Rooting and Carbohydrate Metabolism in Creeping Bentgrass Putting Greens in Response to Summer Irrigation and Aeration

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Objectives:

1. Evaluate physiological processes and rooting of putting green height creeping bentgrass in response to two irrigation management and three aeration regimes.
2. Determine the influence of aeration and irrigation frequency on creeping bentgrass summer performance and root longevity during periods of supraoptimal temperature stress.
3. Provide information on the effects of soil temperature and soil water content on carbohydrate metabolism and its relationship to summer bentgrass decline.

Start Date: 2006
Project Duration: three years
Total Funding: $90,000

Although the significance of rooting on whole plant function is widely recognized, there has been little study on the impact of irrigation and aeration management on rooting in creeping bentgrass grown in a sand-based rootzone under field conditions. Very little is known about physiological processes controlling root mortality in response to irrigation and aeration management.

'Providence' creeping bentgrass was established in September 2005 on a sand-based rootzone built to USGA specifications at the University of Maryland Turfgrass Research Facility. One study assessed three aeration regimes (no aeration, spring only, and spring plus summer) and a second study assessed two irrigation regimes (frequent and infrequent).

A spring aeration program included core aeration using hollow tines (0.5 in. diam.) on April 29, 2007. A spring plus summer aeration June 6 and July 3 and 31, 2007 was conducted using narrow diameter tines (0.25 in. diam.). In the irrigation study, plots were irrigated daily to a depth of 4 to 6 cm (i.e. light, frequent) or irrigated deeply and infrequently about once weekly to saturate soil to rootzone depth at the first signs of wilt.

Root growth and production were quantified on May 23, July 20, and September 4 for the irrigation study and on May 1 and 30, July 13, and September 4, 2007 for the aeration study by using the minirhizotron imaging technique. Clear butyrate tubes remained in place over winter and were used again in 2007. A total of 5,400 video images of roots visible against the surface of the tubes were recorded in 2007 using a high-magnification minirhizotron camera and camcorder.

Soil temperature was measured by installing temperature sensors about 0.8 inches below the soil surface.

Soil moisture at 2.6 to 5.9 inches deep was determined using Trase time domain reflectometry. Soil moisture at 0 to 2.6 inch depth was measured using an HH2 moisture meter. Soil temperature was measured by installing temperature sensors about 0.8 inches below the soil surface.

Turf quality and color were assessed visually using a scale of 0 = brown or dead turf; 7.0 = minimum acceptable quality or color; 10 = optimum greenness, uniformity, and density. Five soil cores were removed from each plot on April 25, July 18, and September 5, 2007 and uncompressed thatch depth was recorded. Organic matter in the thatch/mat layer was determined by combustion.

Canopy net photosynthesis and whole plant respiration were measured on May 31, July 2 and 24, August 14, and September 6, 2007 using a LI-6400 portable gas exchange system. Leaf and root tissues were collected biweekly and analyzed for carbohydrate content. Canopy temperature was measured periodically (June 8, July 7 and 15, and August 13 and 30, 2007) at the first sign of wilt using a hand-held infrared thermometer.

Summary Points

- Both spring and summer aeration caused a transient reduction in turf quality and the recovery period was approximately 3 to 4 weeks.
- Summer and spring aeration generally enhanced photosynthesis but had no effect on respiration. Aeration reduced the amount of organic matter but not the depth of the thatch/mat layer.
- Soil moisture at 0 to 2.6 and 2.6 to 5.9-inch soil depths was significantly lower for deep infrequent-irrigated plots compared to light, frequent-irrigated plots.
- Deep, infrequent irrigation reduced creeping bentgrass quality, photosynthesis, and thatch/mat depth but had no effect on respiration during the experimental period.
- Deeply and infrequently irrigated creeping bentgrass experienced an increase in canopy temperature, a reduction in soil temperature, and a decrease in organic matter in the thatch/mat layer during the summer.
- When data were analyzed over the entire 9.25-inch soil profile, deep, infrequent irrigation of creeping bentgrass resulted in greater total root count, longer total root length, larger total root surface area, and greater total root volume on all four monitoring dates in 2006 compared to light, frequently irrigated bentgrass.
- In the immature (<1 year) creeping bentgrass in 2006, spring plus summer aeration generally reduced total root count, and resulted in shorter total root length, smaller total root surface area, and less total root volume compared to spring and non-aerated bentgrass.