Syringing: To Cool or Not to Cool

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For years superintendents have combated heat stress on their putting greens by syringing. When asked to justify the practice, though, there is surprisingly little scientific data on which to base syringing practices. In fact, the data which exist reveal a disturbing lack of consensus on the value of syringing. In some cases the effectiveness of syringing may be related to other factors such as air and soil temperature or soil moisture.

What is syringing?

Syringing is a light application of water, intended to moisten the leaves but not the soil. Often used for cooling a turf, syringing can alleviate moisture stress for a short time until soil moisture can be replenished. The most obvious case might be where excessive evapotranspiration rates significantly reduce soil moisture during mid-day play: syringing might reduce the need for soil moisture until later in the day. Syringing may also reduce foliar diseases if applied in the morning to knock dew and guttation moisture from the canopy. The disease cycle can be interrupted by removing the nutrient-enriched dew and guttation moisture and by dislodging germinating fungal bodies from the leaves.

How does syringing work to cool a turf?

Syringing will create a boundary layer over the turf canopy and/or around each leaf. The boundary layer consists of moisture-saturated air. A boundary layer normally exists around each leaf assuming sufficient soil moisture and transpiration is present, though syringing can increase thickness of the boundary layer.

Water is a remarkable molecule. One of its many unique properties is its high specific heat, that is, the amount of energy required to increase water's heat. For water it's simple: it takes 1 calorie of energy to heat 1 gram of water 1 degree Celsius. Potentially such a boundary layer can work either by absorbing heat from the leaf or by absorbing heat from sunlight before it reaches the leaf; as the water vaporizes it transfers the heat to the atmosphere and is carried away by wind.

In reality neither mechanism may really be effective where syringing is concerned. If cool water could be applied to turf, syringing could be much more effective. However, as cool irrigation water is propelled into the atmosphere before falling on the turf, the small water droplets begin to equilibrate with the air temperature. In terms of enhancing the boundary layer, the thickness of the boundary layer is often dictated by wind movement and relative humidity—the greater the wind speed and the lower the humidity, the thinner the boundary layer.

What do the data show?

As far back as 1965 researchers showed irrigation applied to a tomato field decreased air temperatures just above soil level by as much as 18°F (Van Den Brink and Carolus, 1965). That same year, Hawes (1965) showed syringing lowered turf canopy temperature 7°F within two minutes of syringing, but canopy temperatures resumed presyringing temperatures within 15 to 30 minutes.

One of the standard turf syringing references was published a year later, titled "Effects of air movement and syringing on microclimate of bentgrass turf" (Duff and Beard, 1966). The authors conducted two field experiments, both primarily designed to document the effect of wind speed on turf temperature. In the second experiment, syringing was added as a variable. The turf was a 'Toronto' creeping bentgrass maintained at 0.25 inch height (time has seen the demise of both Toronto bentgrass and the 0.25 inch greens mowing height). Turf was syringed at 12 p.m., with air and turf mat layer temperatures recorded at 30 minute intervals during the day over a three day period. Ambient air temperatures ranged from 67°F to a high of 78°F. With a 4 mph wind, mat temperatures were as much as 10°F below the air temperature; at 0 mph wind speed there was little to no difference. The conclusion was that even a slight reduction in turf temperature at mid-day, for a two-hour period, could be important for turf growth and quality. Unfortunately, no data were presented to compare syringed to non-syringed turf.

A follow-up study published 20 years later has received little attention. DiPaola compared syringe rates of 0, 0.002, 0.004, 0.028, 0.055, 0.106, 0.161, and 0.216 inches on a 0.25 inch 'Penncross' putting green turf. The study was conducted on several days in both 1981 and 1982 using a well-defined experimental design. Syringing at neither 11 a.m. or 1 p.m. affected turf canopy temperatures one hour after treatment regardless of the volume of water applied. Rates of 0.055 inch water and greater did occasionally reduce turf canopy temperature within 30 minutes, but the average effect was only 0.25°F. Ambient air temperatures ranged from 90 to 99°F, quite a bit higher than the mid-70°F temperatures in the Duff and Beard study. It is possible that syringing may be more effective at temperatures below 90°F. Relative humidities were both lesser and greater in the DiPaola study compared to the Duff and Beard study making it difficult to draw any conclusions regarding humidity effects on syringing.

So When is Syringing Effective?

There is no question syringing can be an effective management practice. As long as soil moisture and transpirational cooling are not limited, syringing probably will have little effect on turf cooling. When transpirational cooling is limited, though, turf will gain heat because transpiration is the most efficient way of removing heat from the system.

Transpirational cooling slows or ceases when the plant is unable to absorb moisture from the soil because a) soil moisture is depleted, b) the turf root system is negligible, or c) the soil is saturated. The effects of soil moisture depletion should be clearly apparent: if there is no available moisture for plant uptake, the plant can't absorb water, move it through the plant (absorbing heat as it goes), and emit it into the atmosphere through its stomates. In some cases take-all patch or other root-rotting diseases reduce the effective root mass below critical levels. *Poa annua* greens are particularly susceptible because the majority of their roots are in the upper one inch of soil-sufficient moisture at 2 or 4 inch depth does the turf no good.

Occasionally soil becomes saturated with water, for example, after one or a series of heavy rainstorms. Roots cannot function without oxygen, consequently water uptake slows or stops. If temperature and/or sunlight are at sufficiently high levels, turf temperature will increase. If the temperature increase is much above 105°F or is steadily above 90°F for several days, damage or even death may occur.

Syringing when transpirational cooling is compromised can temporarily reduce heat and water-related stress, both by providing a temporary boundary layer and perhaps by getting a little water into the turf to maintain turgor (stiffness) of the leaves. Since the small amount of water applied in a syringe cycle may quickly dissipate, several syringe cycles may be needed in a single day. Syringing should not be relied upon as a long-term solution to water deficits, however; instead, get soil moisture to an optimal level as soon as possible.

What Else is Needed?

Additional data collection is needed to determine the inter-related effects of air, soil, and irrigation water temperature, relative humidity, sunlight, wind speed, turf type and mowing height, timing, and frequency. For example, the turf was mowed only every other day in the DiPaola study; daily mowing, as is currently practiced, would undoubtedly increase the water loss from the turf system. The complexity of the experiments needed to document the effect of syringing mean a scientific-based answer may be a long-time in coming. Until then, it may be best to rely on experience and gut instinct.

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