Long-Term Aerification

A bentgrass fairway study compares hollow- and solid-tine core aerification.

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Saturated hydraulic conductivity in field plots was estimated using a Guelph permeameter. In general, saturated hydraulic conductivity was inversely related to the intensity of aerification.

TURF CULTIVATION by core aerification has many beneficial effects on turf. Better thatch control, less soil surface compaction, more uniform water infiltration, and improved surface aeration and rooting are often observed (Carrow et al., 1987; Erusha et al., 1989; Dunn et al., 1995; Lederboer and Skogley, 1967; Shildrick, 1985; White and Dickens, 1984). However, since thatch substantially increases pesticide sorption, reduction in thatch by coring may increase the potential for pesticides to move off the site (Dell et al., 1994).

Soil compaction in heavily trafficked areas of golf course fairways is often a problem, especially on heavy, wet soils, as frequently occur in the Pacific Northwest. Aerification with hollow tines, generally followed by sand topdressing, is commonly used to relieve this stress, but the aerification frequency needed, the turf disturbance caused, and the time and labor required are not always desirable. Aerification with solid tines rather than hollow tines has been used to some degree to reduce surface disturbance and labor requirements. However, core aerification may enhance turfgrass injury due to stress, increase weed establishment, decrease turf quality through disruption of the turf surface, and possibly slow water percolation through creation of a compacted zone of soil below the depth of coring tines (Erusha et al., 1989; Murphy, 1993; Shildrick, 1985).

A compaction zone, if present, may be different between hollow-tine coring (HTC) and solid-tine coring (STC) due to the differences in downward forces imposed by tine structure on soils. This study was designed to measure the effects of HTC and STC over several years on thatch development, soil bulk density, and hydraulic conductivity in a bentgrass fairway-type turf.

Experimental Methods

A five-year study was conducted on a fine sandy loam soil at the Turfgrass Field Laboratory at the Washington State University Puyallup Research and Extension Center, Puyallup, Wash. Core aerification was performed by HTC or STC on a well-established bentgrass fairway turf. At the beginning of aerification treatments in 1983, there were 1.6 to 1.9 inches of thatch. The turf was routinely clipped at 0.75 inches, fertilized at 131 lb./A (3 lb./1000 sq. ft.) annually with 21-7-14, and irrigated to prevent stress. A Greensaire II aerifier (Ryan/Ransomes America Corp., Lincoln, Neb.) was used in aerification and was equipped with 0.5-inch diameter hollow or solid tines. Treatments consisted of 0, 2, 4, or 6 aerifications annually between March and October via HTC, STC, or alternate hollow- and solid-tine coring (H/STC). Aerifications were made at the following times: two times annually during March and October; four times annually during March, May, August, and October; and six times annually during March, May, June, August, September, and October. Aerification was done when soil moisture was below field capacity and never when the soil was considered to be wet. Soil cores following HTC were removed, and the turf, including non-aerified treatments, was topdressed with approximately 8 cu. ft./1000 sq. ft. of sand (1 to 2 mm, 3.6%; 0.5 to 1.0 mm, 32.2%; 0.25 to 0.5 mm, 52.9%; 0.1 to 0.25 mm, 8.4%; and < 0.1 mm, 1.3%) following each treatment.

Thatch depth, dry weight, and density were determined in July 1983 and again in November 1988. Field-saturated hydraulic conductivity estimates were made during July and August 1989 using a Guelph permeameter (Soil Moisture Equipment Corp., Santa Barbara, Calif.). Soil bulk density values were taken in September 1989.

Results

After five years of core aerification, the net increase in dry weight of thatch was different between coring methods. HTC was more effective than STC in reducing net thatch buildup. Two to four aerifications annually were highly effective in controlling the change in thatch depth and dry weight (Table 1). White and Dickens (1984) previously found four to six core aerifications annually were required to have a major effect on thatch or related soil properties. However, in this study, six corings annually did not completely maintain thatch depth or dry weight at pre-study levels.

Thatch density increased markedly with increasing intensity of aerification over the five-year period. High-density thatch provides a more tortuous path for water, which increases resistance and allows for greater infiltration and reduced surface runoff from bentgrass fairways (Linde et al., 1995). The response in thatch to aerification intensity was the same for all aerification methods.

Since HTC, to some extent H/STC, and increasing the number of annual core aerifications were all effective in reducing net thatch development, it seemed that physical removal of cores was an important factor controlling thatch development in bentgrass fairway turf. Improved soil biological activity due to frequent aerification plus sand topdressing following aerification may have been important in reducing thatch in these treatments.

Soil bulk density, following five years of coring at the 4- to 5-inch soil depth, was not affected by aerification method or by increasing the intensity of aerification (Fig. 2). However, there was a trend toward soil bulk density steadily increasing as the number of annual aerifications increased, which may indicate the development of a compaction zone below the depth of tine penetration over a period of time. Field-saturated hydraulic conductivity below the aerification zone (4 inches below the turf surface) was slightly greater with STC than HTC or H/STC. However, Murphy et al. (1993) reported that when aerifying a moist or wet loamy sand putting green soil profile, saturated water conductivity was 49% greater with HTC than STC. They also reported that STC provided short-term benefits, required repeated applications, and exhibited the potential for development of a cultivation pan. Field-saturated hydraulic conductivity was, in general, inversely related to the intensity of aerification annually. Two corings annually had a marked reduction in hydraulic conductivity with little additional decrease caused by additional coring annually.

Conclusions

HTC was more effective than STC in controlling change of thatch dry weight over a 5-year period. H/STC tended to be intermediate in performance. Two aerifications annually had a positive impact on change in thatch; however, six aerifications annually were required to have a major effect on thatch or soil properties. Soil bulk density below the depth of tine penetration was not changed by method of coring. However, soil bulk density below the aerification zone consistently increased as the number of annual corings increased, which suggests that long-term use of core aerification, especially in heavy soils, may result in development

Table 1
Net change in bentgrass thatch depth, dry weight, and density after five years due to 0 to 6 core aerifications per year.

Number of annual core aerifications	Net change in thatch: Depth (cm)	Ashed dry weight ($kg\ m^{-2}$)	Density ($kg\ m^{-3}$)
0	3.0 a	1.6 a	-2.7 d
2	2.7 ab	1.0 b	2.5 c
4	2.2 bc	0.6 c	6.4 b
6	2.0 c	0.2 d	11.0 a

Mean of 36 10cm cores averaged over coring methods. Means within columns not followed by the same letter are different by Fisher's protected LSD ($P = 0.05$).

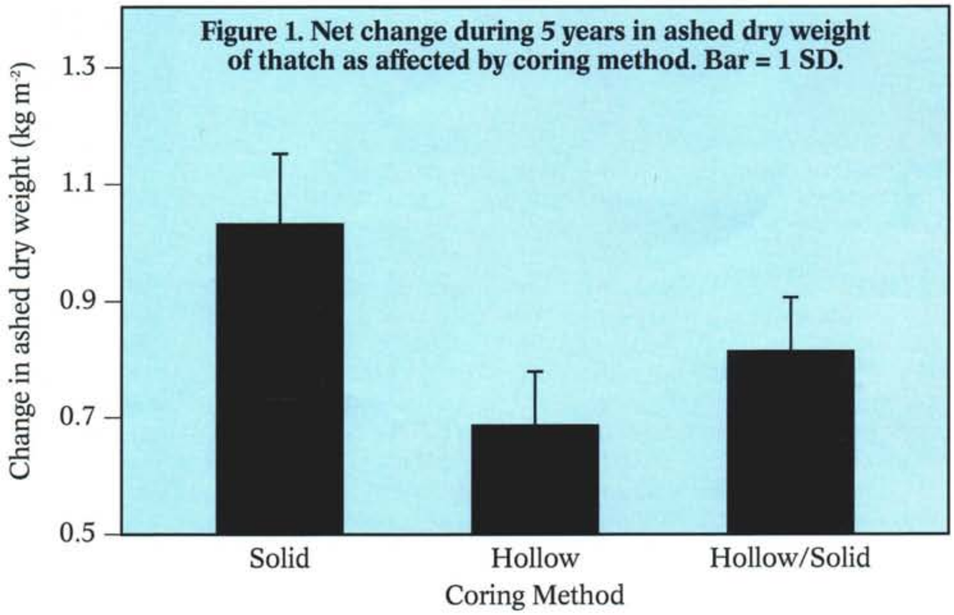

Figure 1. Net change during 5 years in ashed dry weight of thatch as affected by coring method. Bar = 1 SD.

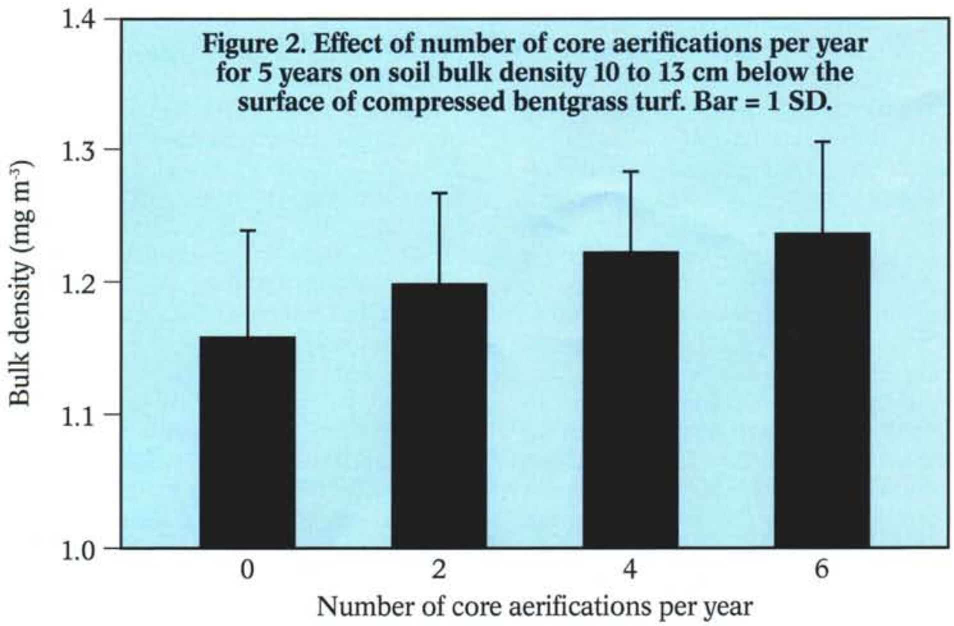

Figure 2. Effect of number of core aerifications per year for 5 years on soil bulk density 10 to 13 cm below the surface of compressed bentgrass turf. Bar = 1 SD.

Core aerification was conducted on the bentgrass fairway research plots at the Washington State University Research and Extension Center, Puyallup, Washington, during the five-year study of long-term aerification techniques.

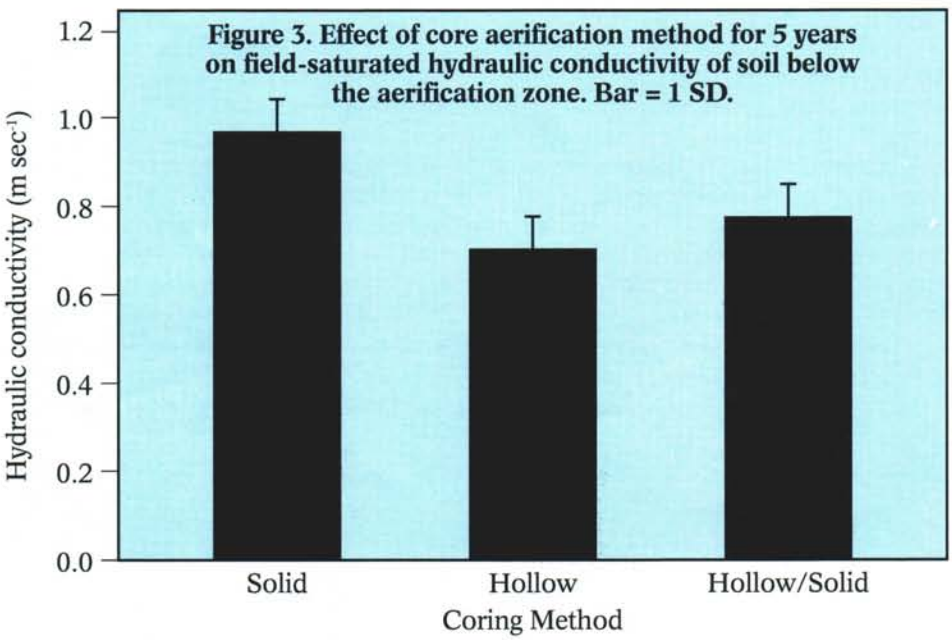

Figure 3. Effect of core aerification method for 5 years on field-saturated hydraulic conductivity of soil below the aerification zone. Bar = 1 SD.

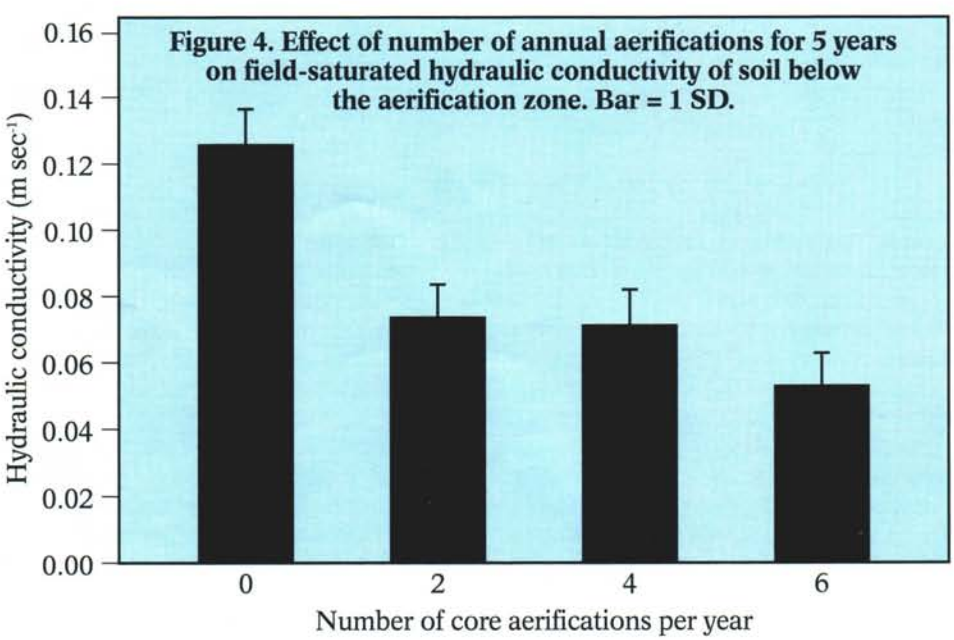

Figure 4. Effect of number of annual aerifications for 5 years on field-saturated hydraulic conductivity of soil below the aerification zone. Bar = 1 SD.

of a compacted zone. Field-saturated hydraulic conductivity 4 inches below the turf surface was reduced by increasing the number of annual corings, but soil receiving STC retained the ability to conduct water to a greater extent than that receiving HTC. Hydraulic conductivity values suggest that a compacted zone below the depth of tine penetration may be formed earlier with HTC than with STC, particularly when STC is conducted on soils that are dry and easily fracture in the compaction zone.

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