Effects of Core Aeration on USGA Putting Greens

By Peter Sorokovsky

Everyone aerates greens. But just what are the effects of core aeration on soil physical properties of United States Golf Association (USGA) putting greens?

A study was conducted in Surrey, British Columbia, under temperate climate with cool and wet winters and relatively warm summers. Mean annual precipitation was 1,310 millimeters (mm). Three of the regular playing putting greens as well as four practice greens at Northview Golf and Country Club were used in the study.

All greens were constructed using USGA specifications, and turfgrass was a mix of Providence bentgrass (30 percent to 40 percent) and annual bluegrass (60 percent to 70 percent). The experiment was laid out as a randomized, complete block design with three 100-square meter (m) replicates. Treatments included:

(1) no core aeration (NCA);
(2) core aeration (CA); and
(3) control.

All regular maintenance practices, such as mowing, fertilizing, irrigation, sand topdressing, vertical cutting, brushing, rolling and regular foot traffic, occurred on both the CA and NCA treatments. The control only received fertilizing, irrigation, mowing and no foot traffic through the duration of the experiment.

Core soil samples were collected using a standard cup cutter (diameter 10.8 centimeters cm) at the 0 cm to 17 cm depth (mat layer [approximately 4 cm to 7 cm deep] and the sand layer [approximately 8 cm to 17 cm deep]) for bulk density and water content. Mechanical resistance was measured up to 20 cm in depth, using a Rimik cone penetrometer.

Infiltration rates were measured from steady

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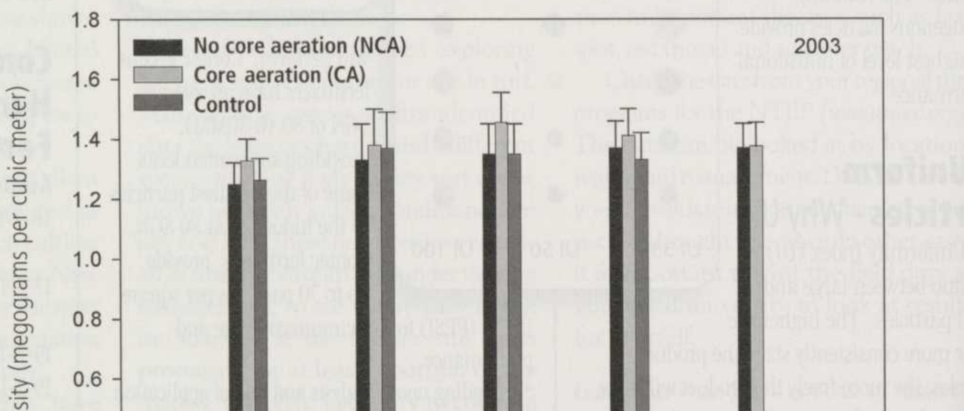
FIGURE 1



Soil bulk density measured in the mat layer (0 cm to 7.5 cm) under three different management practices in 2003. Error bars represent confidence limits from the MS error anova (n=3). Control for September is absent due to the reconstruction of two of three control putting greens by management

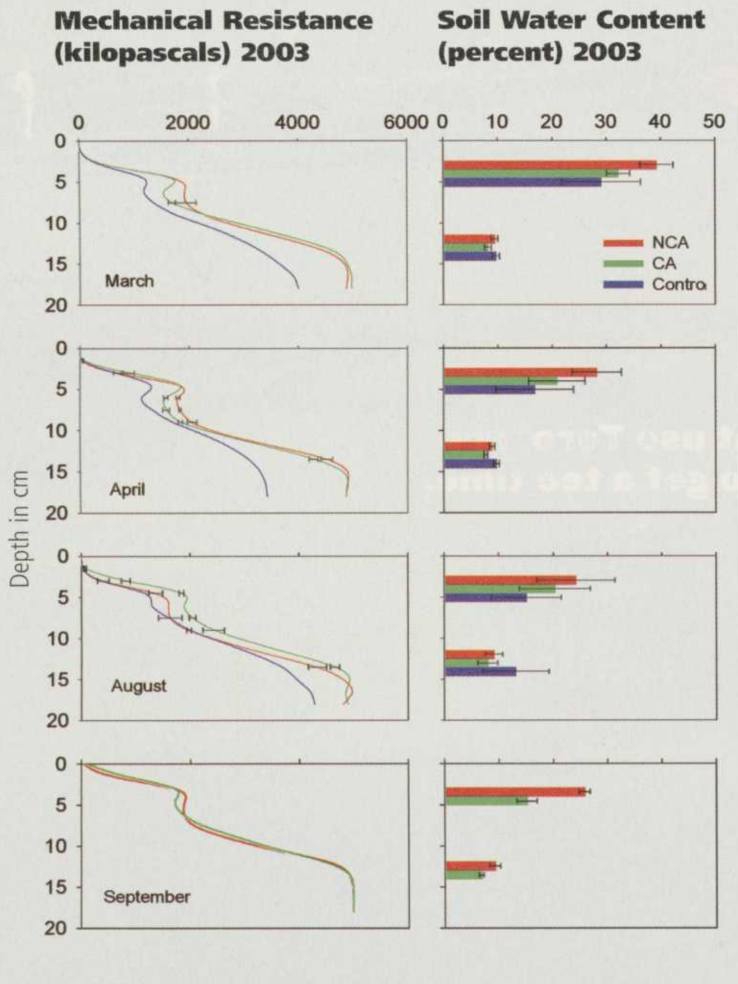
TABLE 1

Average soil bulk density for mat and sand layers:

Bulk Density (megograms per cubic meter)	Sep	Oct	Mar*	Apr*	Jun*	Aug*	Sep*
	Sampling Months for 2002, '03*						
Mat Layer	1.36	1.36	1.28	1.36	1.39	1.37	1.37
Sand Layer	1.56	1.56	1.57	1.57	1.59	1.48	1.64

For August and September 2003 the average soil bulk density is a represented by NCA and CA treatments only.

FIGURE 2



Soil mechanical resistance and water content measured under three different management practices in 2003. Error bars represent confidence limits from the MS error anova (n=3). The control treatment for September is absent due to the reconstruction of two of three control putting greens by management.

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state using a double-ring infiltrometer (inner ring diameter = 28 cm, outer ring diameter = 56 cm). Percent organic matter was determined by loss on ignition. Sampling and measurements were done before and after three core aeration events on Sept. 28, 2002, and March 30 and Aug. 24, 2003. All core aeration previous to 2004 was done twice a year (spring and fall) at a consistent depth, i.e. from 4 cm to 6 cm.

Soil bulk density measurements of the mat layer revealed no difference in any of the treatments (Figure 1.). However, this was not the case when soil bulk density from the mat was compared to the sand layer.

All sampling times were significantly different to the 0.01 probability level on analysis of variance. This is partly attributable to the development of a compaction pan and almost no organic matter accumulation in the sand layer. From September 2002 to September 2003 the mat layer average soil-bulk density for all treatments was 1.36 megograms (Mg) per cubic meter while for all sand layers it was 1.57 Mg per cubic meter.

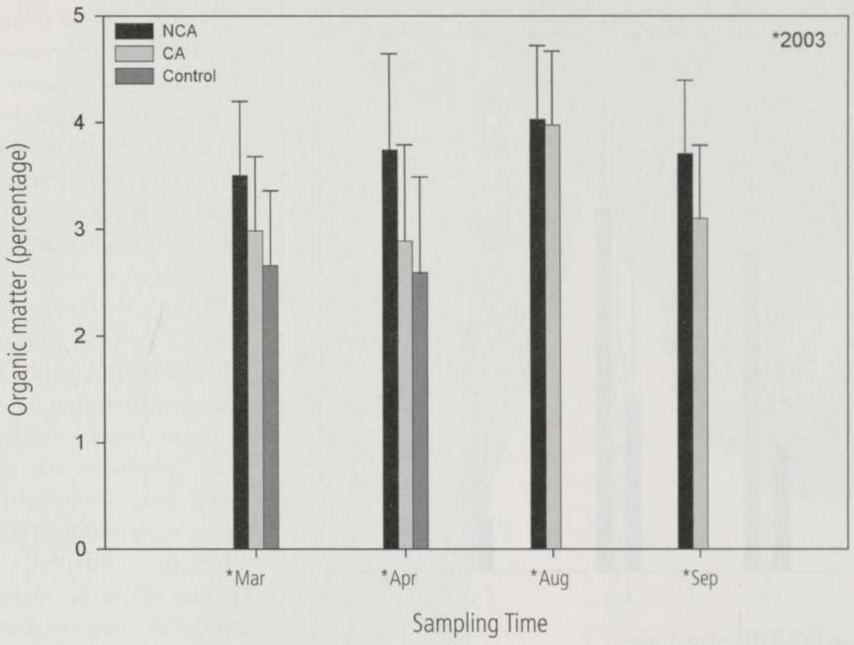
Table 1 shows average soil bulk density of all treatments for each sampling time from the mat and sand layers. This data clearly shows a significant increase in soil bulk density below the depth of core aeration indicating the development of a compaction pan. According to Guertal et al (2002), care should be taken to avoid creation of a compaction pan, caused by aerifying at the same depth for a prolonged period of time.

There was no trend in the data to indicate that treatments differed from one another with respect to soil mechanical resistance (Figure 2).

All the soil mechanical resistance data consistently gave the same pattern form each sampling time with a greater compacted area occurring within the mat layer at about 4.5 cm to 7 cm. Although the graph pattern had not changed throughout the study, the average soil mechanical resistance increased from 1,413 kilopascals (kPa) (March 2002) to 2,055 kPa (May 2004) in the most compacted area of the mat layer (4.5 cm to 6 cm). The mechanical resistance data clearly reveals a pan layer developing and increased soil strength preventing root penetration below 6 cm to 8 cm.

Somewhat surprisingly, there was no difference between treatments when percent organic matter (by mass) was measured after core aeration

FIGURE 3



Percent organic matter (by weight) content measured under three different management practices in 2003. Error bars represent confidence limits from the MS error anova (n=3). The control treatment for August and September is absent due to the reconstruction of two of three control putting greens by management.

practices. The probable reason for this was due to the small-diameter tines that were used (13 mm outside diameter) and the spacing pattern of core holes (50 mm x 65 mm) only impacting 6.4 percent of the total surface area of the putting green. This small percentage of surface area impact could easily fall within sampling error.

Figure 3 shows the percent organic matter content for each treatment. Similar to this study, Murphy et al (1993) found that core aeration on sand-based putting greens (at a 5 percent surface area impact) applied twice a year did not permanently reduce total organic matter content. Smith (1979) reported that organic matter content (in a bermudagrass loamy fine sand putting green) was only reduced when core aeration was increased from twice yearly to monthly over a seven-month study.

Although core aeration under the current level of impact does not, in a single management application, reduce organic matter, it does help to keep organic matter levels under control when combined with sand topdressing.

In March 2002 the percent organic matter was about 2.75 percent, and by the end of the study (May 2004) it was 2.90 percent. According to Carrow (2004), keeping organic matter below 4 percent would reduce the impact of summer bentgrass decline.

The only soil property that was impacted significantly by core aeration was water infiltration rate. The two sample times (April and September) revealed that CA treatment had greater water infiltration rates than the NCA treatment after core aeration had occurred (Figure 4). Not surprisingly, the greatest infiltration rates were observed on the control plots where little to no traffic occurred.

According to Shreier (2004), high traffic rate would cause a fractionation of the organic matter into smaller size, increasing its surface area and increasing water-holding capacity and decrease infiltration rate. According to McCarty (2001), infiltration rate on USGA-designed putting greens should be no lower than 100 mm per hour for maturing putting greens (over 1 year old). The exception was found for the NCA treatment in April and September, where infiltration rate is below 100 mm per hour.

After core aeration, Carrow (2004) indicated that higher infiltration rates last only five weeks to

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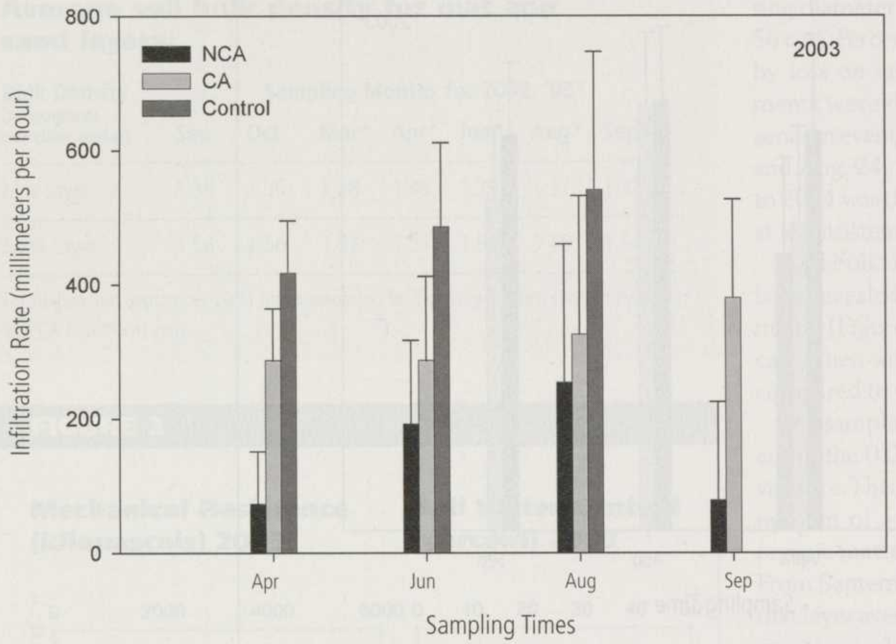
FIGURE 4



Water infiltration rate measured using a constant-head double-ring infiltrometer under three different management practices in 2003. Error bars represent confidence limits from the MS error anova (n=3). The control treatment for September is absent due to the reconstruction of two of three control putting greens by management.

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eight weeks before reducing to normal and would need some manner of summer cultivation to keep infiltration high. The most probable reason for seeing higher infiltration rates through the summer on NCA and CA treatments was due to a wetting agent application in mid-May and bimonthly verticutting and topdressing.

Guertal et al (2002) and Murphy et al (1993) state that core aeration in a non-compacted site is damaging to soil structure and should not be used without a clear objective and that core aeration in the non-compacted plots had no effect in reducing bulk density. Similar to those studies, the data recorded from this study indicate that core aeration applied twice annually will not reduce bulk density in a non-compacted sand-based putting green.

It does appear from the soil mechanical resistance data that core aeration will increase soil strength below the depth of core aeration if it is used continuously at a specific depth of application. Although water content was not significantly different between treatments, the NCA treatment was consistently higher than the other treatments.

Qualitatively speaking, the NCA treatment was softer under foot throughout the study. Again, although not significantly different, the amount of organic matter in the NCA was consistently higher, which would increase water-holding capacity and reduce infiltration rates.

Core aeration with 13 mm tines and 25 mm x 25 mm hole spacing could impact a greater amount of surface area (22.3 percent). If properly timed, a single core aeration application per year may be adequate to ensure good drainage through the rootzone mix. Also, reducing the number of aerations and changing depth of application each time may reduce the chance of developing a compaction pan. Careful consideration of what is to be accomplished with core aeration must be considered before application in order to obtain the best results.

Peter Sorokovsky has worked in the golf industry for over 15 years, starting with a summer job to pay his way through the University of British Columbia, where he earned a bachelor's degree in biology. Ten years later, he returned to UBC to pursue a master's in soil science to further his career opportunities.

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