Data-Driven Moisture Management for Sand-Capped Fairway Systems

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WATER MANAGEMENT & HYDROLOGICAL SCIENCE

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Background

- It's important that efficient methods for irrigation management on sand-capped fairways be developed due to the increasing trend of sand-capping degraded golf course fairways and the amount of irrigated acres they represent.
- While reference ET-based (ET_o) scheduling provides an effective means of predicting irrigation requirements, reliable access to locally representative data is often a barrier for implementation.
- Open-access NOAA Forecasted Reference ET (FRET) data provides ET_o data regardless of proximity to a weather station.
- In-ground wireless soil moisture sensors (SMS) could potentially be another tool for scheduling irrigation in sand-capped systems due to the high degree of soil texture and depth uniformity.

Objectives

- Evaluate turf performance and overall water use during the growing season for various irrigation scheduling techniques.
- Determine whether the critical moisture threshold changes by season for application in SMS based systems.

Methods

- This study was conducted during the 2019 and 2020 growing seasons on newly constructed sand-capped Latitude 36 Bermudagrass (*Cynodon dactylon* L. Pers. x C. *Transvaalensis* Burtt-Davy) plots at the Texas A&M Turfgrass Field Laboratory in College Station, Texas.
- Irrigation treatments were arranged in a randomized complete block design, with 4 replicates. Plot size is 6.4 x 6.4 m.
- Plots were mowed 2-3 times per week at 1.3 cm height. Nitrogen was applied at 3.7 g m^{-2} every 3-4 weeks during both growing seasons. Aquatrols Revolution (Paulsboro, NJ) wetting agent was applied every month during both growing seasons at a rate of 1.9 ml m^{-2}.
- Turf quality was determined using weekly turf quality rankings (NTEP scale 1-9, minimum quality=5) (Morris and Shearman, 1999) and bi-weekly digital image analysis using Turf Analyzer software (Green Research Services, LLC, Fayetteville, AR) (Karcher et al., 2017).
- Water usage was determined by utilizing a water meter installed at the valve of each plot.
- TORO Turf Guard ® Wireless SMS were placed in each plot to monitor volumetric water content (VWC). Each sensor has 2 sets of probes that monitor VWC (%) at the upper portion of the sand-cap (7.6 cm) and upper portion of the subsoil (20.3 cm). A second sensor was placed in Visual Wilt-based plots to monitor VWC at the lower portion of the sand-cap (15.2 cm) and a lower portion of the subsoil (27.9 cm).
- Data were subjected to ANOVA using the GLM procedure of SPSS (IBM, Inc.). Where appropriate, mean comparisons were performed using Tukeys HSD (0.05).

USGA TORO

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Irrigation Scheduling Techniques

1) Wireless SMS

- Irrigation was applied based on 75% allowable depletion. Field capacity and permanent wilting was based on evaluation of wilt in relation to soil moisture in late-May of each year. An example of this evaluation is shown in **Figure 1**.

2) On-site Penman-Monteith ETo

- Plots were irrigated 2x weekly based on the previous 3-day (Monday – Wednesday) or 4-day (Thursday – Sunday) onsite ET_o cumulative values multiplied by the warm-season turfgrass crop coefficient (T_c) (0.6 x ET_o).
- Effective rainfall was used in calculating irrigation requirements.

3) NOAA Forecasted ETo

- Plots were irrigated 2x weekly based on split applications of total weekly FRET values multiplied by the warm-season turfgrass crop coefficient (0.6 x ET_o).
- Effective rainfall was used in calculating irrigation requirements.

4) Visual wilt-based approach

- Wilt-based plots were irrigated with 2.3 cm of water when a plot was expressing 50% wilt.

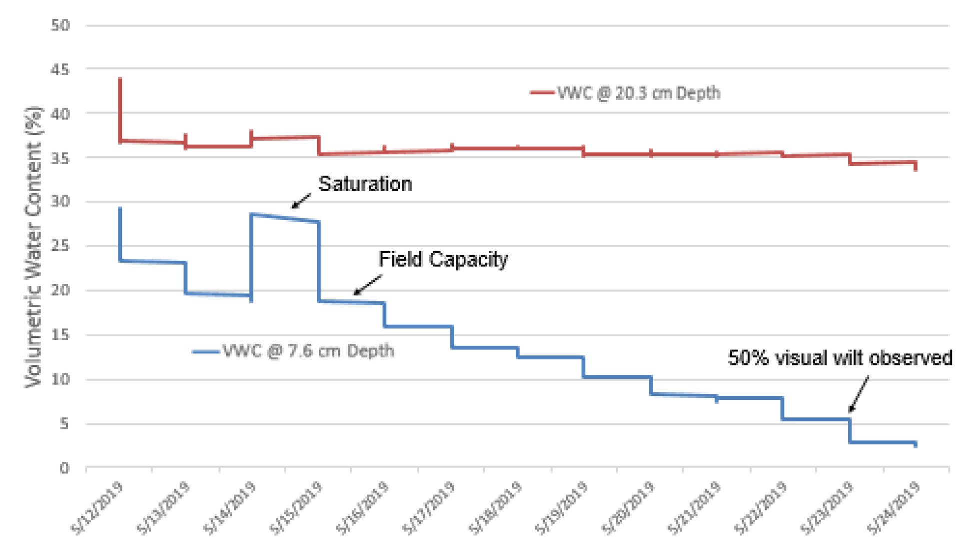

Figure 1. Dry-down in SMS plot used for determining field capacity and wilt endpoints. Data was collected mid-May to late-May 2019.

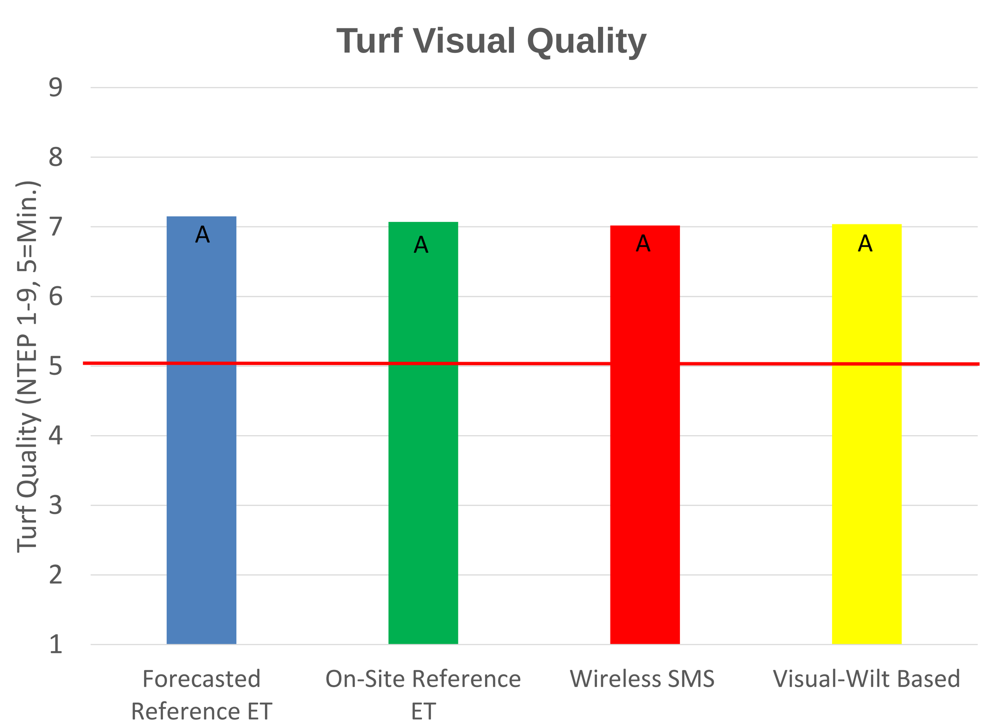

Figure 2. Visual turf quality as affected by irrigation scheduling treatment. Data are pooled across both years and rating dates. Means with same letter are not significantly different based on Tukeys HSD @ $P \leq 0.05$. Horizontal red line indicates minimum acceptable turf quality.

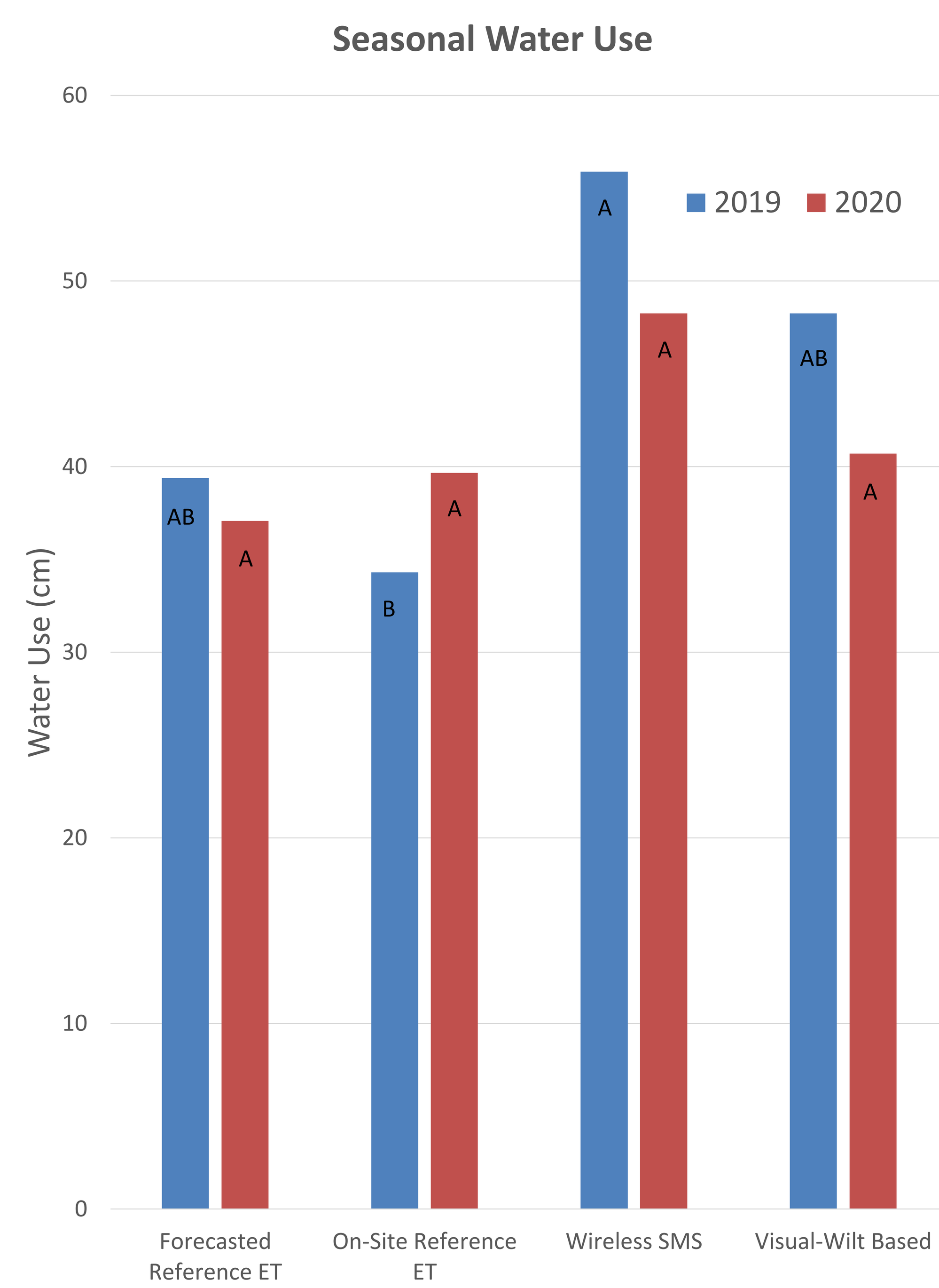

Figure 3. 2019 (left bar) & 2020 (right bar) seasonal water use for each irrigation scheduling treatment. Data are from the difference between water meter readings at the start of each season and the end of season. Means with same letter are not significantly different within each season based on Tukeys HSD @ $P \leq 0.05$.

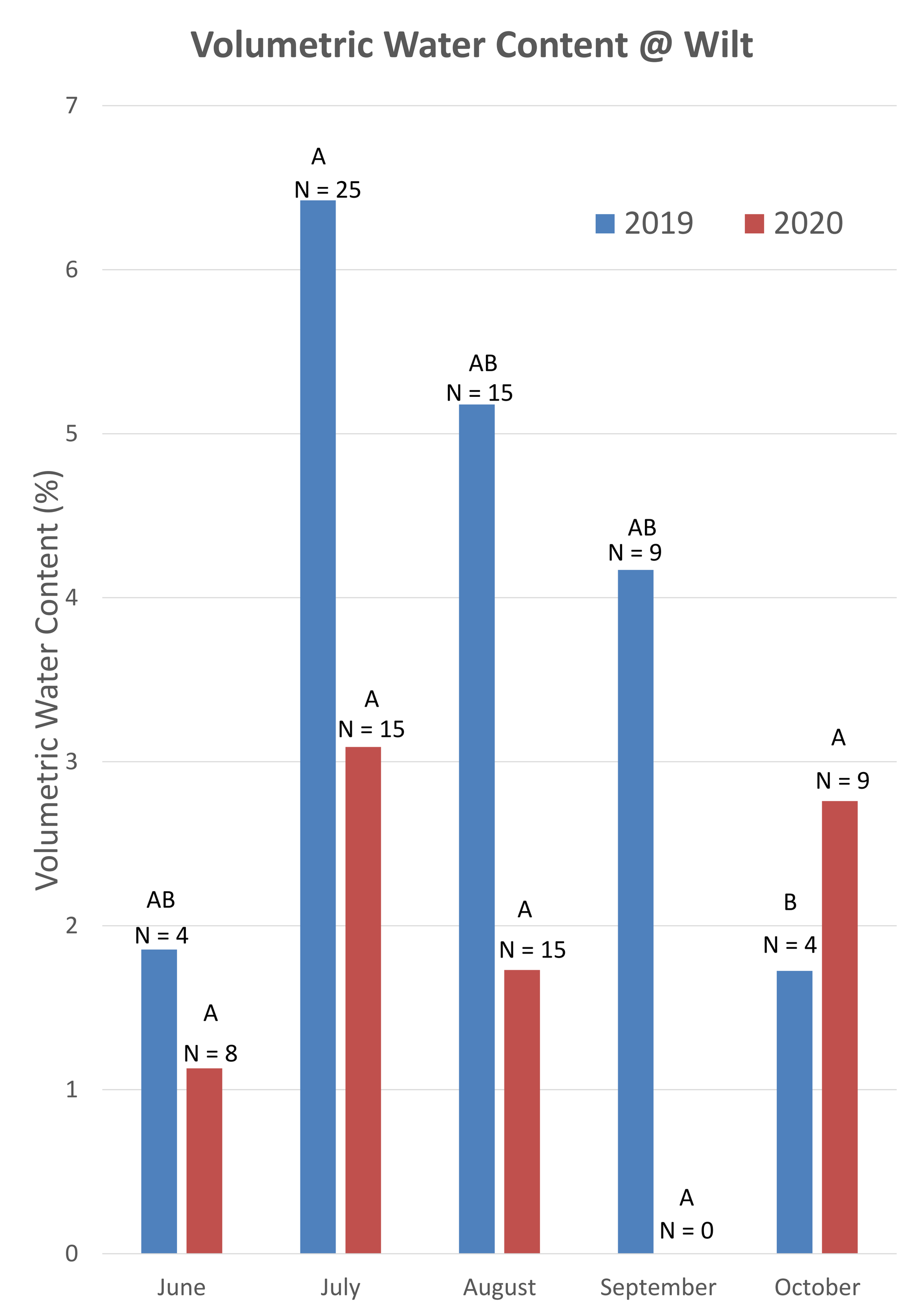

Figure 4. VWC thresholds for the 7.6 cm depth at which wilt occurred during each month of the 2019 and 2020 seasons. Means with same letter are not significantly different within each season based on Tukeys HSD @ $P \leq 0.05$.

Results

- In both years, all irrigation strategies were successful in maintaining above minimum acceptable turf quality with no significant differences detected between irrigation scheduling strategies (**Figure 2**).
- In year 1, water use was 32% higher when scheduling irrigation based solely on VWC as compared to onsite ET_o **(Figure 3)**; however, in year 2 no significant differences were detected for water use between scheduling strategies.
- In year 1, moisture content at which wilt occurred changed on a monthly basis within the upper portion of the sand-cap with lower VWC at which wilt occurred observed in early and late season months (**Figure 4**). This trend was not observed in year 2; however, the mean VWC at which wilt occurred was significantly lower in the upper portion of the subsoil in year 2 (year 1 = 35%, year 2 = 33%).

Conclusions

- Results for both years suggest FRET to be a reliable estimator of actual ET_o.
- While ET based treatments were irrigated based on the 60% x ET_o T_c throughout the season, this could be a deficit value as previous studies have shown the T_c to increase during high evaporative demand times of the year which could explain lower water use values for the ET based treatments in year 1.
- No differences for water use between treatments in year 2 could be a function of seasonal weather differences as multiple wet-weather periods were experienced during the 2020 season. This finding is consistent with prior studies in maintaining that a higher water savings potential could be realized during wet-weather conditions when scheduling irrigation based on SMS (Cardenas-Lailhacar et al., 2008).
- The lower wilt point observed for year 2 was accompanied by greater water extraction at lower depths.

References

Cardenas-Lailhacar, Bernard, Michael D. Dukes, and Grady L. Miller. "Sensor-based automation of irrigation on bermudagrass, during wet weather conditions." *Journal of Irrigation and Drainage Engineering* 134.2 (2008): 120-128.
Karcher, D.E., C.J. Purcell, M.D. Richardson, L.C. Purcell, and K.W. Hignight. 2017. A new Java program to rapidly quantify several turfgrass parameters from digital images. In: 2017 Agronomy abstracts. ASA, CSSA, and SSSA, Madison, WI. p. 109313.
Morris, K.N. and R.C. Shearman. 1999. NTEP turfgrass evaluation guidelines. Natl. Turfgrass Evaluation Program, Beltsville, Md.