UCRTRAC Accumulative Research Summary
Section A: Irrigation Water Use Efficiency Including Utilization of Effluent Water
Project 1

Title: Influence of irrigation scheduling on tall fescue performance.

Objective: To determine if tall fescue performance, when irrigated at 80% ET_{crop} (80% ET_{crop}/irrigation distribution uniformity (DU) (Fig. 1 and Table 1), can be improved by changing irrigation frequency, cultivar, and mowing height (Table 2).

Location: A specially constructed irrigation plot located at the UCR Turfgrass Field Research Facility. Twelve independently-operated irrigation cells defined main plots which were split with two tall fescue cultivars and further split by two mowing heights (Fig. 2).

Duration: Two consecutive summer to fall seasons (27 July to 9 Dec. 1994 and 31 May to 15 Nov. 1995) (Table 3).

Funding Source: Metropolitan Water District of Southern California

Findings:

- Note that the total irrigation amount applied was equivalent to 80% and 85% CIMIS ET_o in 1994 and 1995, respectively (Table 4).
- When the weather was mild, such as in 1994, quality tall fescue was produced.
- When the weather was more severe, such as in 1995, only minimally acceptable tall fescue was produced.
- These data suggest that the total irrigation amount needed during weather conditions typically found in Riverside during the summer will not be less than the equivalent of 85% CIMIS ET_o.
- Tall fescue visual quality (color, overall quality) was improved by irrigating less frequently (2x per week) compared to more frequently (3x or 4x per week).
- Coupled with higher turfgrass qualities was a significantly higher soil water level (particularly at the 24- and 36-inch depths) and significantly lower soil water tension (12-inch depth on some measurement dates).
- Higher soil water at these depths would be beneficial for trees and other deeply rooted plant materials grown in association with turf in the landscape. Less frequent, deeper irrigation should also discourage surface rooting of these same plant materials.
- Tall fescue visual quality also can be improved by choice of cultivar, i.e. choosing cultivars that maintain their color and quality under drier soil conditions, and by reducing mowing height. It should be noted that lower mowing heights may result in poorer rooting along with poorer soil water mining capability.

Status: A study of two consecutive summer to fall seasons was completed. Information associated with this study was reported at a UCR Turfgrass Research Conference and Field Day and in Annual Reports submitted to the Metropolitan Water District of Southern California. Also, a technical paper was published in *Crop Science* [42:2011–2017 (2002)].

Figure 1. Calculating irrigation quantity.

$$\left[\left(\begin{array}{c} \text{CIMIS Reference} \\ \text{Evapotranspiration} \\ (\text{CIMIS ET}_o) \end{array} \right) \times \left(\begin{array}{c} \text{Monthly Crop} \\ \text{Coefficient} \\ (\text{Monthly K}_c) \end{array} \right)^{z} \times 0.8 \right] \div \begin{array}{c} \text{Coefficient of} \\ \text{Irrigation Uniformity} \\ (\text{C}_v\text{U}) \end{array}$$

[z] See Table 1 for monthly cool-season crop coefficients.

Table 1. Cool- and warm-season turfgrass crop coefficients (K_c) developed in Irvine, Calif. with monthly, quarterly, semi-annual, and annual irrigation programming.

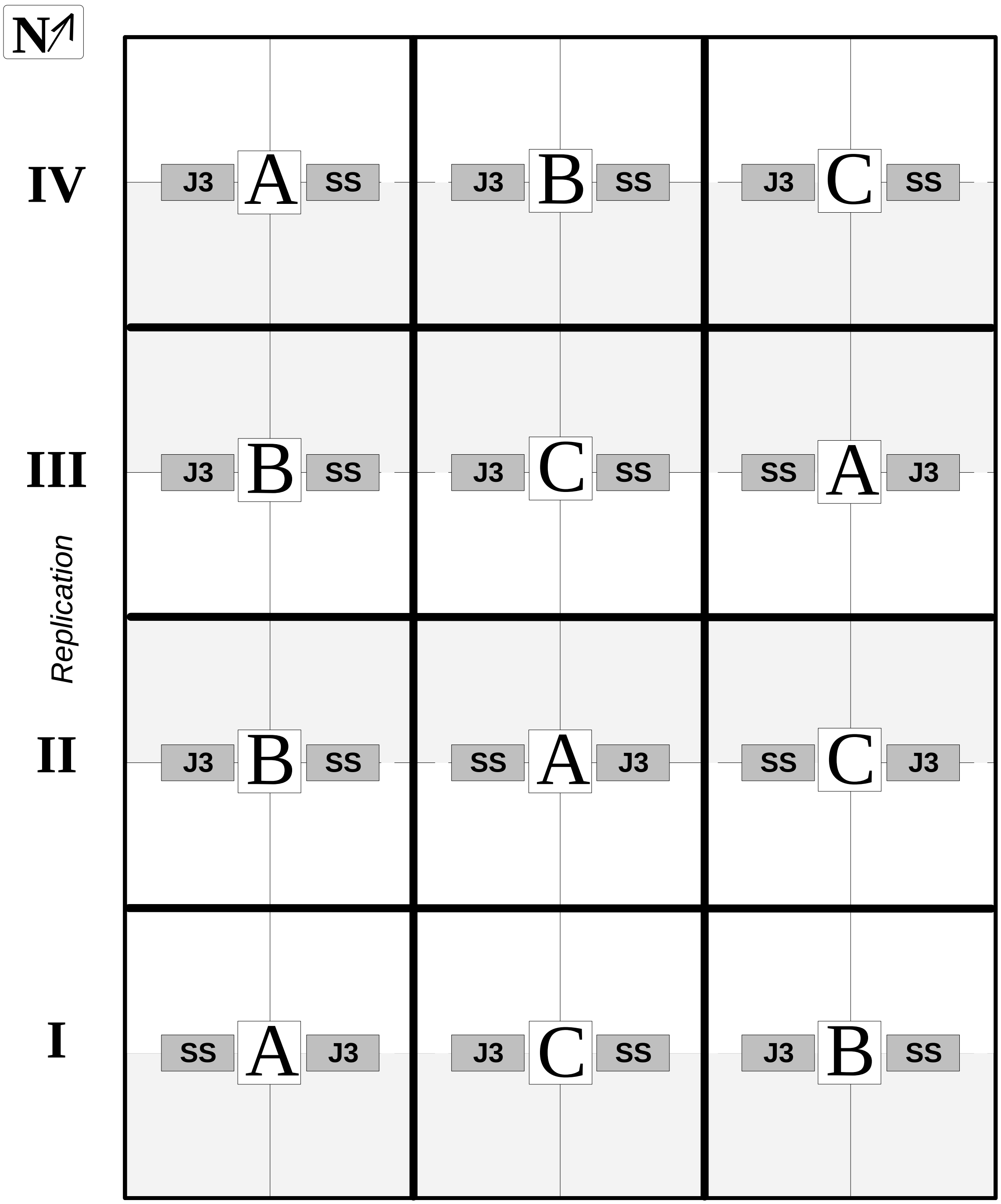
	Cool-season crop coefficients (K_c) [z]				Warm-season crop coefficients (K_c)[z]			
Month	Monthly	Quarterly	Semi-annually	Annually	Monthly	Quarterly	Semi-annually	Annually
April	1.04				0.72			
May	0.95	0.96			0.79	0.73		
June	0.88				0.68			
July	0.94		0.90		0.71		0.71	
August	0.86	0.85			0.71	0.68		
September	0.74				0.62			
October	0.75			0.79	0.54			0.65
November	0.69	0.68			0.58	0.56		
December	0.60				0.55			
January	0.61		0.67		0.55		0.59	
February	0.64	0.67			0.54	0.62		
March	0.75				0.76			

[z] Meyer, J.L., V.A. Gibeault, and V.B. Youngner. 1985. Irrigation of turfgrass below replacement of evapotranspiration as a means of water conservation: Determining crop coefficient of turfgrasses, p. 357-364. In: F. Lemaire (ed.). Proc. 5th Intl. Turfgrass Res. Conf., Avignon, France, July 1985. INRA Publications, Versailles, France.

Table 2. 1994-1995 MWD tall fescue irrigation frequency study.

Objective	To determine if turf performance can be improved by manipulation of irrigation frequency, mowing height, and cultivar when tall fescue is irrigated at 80% crop ET.
Cultivar treatments	Two tall fescue cultivars, Jaguar III and Shortstop, representing a standard turf-type and a dwarf variety, respectively.
Location	UCR Turfgrass Research Project. Root zone is a well-drained native alluvial soil (Hanford fine sandy loam).
Experimental design	Split-strip plot design with four replications of each treatment combination. Irrigation treatments form the main plots which are 20 x 20 ft. Cultivars (turf-type or dwarf) form subplots which are split across main plots and are 10 x 20 ft. Mowing heights (1.5- and 2.5-inch) are stripped across subplots, forming sub-subplots measuring 10 x 10 ft.
Fertilization	Experimental plot is fertilized at a rate of 0.5 lb N/1000 ft^2 every 3 weeks.
Mowing treatments	Mowed twice weekly with a Toro 20-inch commercial rotary mower with clippings removed. Mowing heights are 1.5 and 2.5 inches.
Irrigation treatments	An equivalent amount of water is applied to each experimental plot, and is calculated from the previous week's ET_o (from CIMIS) x monthly crop coefficient (K_c) x 0.8. This value is multiplied by each plot's precipitation rate and divided by the respective coefficient of uniformity (C_vU). Irrigation is applied in three different frequencies, or main treatments. These treatments are 4, 3, and 2 irrigations per week.
Measurements	**Turf quality and characterization:** • Visual turf and color measured on a 1 to 9 scale with 1 = poorest, 5 = minimally acceptable, and 9 = best tall fescue. • Clipping yields from each treatment combination (g dry weight/23.3 ft^2 per 4 days) collected via a 'yield box' attachment on a rotary mower. After each subplot is mowed, clippings are removed from the box, dried for 48 hr at 60 °C, and then weighed. • Shoot and leaf density counted from a 0.5 dm^2 area, multiplied by 2. • Leaf length, measured from top of petiole to leaf tip. • Leaf width, measured at widest portion of leaf. • Leaf area calculated by multiplying average leaf lengths by average leaf widths. • Root and crown mass obtained in 1995 from 2-inch diameter x 12-inch deep core samples (three per sub-subplot of Jaguar III). • Moisture status of leaf tissue (relative leaf water content) of 10 fully-expanded new leaves harvested from each mowing height within Jaguar III subplots. • Stomatal conductance (1994 only) measured with LiCor 1600 Steady State porometer with 'grass' aperture. Three measurements taken from each mowing height within Jaguar III subplots. • Canopy temperature measured with Teletemp model AG42 infrared thermometer. **Soil Moisture:** • Neutron probe readings taken weekly at 9-, 12-, 18-, 24-, 36-, and 48-inch depths. • Soil tension measured with Watermark granular matrix sensor readings. Readings taken daily at 6- and 12-inch depths. • Gravimetric soil samples taken weekly at 6- and 12-inch depths to monitor soil moisture and to develop standard curve for Watermark sensors.
Study duration	2 years (warm seasons of 1994 and 1995).

Figure 2. MWD tall fescue irrigation frequency study plot plan.



Irrigation Treatments: A = 4x/wk B = 3x/wk C = 2x/wk
SS= Shortstop J3= Jaguar III

= 2.5" = 1.5"

Table 3. 1994-1995 MWD tall fescue irrigation frequency study time frame.

Activity	Date
Irrigation system repair, seedbed preparation	Dec. 1993
Plot seeding	13–14 Jan. 1994
Establishment	14 Jan. – 8 July 1994
First mowing	11 Mar. 1994
Watermark installation	5 May – 1994
Initiate mowing treatments	17 May 1994
Fertility regime initiated (0.5 lb N/1000ft^2 per 3 weeks)	17 May 1994
Neutron probe access tube installation	1–8 June 1994
Irrigation uniformity tests on all plots	17–18 June 1994
Trial experiment (80% ET_o on all plots) and turf acclimation	8–27 July 1994
Irrigation treatments initiated (ET_o x K_c x 0.8) based on previous week's ET_o	27 July 1994
1994 study conclusion	9 Dec. 1994
Uniformity tests on 12 irrigation systems, adjust heads and system operating pressure	18–29 May 1995
Begin irrigation treatments (ET_o x K_c x 0.8) based on previous week's ET_o	31 May 1995
Initial neutron probe, and Watermark soil moisture measurements	31 May 1995
Initial visual color and quality rating	14 June 1995
Initial gravimetric moisture samples	28 June 1995
2-inch diameter x 12-inch deep cores taken for root analysis	2–13 Oct. 1995
1995 study conclusion	15 Nov. 1995

Table 4. 1994-1995 MWD tall fescue irrigation frequency study applied irrigation summary.

	1994	1995
Time frame	20 July – 10 Dec. (143 days)	24 May – Nov. 15 (175 days)
ET_o (CIMIS)	576 mm (22.7 inches)	893 mm (35.2 inches)
Water applied	462 mm (18.2 inches)	760 mm (29.9 inches)
% CIMIS ET_o	80%	85%