To Air Is Human When It Comes to Anaerobic Greens

By Chong, S.-K., R. Boniak, S. Indorante, C.-H. Ok and D. Buschschulte

Management of anaerobic golf greens has always been a dilemma to golf course superintendents and turf researchers (Bunnell and McCarthy, 1999; Chong et al., 2000). Anaerobic soils limit the amount of free oxygen available in the rootzone and therefore will impede root development and restrain nutrient availability for turf growth.

Since soil air content in the rootzone depends very much upon the aeration rate with the atmosphere, respiration rate of microorganism and plant roots and solubility of gases in water, it's important to further understand the influences of soil air on turf growth. The objective of this study was to examine the influence of carbion dioxide ($CO_{2)}$ content in golf green rhizosphere on turf quality.

The study was conducted on the existing greens at the Hickory Ridge Golf Center in Carbondale, Ill. The 18-hole golf course was constructed in 1993 and opened in 1994. The greens were constructed in California-style without a layer of gravel between rootzone mix and the native soil.

Nine greens were randomly selected. On each green, five 1-meter diameter circular plots were randomly selected for measurement. The first measurement was made on Aug. 29, 1998.

Data collected from each plot included water content, CO_2 content, turf quality index and soil physical and chemical properties. In order to be consistent and to minimize the climatic influence on CO_2 content, all experiments were conducted between 6 a.m and 10 a.m.

The greens were cultivated using the hollow tine (1.2-centimeter (cm) diameter, 5 x 5-cm spacing and 7.5-cm deep) in the first week of April and the last week of August in1998. In 1999 the cultivation was performed again in the first week of April. In mid-June, the green was water-injection cultivated once using a Hydroject (Murphy and Rieke, 1994). No other cultivation was conducted until the end of the experiment.

Water content (from 0-20 cm) was detected

FIGURE 1

Mean variation in rootzone CO_2 content between August 1998 and September 1999 in golf green at Hickory Ridge Golf Center, Carbondale, Ill.

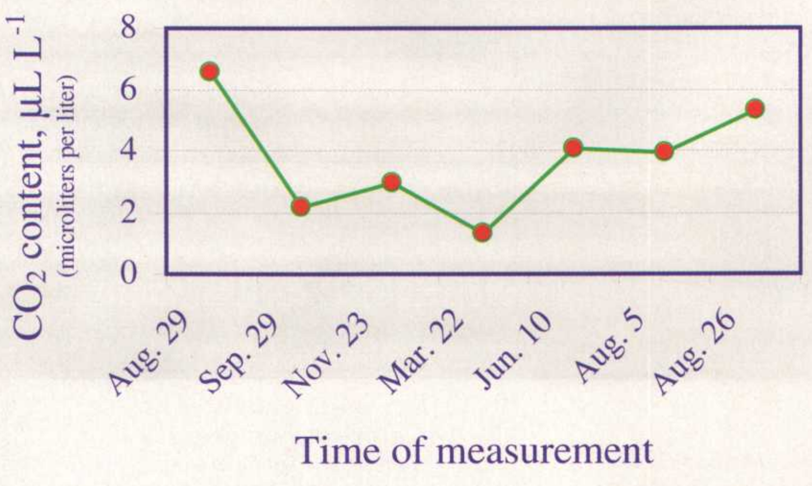
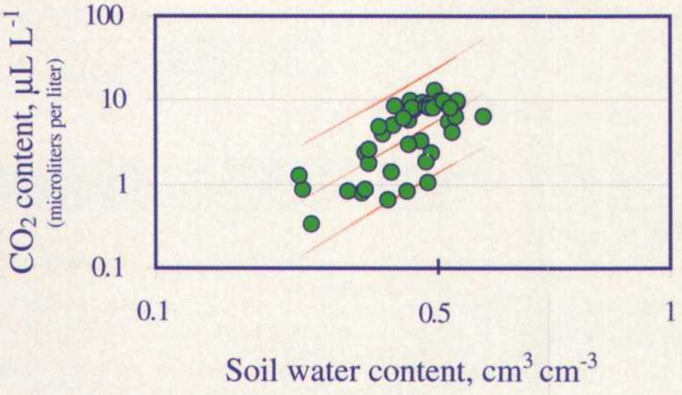


FIGURE 2

CO_2 content increased when water content in the golf green rootzone increased.



er value and finally it decreased because of infiltration of atmospheric air into the profile. The highest reading was recorded for analysis. Turf quality was scored at the same time when CO_2 was measured using the method described by Chong et al., 2000.

The CO_2 was measured seven times for the entire study from August 1998 to August 1999. Infiltration was measured only once using a single-ring (12.7 cm in diameter) infiltrometer.

by time domain reflectrometry (TDR, by Soil moisture Equipment, Santa Barbara, Calif.). The *in situ* CO_2 content in the rootzone was measured using a gas analyzer (Subair, Inc., Deep River, Conn.). In the measurement, a 16-cm (depth) hole was prepared using a 1.2-cm diameter auger. Right after pulling the auger out from the green, a small Plexiglas tube (8 cm long, with 3.2 and 6.35-millimeter (mm) inside and outside diameters, respectively) was immediately inserted into the hole for extracting CO_2. The inlet of the tube was inserted into the hole and held at 8 cm below the green surface. The outflow of the tube was connected to a gas analyzer through a rubber stopper. The rubber stopper was used as a plug for the hole in the green to prevent soil air contamination by the surrounding atmospheric air.

Soil air was withdrawn directly from the profile and CO_2 content was detected as the soil air passed through the gas analyzer. The reading of CO_2 content started from zero and gradually increased to a high-

Results and discussion

Large variations in rootzone CO_2 content were found both spatially and temporarily (see Figure 1) in a golf green.

In general, CO_2 content in the golf green rhizosphere was low during the dormant season. But, it increased to as high as 13 microliters per liter ($\mu L\ L^{-1}$) during the late summer. A curve linear relationship (see Figure 2) was found between soil moisture and CO_2 content.

Continued on page 64

FIGURE 3

CO_2 content decreased as infiltration rate of golf green increased.

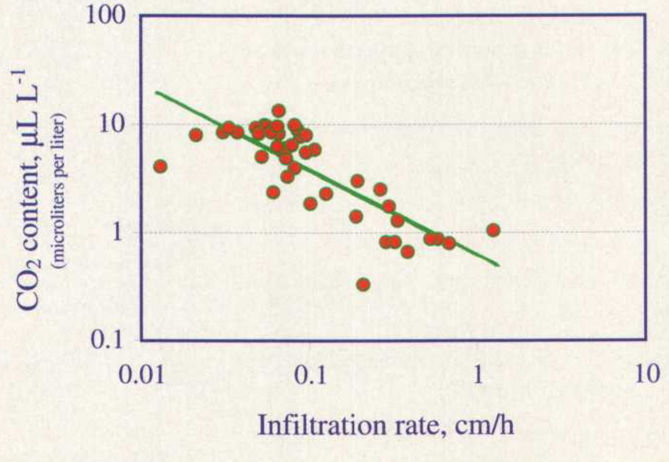
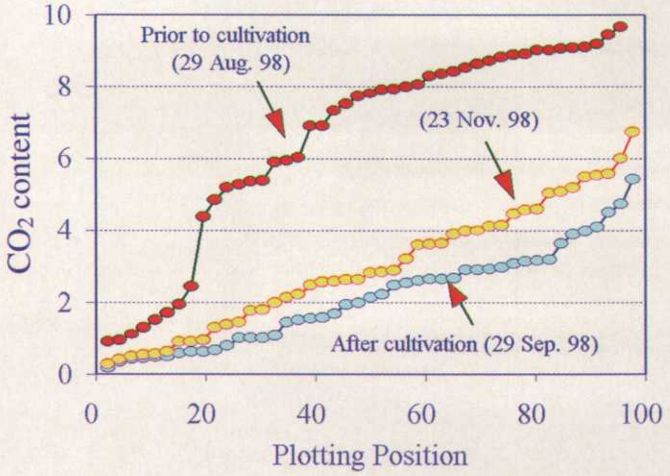


FIGURE 4

CO_2 vs. probability (before and after cultivation)



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As water content increased, CO_2 content in the rootzone increased, but CO_2 content decreased as water infiltration rate of the rootzone increased (Figure 3). When CO_2 content in the rootzone accumulated higher than 5 microliters per liter, turf quality drastically declined.

Undoubtedly, cultivation of the green can reduce CO_2 content in the root zone but the benefit of cultivation decreased with time (Figure 4). Green cultivation generally runs in the early or late growing seasons. Unfortunately, CO_2 content in rootzone could accumulate over 9 microliters per liter, particularly in the middle and late summer.

At the time aeration is needed, other concerns such as causing turf injury, disturbing golf green and losing playability time has prevented superintendents from aerifying. Therefore, nontraditional cultivation methods such as water injection and sub-airing should be applied to alleviate anaerobic condition to enhance turf growth.

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REFERENCES

Bunnell, T. and B. McCarthy. 1999. "Gas underground." *Golf Course Management.* 67(10): 65-69.

Chong, S.-K., S. Indorante, D. Buschschulte and R. Boniak. 2000. "Is your turfgrass suffocating." *Golf Course Management.* 68 (7):72-75.

Chong, S.-K., Richard Boniak, S. Indorante, C.-H. Ok and D. Buschschulte. 2003. "CO_2 Content in Golf Green Rhizosphere." *Crop Science* (In press).

Murphy, J.A and P.E. Rieke. 1994. "High pressure water injection and core cultivation of a compacted putting green." *Agronomy J.* 86 (4) 719724.

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