Effect of Sunlight, Temperature, and Relative Humidity on Putting Green Health in Chicago

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Background

Light is essential for maintaining healthy turfgrass. However, landscape features can lead to light deficiencies on golf courses, especially on greens. During July and August of 2007, air temperature, soil temperature, relative humidity, and photosynthetically active radiation (PAR) were measured at 15-minute intervals on one putting green at 15 Chicago area golf courses. The transition period between July and August was selected to capture the historical period of golf green physiological decline in Chicago, IL.

Research Objective: At midsummer, determine greatest environmental contributor to physiological decline of greens, an abiotic disorder of creeping bentgrass (*Agrostis stolonifera),* and *Poa annua*.

Materials and Methods

At each course (see below), the superintendent allowed the deployment of a mini-weather station, mounted 1 ft high, on the green collar edge. Soil temperature was measured at a 2 in depth. Environmental measurements were averaged over the entire month. Whenever possible, a shaded location was selected. On two dates, 23 Jul and 23 Aug, plant health was assessed by visual quality ratings and normalized difference vegetative index (NDVI). Plant health measures were taken from two strips within a split area of 12 ft X 18 ft nearest the weather station on collar edge. The outer 6 ft strip showed greater stress/decline (visual quality/NDVI, $P < 0.01$). Mechanical stress did not influence correlations with environment, so two plant health measures per site were pooled for analysis. Statistical analysis was performed to identify correlations between measured environmental data and turf health indicators. All measurements occurred between 23 Jul and 23 Aug. Composition of turfgrass species (bentgrass : *Poa annua*) on each green was estimated at study start.

Golf Course/Country Club, City, and Golf Course Superintendent

North suburbs
- Biltmore CC in N. Barrington, Brian Thomson
- Bryn Mawr CC in Lincolnwood , Brian Bossert
- Knollwood Club in Lake Forest, Randy Wahler
- North Shore CC in Glenview, Dan Dinelli
- Skokie CC in Glencoe, Don Cross

West suburbs
- Aurora CC in Aurora, John Gurke
- Cantigny Golf in Wheaton, Scott Witte
- Chicago GC in Wheaton, Jon Jennings
- Medinah CC in Medinah, Tom Lively
- Ruth Lake CC in Hinsdale, Dan Marco

South suburbs
- Beverly CC in Chicago, Keith Peterson
- Coyote Run GC in Flossmoor, Dave Ward
- Crystal Tree Golf & CC in Orland Park, Les Rutan
- Joliet CC in Joliet, Mark Kowaliczko
- Prairie Bluff Public Golf Club in Lockport, Ken Shepherd


Each site: weather station with PAR sensor

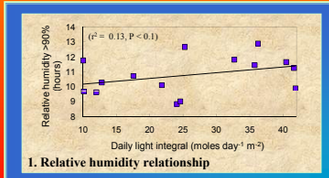

Compromised light levels by surrounding trees


Greens were optimally maintained by staff

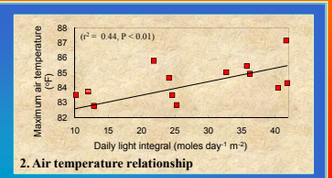
Measuring reflectance/NDVI at Aurora CC on July 23, 2007

Weather station installation at Cantigny GC, July 23

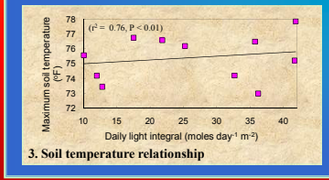
Installing soil temp. sensor



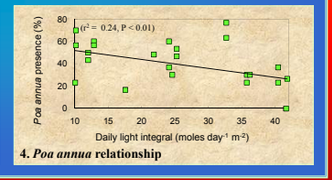
1. Relative humidity relationship



2. Air temperature relationship



3. Soil temperature relationship

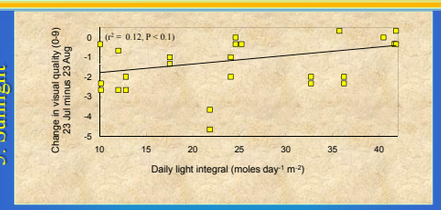


4. *Poa annua* relationship

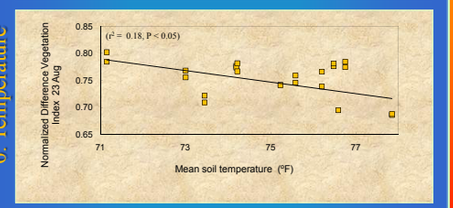
Effects of Daily Light Integral on a Putting Green Environment

1. DLI was positively correlated with hours of relative humidity greater than 90% , an indicator of turfgrass leaf wetness duration. DLI was also positively correlated with maximum relative humidity ($r^2 = 0.15$, $P < 0.05$).
2. DLI was positively correlated with maximum air temperature. DLI was also positively correlated with average air temperature ($r^2 = 0.10$, $P < 0.1$), but not minimum air temperature.
3. DLI was positively correlated with maximum soil temperature, as well as average soil temperature ($r^2 = 0.67$, $P < 0.01$), and minimum soil temperature ($r^2 = 0.37$, $P < 0.01$).
4. DLI was negatively correlated with presence of *Poa annua* on bentgrass greens when rated at study start on 23 July.

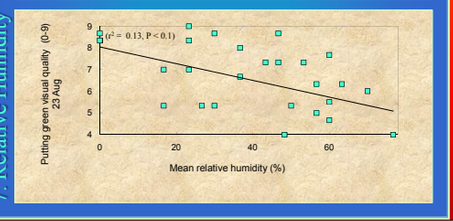
5. Sunlight



6. Temperature



7. Relative Humidity



Midsummer Decline of Greens versus Sunlight, Temperature, and Humidity

➢**5. Sunlight** DLI was positively correlated with less change/decline in visual quality during the month period (above).

➢**6. Temperature** NDVI was correlated with soil temperatures of average (above), minimum ($r^2 = 0.20$, $P < 0.05$), and maximum ($r^2 = 0.16$, $P < 0.1$). Air and soil temperatures were not correlated with visual decline (data not shown).

➢**7. Relative Humidity** Relative humidity had little impact on putting green decline. Only a change in NDVI was correlated with average relative humidity (above). RH was never correlated with visual decline (*data not shown*).

Summary

Environmental conditions

➢Daily light integral is a useful measure for putting greens, and was found correlated with multiple environmental factors. DLI also influenced the presence of *Poa annua* which lacks heat tolerance at midsummer. More shade = more *Poa annua.*

➢DLI positively related to:
- ✓Relative humidity (Fig. 1)
- ✓Air temperature (graph 2)
- ✓Soil temperature (graph 3)

➢DLI negatively related to:
- ✓*Poa annua* (graph 4)

Midsummer Physiological Decline

➢Midsummer physiological decline of greens was positively related to increasing shade on individual greens monitored at 15 Chicago golf courses, based on a change in visual quality during a month at midsummer (graph 5).

➢Air and soil temperature were related to decline, but only when compared to NDVI and not with visual quality. Soil and air temperature effects to greens can be difficult to see, and NDVI may actually be quantifying other physiological effects (graph 6).

➢Relative humidity had little impact on midsummer physiological decline of greens (graph 7).

Future Research

More research is needed to investigate whether shade itself is the main contributor to decline of putting green health at midsummer. In Chicago, one possible explanation is that shade's greatest fault is that it increases the *Poa annua* component of bentgrass greens. Compared to bentgrass, *Poa annua i*nherently has greater shade tolerance, but is less heat tolerance. It suggests bentgrass greens without a *Poa annua* component may avoid midsummer physiological decline, as long as best management practices are used by golf course superintendents.

Acknowledgements

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