Day versus night irrigation loss from sprinkler irrigation of urban crops

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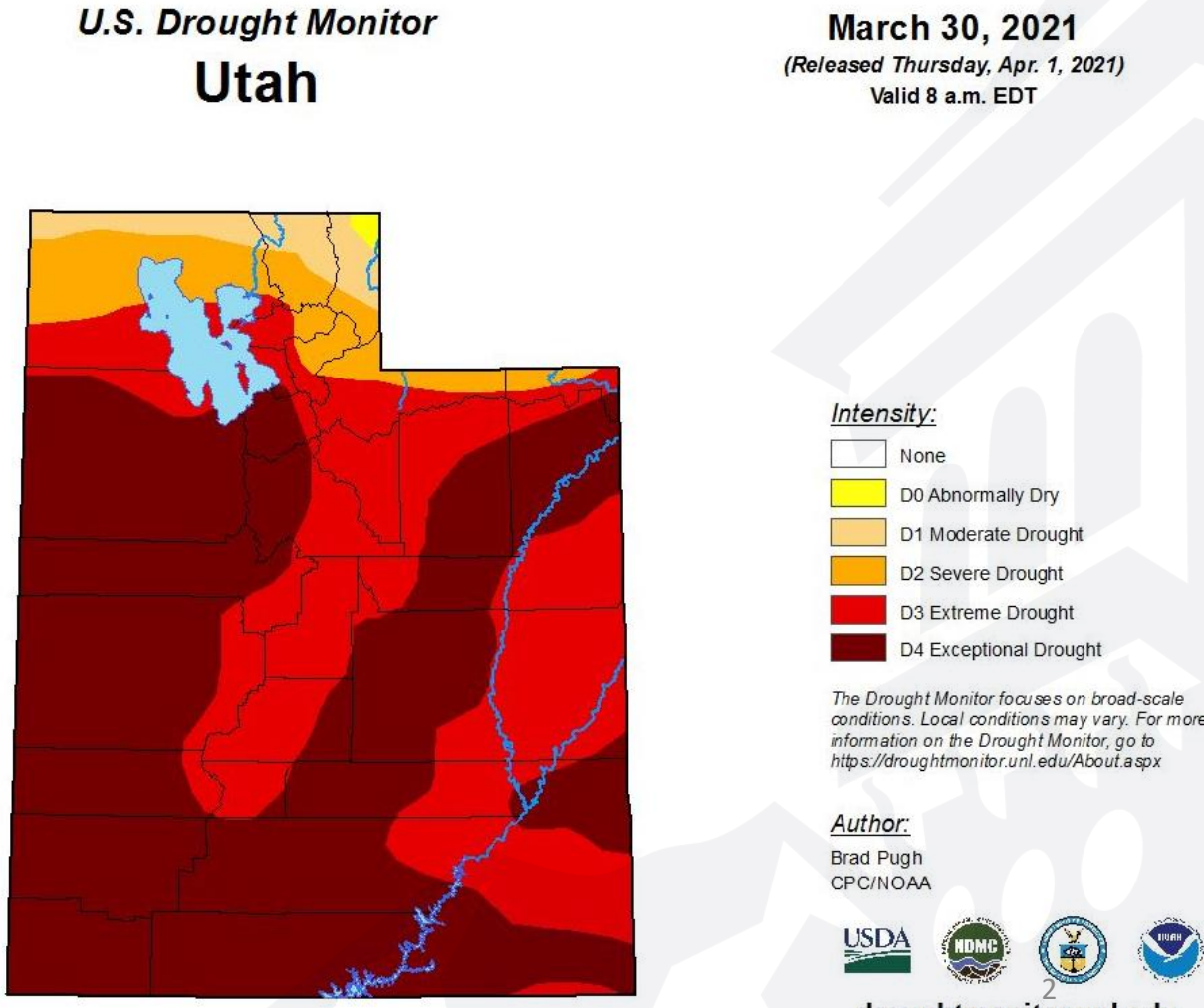
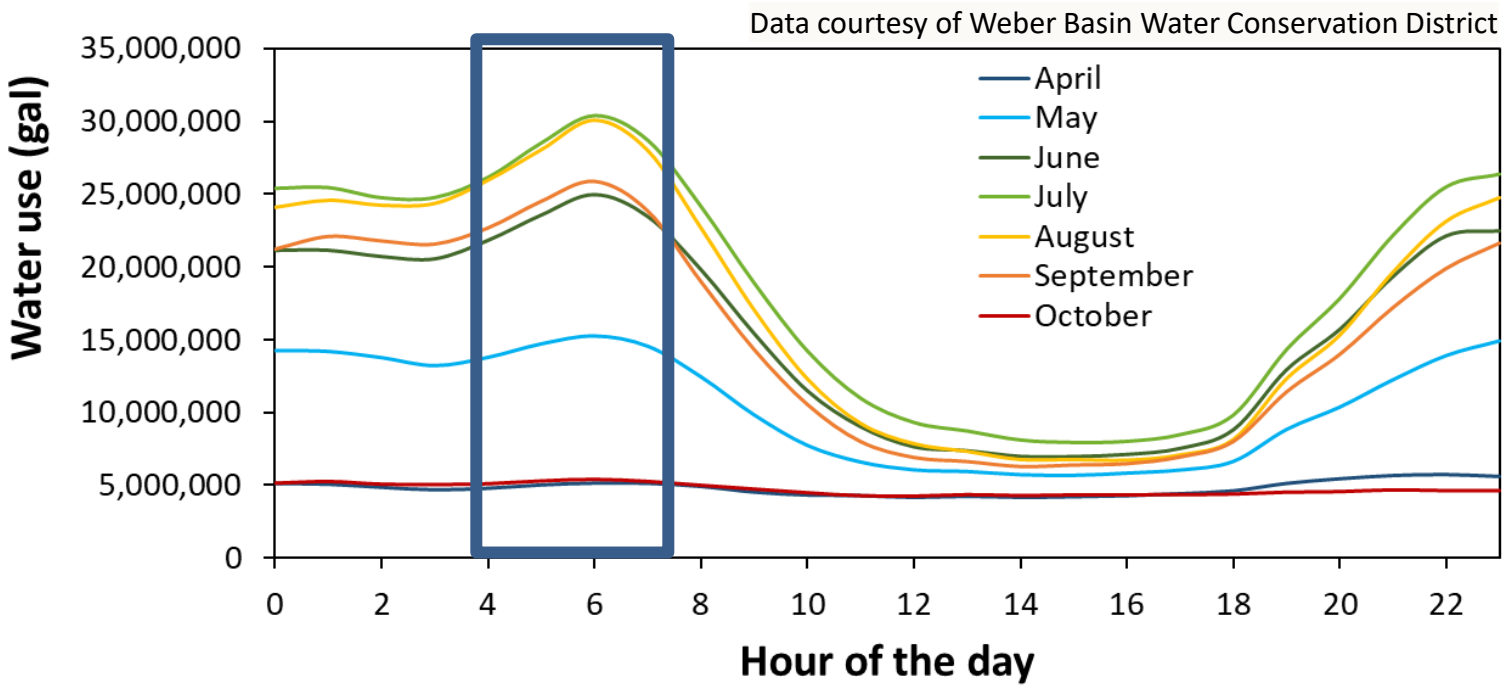
Utah: balancing population growth and water use

- 90% of the population lives in urban areas[1]
- 3rd fastest growing state population [1, 2]
  - 2019: 3.2 million people
  - 2065: 5.8 million people
- 2nd highest per capita water use in the US and 2nd driest state [3]
- Drought emergency has been declared in 2018 and 2021 [4]
- 83.% of water in residential use [5]



1. Perlich, Pamela S. 2016.
2. GWSAT, 2017
3. Utah Division of Water Resource 2018
4. U.S. Drought monitor 2021
5. Weber basin conservancy districts 2019

Peak water use is from 4-8 AM



Nighttime irrigation is advised for landscapes as a conservation strategy, as nighttime conditions may decrease evapotranspiration (ET):

- Cooler air temperatures
- No solar radiation
- Higher relative humidity
- Less wind = less drift

How much water can we save by irrigating at night?

ET

- In tomato, daytime irrigation ET: 5.85 mm d^{-1}, nighttime irrigation ET: 6.45 mm d-1 (1)

Wind drift and evaporation loss (WDEL)

- Daytime WDEL nearly double that of nighttime with sprinkler irrigation in Spain (2, 3, 4)

Microclimate

In maize, vapor pressure deficit (VPD) with daytime irrigation ranges 0.5 to 1.4 kPa nighttime ranges 0.08 to 0.2 kPa (5)

Canopy temperature ranges from 0.6 ℃ to 3.6 ℃ with daytime irrigation, 0.3 to 1.0 ℃ with nighttime irrigation (5)

Challenges with the data

- Study sites are dissimilar to the US Intermountain West
- Only agronomic crops were tested

1. Yacoubi et al., 2010 2. Playán et al., 2005 3. Cavero et al., 2008 4. Martínez-Cob et al., 2008 5. Cavero et al., 2016

Objectives of the Study

1. Quantify whether a water savings exists between day and night irrigation by using a water balance approach with urban crops

   Turf (*Poa pratensis*, Kentucky Bluegrass)

   Zinnia (*Zinnia elegans*, 'Benary's Giant Salmon Rose')

2. Analyze the microclimate effects by irrigation timing to determine any changes to WDEL and evaporative demand

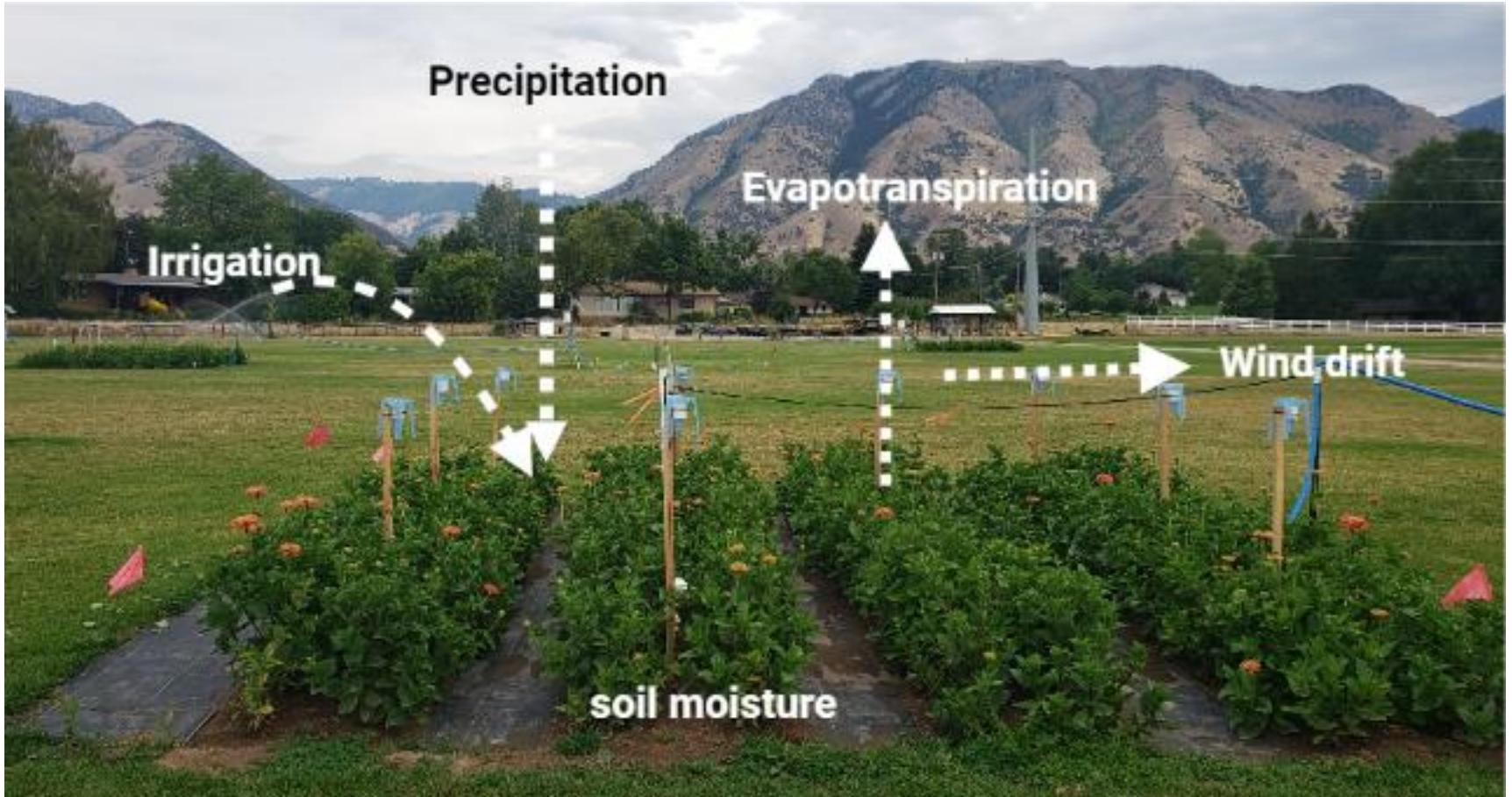
3. Assess the quality and yield response of two urban crops

Methods:
Site description

- Utah Agricultural Experiment Station in North Logan, UT (41.77° N, -111.81° W)
- 2019 – 2021
- Treatments included 2 irrigation timings x 2 crops, in triplicate:
  - Daytime turf
  - Nighttime turf
  - Daytime zinnia
  - Nighttime zinnia

Water Balance & Microclimate Measurements

Precipitation + Irrigation = ET + WDEL + Soil Moisture



Measurement of microclimate, yield, and quality

Weather station

Flowmeter

Catch cups

Canopy relative humidity (RH) and temperature sensor

Surface temperature sensor

Net Radiation

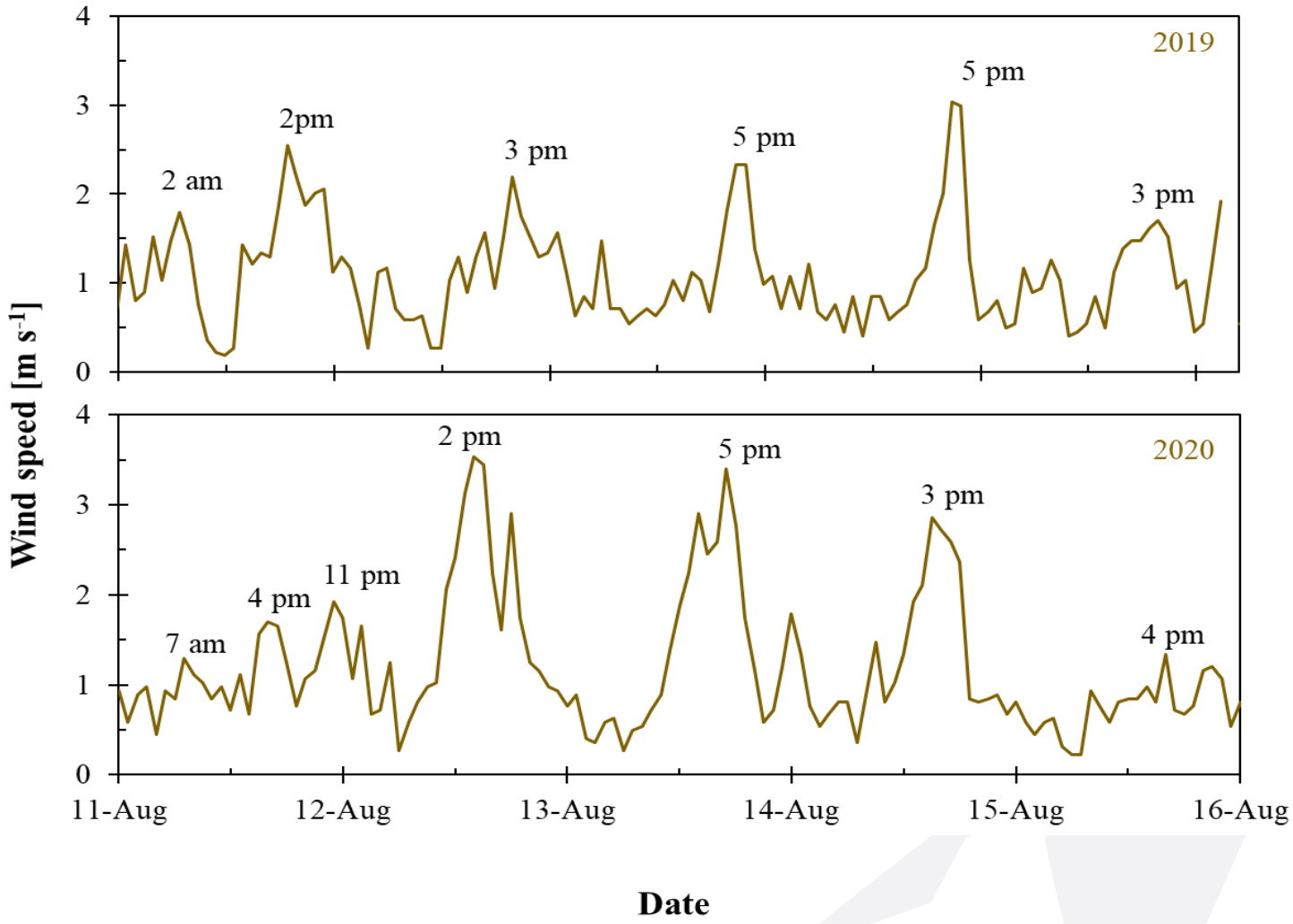
Soil moisture sensor

Soil moisture sensor

Turf quality

Zinnia quality

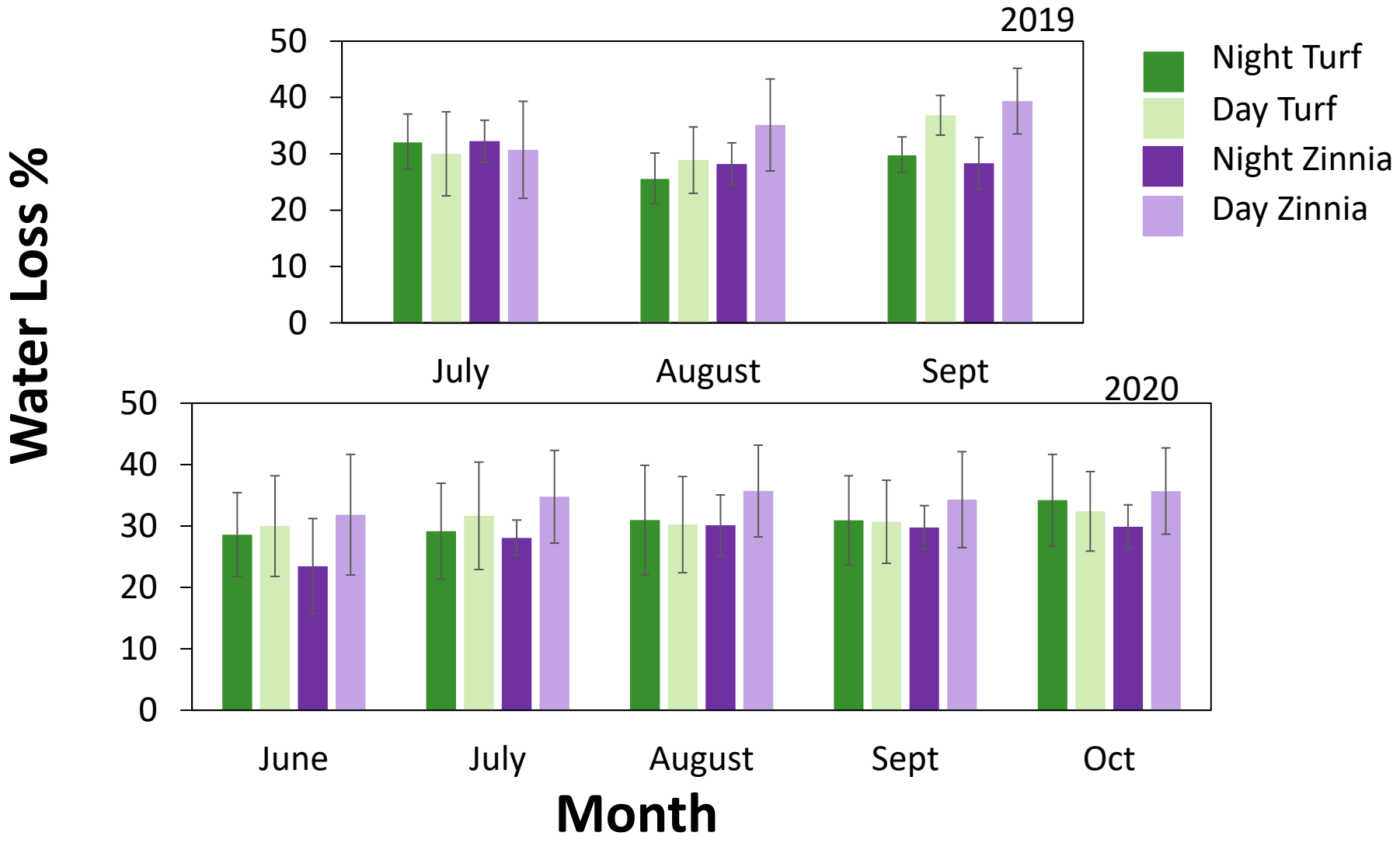
Result: daytime wind speed is twice the nighttime



Result: Monthly ET was 2-4 mm greater with night than daytime irrigation

Total monthly ET [mm] 2020				
Month	Night Zinnia	Day Zinnia	Night Turf	Day Turf
May	13.1	13	12.7	12.6
Jun	130	128.4	128.5	127.5
Jul	160.6	158.6	161.4	159.3
Aug	124.3	120.7	132.9	131.3
Sep	78.3	75.2	80.8	80.1
Oct	23.5	21.6	24	22.7
Total	**529.8**	**517.5**	**540.3**	**533.5**

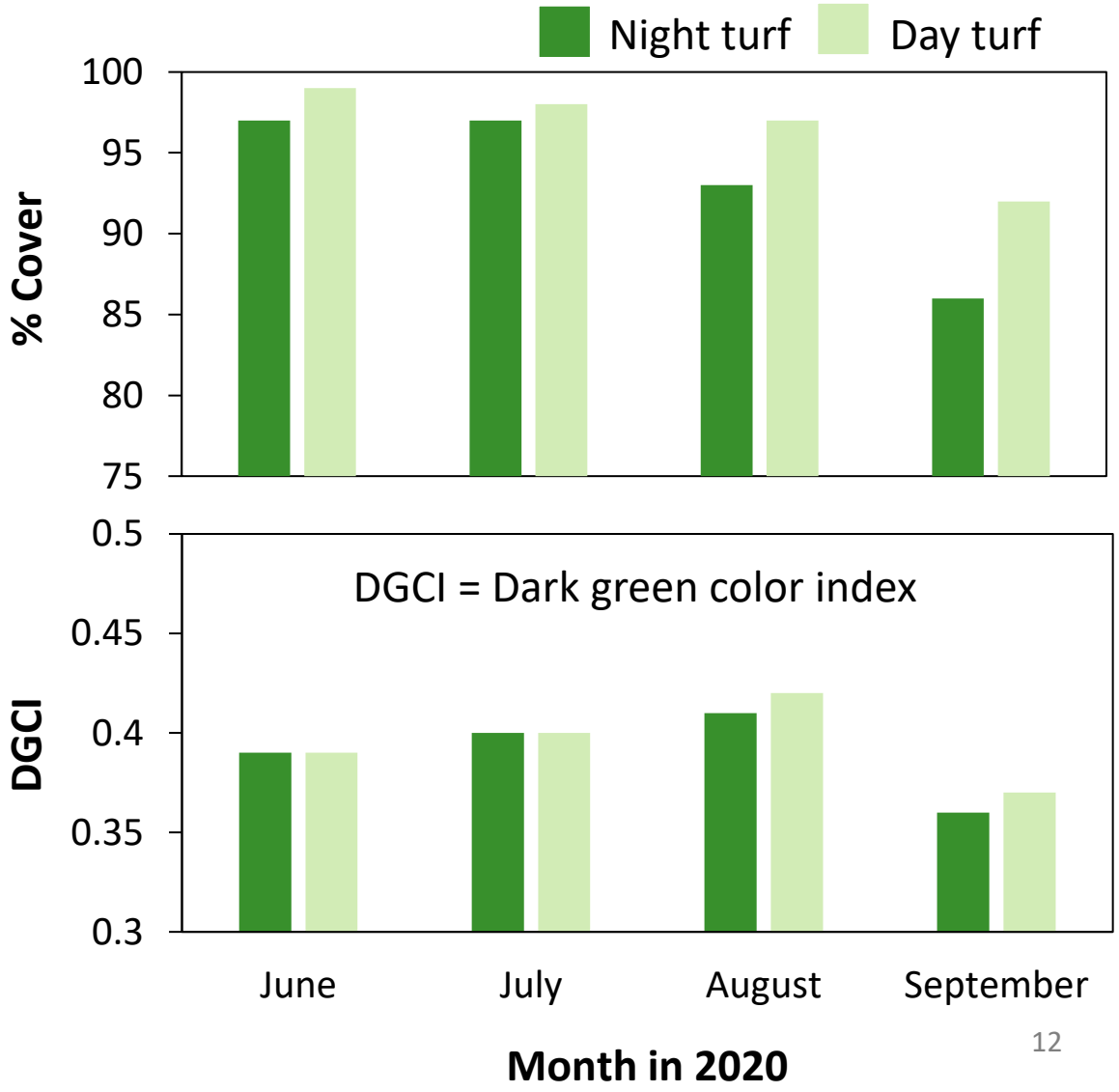
Water loss to WDEL was 2-6% greater with daytime irrigation



Yield and quality of turf and zinnia

Turf	2019	2020
Timing	Avg. Dry matter [kg ha^{-1}]	
Night	137.6	2839.2
Day	104.7	2801.3

Zinnia	2019		2020	
	[Stems m^{-2}]			
	Avg. Marketable	Avg. Culled	Avg. Marketable	Avg. Culled
Night	30	48	24	78
Day	31	37	27	65



Summary

- WDEL is 2-6% higher with day irrigation than nighttime.
- ET is 1- 4 mm greater with night irrigation per month but no difference per day.
- The changes in wind drift and evapotranspiration could cancel each other out.
- No significant differences in quality or yield of the urban crops that we tested.

Next steps

- Calculate the water balance, analyze microclimate conditions of each plot, perform statistical analysis, analyze turf quality
- Continue data collection in 2021
- Share urban irrigation findings with stakeholders and develop recommendations together

Thank You

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