Temperature Optimums and Lethal Thresholds

James B Beard

Turfgrasses can grow and/or survive across an amazingly wide range in temperatures. Actually the turf canopy interface between the soil and the atmosphere is the main surface for reflection, absorption, and reradiation of solar radiation. Thus **turfs are subjected to a wider range of extremes in temperature during a 24-hour period than either higher heights in the atmosphere or below in the root zone.** Temperatures for optimum growth and/or stress thresholds are summarized in the accompanying table as grouped by C_4 warm-season and C_3 cool-season turfgrass. Note that in most cases a temperature range is provided. This is because there are significant differences among individual turfgrass species and also among cultivars within a species. In addition, the environmental conditions for plant hardening and the physiological state of the plant as affected by cultural practices and the rate at which the temperature stress is imposed all influence the lethal temperature threshold for a given grass plant.

Soil Temperature. Many root growth responses are controlled specifically by the soil temperature. This **requires monitoring the soil temperature on site, preferably at a depth of 4 inches (100 mm) in the root zone.** This temperature gives you the best long-term prediction of temperature trends and minimizes sharp day-to-day variations that have minimal influence in most cases.

Canopy Temperature. Typically canopy temperature represents a composite integration that is affected by the soil temperature and nocturnal air temperature. High atmospheric temperatures that occur in June at soil temperatures below 80°F (27°C) are far less likely to cause heat kill than if they occur in August when soil temperatures might be at 85 to 90°F (26–32°C). The most practical way for monitoring canopy temperature is by the use of an infrared thermometer.

Tissue Temperature. The actual temperature in the tissue, especially the meristematic tissue, determines whether a grass plant will or will not be killed. Thus, a plant may grow successfully at atmospheric temperatures of 120°F as long as the tissue temperature remains below the lethal threshold point, which in the case of annual bluegrass (*Poa annua*) is in the order of 108°F (42°C). The plant will survive as long as the transpirational rate of the grass plant sustains a cooling effect to prevent tissue temperatures from rising to the lethal threshold point. Thus, the reason for stating that the tissue temperature is the critical lethal temperature and not the air temperature, especially in the case of aboveground grass shoots.

In summary, the temperature at which the grass is growing or surviving has many effects on which cultural practices are best accomplished and when. Accordingly, a microclimate monitoring system on the golf course that is connected to recording and processing software in the Operations Center for daily readouts can be a very important asset in day-to-day decision making concerning key cultural practices.

Summary of temperature criteria affecting cool- and warm-season turfgrasses.

Temperature Parameter	Most C_3 Cool-Season Turfgrasses		Most C_4 Warm-Season Turfgrasses	
Optimum* Shoot Growth	60 to 75°F	(16 to 24°C)	80 to 95°F	(27 to 35°C)
Optimum** Root Growth	50 to 65°F	(10 to 18°C)	75 to 85°F	(16 to 26°C)
Root Heat** Stress	>80°F	(27°C)	>100°F	(38°C)
High Temperature*** Kill	104 to 112°F	(40 to 44°C)	110 to 120°F	(43 to 49°C)
Cold* Hardening	40 to 34°F	(4 to 1°C)	58 to 66°F	(15 to 19°C)
Chill* Stress	None		54 to 60°F	(12 to 16°C)
Low Temperature*** Kill	26 to –20°F	(–3 to –29°C)	31 to 20°F	(–1 to –7°C)

* Canopy temperature
** Soil temperature
*** Tissue temperature