channels left behind will enhance water infiltration and provide avenues for root extension into deeper portions of the soil profile.

Figure 1 displays the effect of several soil cultivators on the soil strength of a Michigan State University athletic field. Three cultivators were used in this study; the Aer Way aerifier, Toro aerator, and Verti-Drain aerifier. The Aer Way unit creates a triangular shaped slot in the soil with the tip reaching 4 to 5 inches deep. The Toro unit, utilizing 5/8 inch diameter tines, penetrated to the 3 inch depth. The Verti-Drain unit, equipped with hollow and solid tines on 2.5 inch spacings penetrated to the 6 and 9 inch depth, respectively. Cultivation treatments were applied on September 5, 1986 with one pass over and soil resistance (hardness) measurements were taken with a soil penetrometer on September 19, 1986.

Due to the relatively wide spacing of tines on the Aer Way unit this cultivator was limited in its ability to loosen the soil profile. In contrast, the Toro aerator provide significantly greater loosening of the soil surface 3 inches due to closer tine spacing. To achieve similar reductions in soil strength the Aer Way unit should be operated more than once over a field. Neither the Toro or the Aer Way unit produced soil loosening below the 3 inch depth. The Verti-Drain unit provided the most dramatic loosening effect on the soil profile. Soil disruption was detected at the 8 inch depth with hollow tine treatment and the 7 inch depth with solid tines.

These results indicate the necessity for turf managers to evaluate their particular soil compaction problems and equipment capabilities. Soil surface compaction (3 inches deep or less) can be managed with equipment which penetrate through the compacted soil zone. Cultivators with widely spaced tines may require several passes to sufficiently breakup the compacted surface zone. Ideally, coring holes should be spaced no greater than 3 inch apart on highly compacted sites. Deep soil or subsurface compaction can be managed adequately with deep tine cultivators which will penetrate and disrupt those compacted zones, such as the Verti-DRain unit.

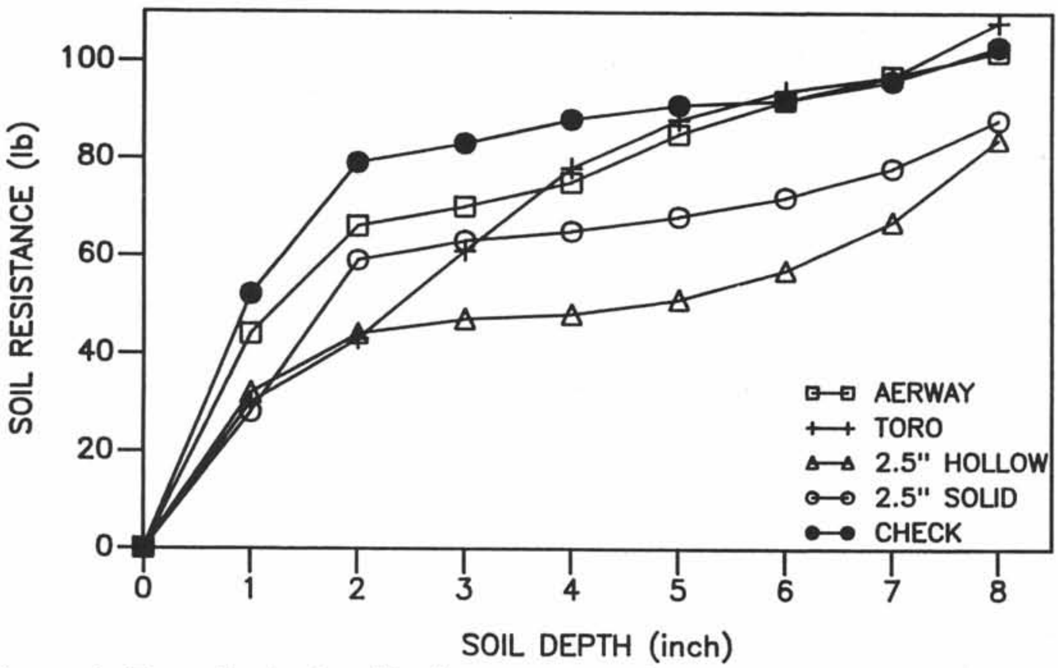

Figure 1. The effect of cultivation on the soil strength of an athletic field.

Table 1 presents turf visual quality data from a cultivation study on a "Ram I" Kentucky bluegrass turf. The cultivators used were the Toro aerator, Coremaster unit, and Verti-Drain unit. The Toro unit was equipped with 5/8 inch diameter hollow tines and penetrated to the 2.75 inch depth. Three treatments frequencies were performed with the Toro aerator; a September only, September-May, and September-May-

June treatment. Two treatments were performed with the Coremaster unit to achieve full depth tine penetration (2.75 inches) and 1 inch tine penetration. The Coremaster was equipped with 1/2 inch diameter tines and treatments were applied in September. Two treatments were applied with the Verti-Drain unit utilizing hollow and solid tines in September. The study was initiated on September 2, 1987. Soil cores brought to the surface with each treatment were broken up with a Ryan's Mataway. The Mataway was used only to break up soil cores and did not penetrate into or remove thatch material. The organic debris left after the soil cores were broken up was taken off with a light raking. The plot area received minimal traffic from routine maintenance operations.

The data in Table 1 demonstrated that visual quality was not consistently influenced by cultivation influence until August of 1988. Frequently treated (3 or more treatments applied) plots showed a positive response to cultivation. Soil incorporated back into the turf/thatch with cultivation on a frequent basis enhanced visual quality by maintaining a slightly darker and more uniform color. Turf density was superior on all plots in this study. Modifying thatch with soil has several desirable aspects. Soil incorporation will serve to cover crowns, rhizomes, and roots growing in the thatch layer. The soil also provides protection (buffering) against extremes in moisture and temperature. Adequate soil additions to thatchy turf will reduce mower scalp. Improved environmental conditions in soil surface/thatch should increase root activity (functioning). A better functioning surface root system will improve nutrient utilization within the turf surface zone.

Table 1. The influence of several cultivators on visual quality of a "Ram I" Kentucky bluegrass turf.

	Evaluation Date (9=Ideal)	
TREATMENTS	6/22/88	8/25/88
Toro Sept	7.3 ab	8.3 bc
Toro Sept-May	8.0 ab	8.7 ab
Toro Sept-May-June	8.3 a	9.0 a
Coremaster full depth	8.3 a	7.8 c
Coremaster 1" depth	7.0 b	7.8 c
Verti-Drain Hollow	8.0 ab	7.8 c
Verti-Drain Solid	8.3 a	8.0 c
Check	8.3 a	7.8 c
L.S.D. (.05)	1.0	0.7

A third cultivation study, initiated in 1988, examined the effect of hollow tine cultivation (HTC) on shoot and root growth of a heavily compacted "Cheri" Kentucky bluegrass turf. All plots received 6 passes of compaction per week with a Ryan's water filled vibrating roller. HTC was applied on 7/6, 8/10, and 9/28 in 1988. Fresh clippings yields were collected on various dates following each treatment date and are presented in Table 2. Soil core samples were collected and roots were washed free of soil for weight analysis in October, 1988.

Table 2. Clipping yield of "Cheri" Kentucky bluegrass as influenced by hollow tine cultivation (HTC) on 7/6, 8/10 and 9/28 in 1988.

	Fresh Clipping Yields							
	Date							
	7/25	8/10	8/19	8/24	8/31	9/6	9/13	9/26
TREATMENTS	$g\ m^{-2}\ day^{-1}$							
Check	13.7	5.7	8.4	8.3	13.4	7.7	3.6	2.6
HTC	11.1	5.5	5.6	5.7	9.8	6.1	3.2	1.8
L.S.D.(.05)	2.3	NS[a]	2.0	1.4	2.1	NS	NS	NS

a NS denotes not significant

HTC reduced shoot growth up to 3 weeks following the second treatment application when compared to the noncultivated treatment (check). The removal and injury of plant crown tissue with HTC could explain some of the loss in shoot growth. However, the maximum area affected by two HTC treatments is considerably less than the percent clipping yield reductions. In addition to heavy compaction stress, high temperature stress predominated this growing season. It is possible the combination of crown tissue injury, compaction and high temperature stress could have resulted in the greater than expected reduction in yields. Once air temperatures declined no differences were detected between HTC and check plot clipping yields. This data points out that midseason cultivation could be harmful to already weak stands of turf. When considering cultivation the vigor of the turf must be evaluated in order to determine the intensity of cultivation the turf can withstand.

Table 3 presents root data of October, 1988. HTC had no significant effect on total root weight or root weight densities. There was a tendency for more roots to occur in the surface 2 inches, however, this response was not consistent across all plots. This data suggests that intense cultivation treatment may not have major a impact on root weight in a single season. However, the activity or functioning of the root system following HTC treatment still needs to evaluated. This research will be continuing.

Table 3. October, 1988 root weight and root weight densities of "Cheri" Kentucky bluegrass as influenced by hollow tine cultivation (HTC) on 7/6, 8/10 and 9/28 in 1988.

	Total Root Weight	Root Weight Density Zones (cm)		
	0-20 cm	0-5	5-10	10-20
TREATMENTS	kg m^{-2}	----------- kg m^{-3}	-----------	
Check	0.106 a	1.38 a	0.35 a	0.19 a
HTC	0.115 a	1.57 a	0.36 a	0.19 a
L.S.D.(.05)	NS[a]	NS	NS	NS

a NS denotes not significant

SUMMARY

Cultivation is one cultural practice the turf manager can use to alleviate poor soil conditions associated with compaction. Aerators with wide tine spacings will require several passes to alleviate problems associated with severely compacted soil. Deep tine cultivators, which penetrate compacted zones, can adequately manage deep soil or subsurface compaction. Incorporating soil back into a Kentucky bluegrass turf/thatch with frequent cultivation can enhance turf quality (slightly darker and more uniform color). Prior to performing cultivation the vigor of the turf must be evaluated in order to determine the intensity of cultivation the turf can withstand. Cultivation treatment may not have major a impact on the amount of roots during that season. However, the activity or functioning of the root system following core cultivation treatment still needs to be investigated.