Assessment of Soil Water Tension Thresholds for Optimum Irrigation Scheduling, Yield and Quality

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Introduction

Scientific evidence of soil water tension (soil moisture) impact in yield and quality of celery (*Apium graveolens* L.) production is very limited. Water stress can reduce yield, promote pithiness, decrease plant vigor and consequently increase susceptibility to diseases (Breschini and Hartz, 2002). Adversely, excessive soil moisture leads to an anaerobic environment that can hinder plant growth and promote disease, in addition to excessive drainage and nutrient leaching.

The only study that aimed to quantify differen soil water tension impact on celery yield (Rekika et al., 2014) had its limitations with frequent rainfall events and with limited irrigation events that actually started at the target soil water tension thresholds (treatments of 15 and 30 centibars). Feigin et al. (1982), while assessing celery response to different nitrogen fertilizer rates under two irrigation regimes, reported maximum celery yield and quality with an irrigation regime that maintained soil water tension at or below 20 centibars, compared to the other regime at 70 centibars. Although those results indicate significant yield differences between the two distinct moisture regimes, sensor-guided irrigation requires more accurate targets (20 to 70 centibars is a significantly wide range).

Exploring a narrower range of SWT thresholds under current production practices, cultivars and representative climate conditions may provide decisive information for soil moisture sensor use, defining how long a crop can wait until the next irrigation without yield reduction. Therefore, better understanding of the subject could set actionable targets for irrigation scheduling and the use of soil moisture sensors, helping growers and farm managers to optimize yield, quality and water use efficiency.

Objective

Determine the optimal soil water tension threshold for maximum celery yield and quality.

Procedures

Celery yield, quality, water use, soil mineral nitrogen (N), plant total N, soil electrical conductivity, root depth and canopy cover were assessed under four irrigation scheduling treatments based on different soil water tension thresholds in Oxnard, CA during the Fall of 2017. Soil water tension was monitored at depths of 8 and 18 inches using Hortau®'s TX4 Field Monitoring Stations. The four treatments consisted of starting irrigation when soil water tension readings at 8 inches depth reached or were close to 20, 30, 40 and 50 centibars, named T-20, T-30, T-40 and T-50, respectively. Soil water tension at 8 inches depth was initially monitored in one replication/block (out of four) for all treatments, however, more sensors were acquired during the project and two more replications were monitoring, totaling 16 sensors and three replications monitored; each treatment had four sensors: three at 8 inches depth and one at 18 inches. The amount of water applied to each irrigation event was calculated based on the crop evapotranspiration (ETc = ETo * Kc) since the last irrigation, with an additional leaching requirement of 30% to ensure that the soil reached saturation on every irrigation. Treatments were replicated four times with randomized complete block design. Each plot consisted of three side-by-side 40 inches-wide and 75 ft long beds, with two celery rows in each bed, and a low-flow drip tape on the top and center of the bed. Yield and quality data were collected in the center 20ft of the middle bed of each plot. The soil type was Camarillo sandy loam. Flow meters and data loggers were installed in each treatment to record volumes of each irrigation event. No rainfall occurred during the study. Statistical analyses were conducted using the SAS statistical package (SAS Institute, Cary, NC) to evaluate the effect of treatments on all measurements using PROC GLM.

Results

The results of all parameters measured at harvest can be observed on Table 1. Total and marketable yield and plant height gradually decreased from T-20 to T-30 to T-50, with significant differences ($P<0.050$) between T-20 and T-50 for these three parameters. Marketable yield for T-40 presented significant variability among replications and didn't follow that trend. Total and marketable yield were 11.4% and 9.0% smaller, respectively, for T-50 compared to T-20 (Figure 1). In average, yield decreased approximately 4% for each increase of 10 centibars.

Whole/total plant weight and marketable plant weight also decreased significantly (P<0.05) from T-20 to T-50 (Table 1). There were no trends nor significant differences (P=0.596) for pith among treatments. Soil water tension values for each treatment can be observed on Figure 2. Average soil water tension at 8 inches depth were 12.7, 17.4, 20.4 and 24.0 centibars for T-20, T-30, T-40 and T-50, respectively. Water use was very similar, totaling 19.7, 18.9, 18.6 and 18.4 inch for T-20, T-30, T-40 and T-50, respectively (Figure 4). Soil mineral N, plant total N, soil electrical conductivity, root depth and canopy cover at harvest were very similar among treatments.

Table 1. Total yield, marketable yield, marketable plants, stem length, plant height, pith, total and marketable plant weight data collected at harvest; values with different letters indicate that differences are significantly different (P<0.05).

	Yield (lb/20ft)		Marketable	Stem length	Plant height	Pith	Plant weight (lb)	
Treatment	Total	Marketable	plants/20ft	(inches)		(1-4)	Total	Marketable
T-20	195.4 a	131.8 a	60 a	9.7 a	30.9 a	0.4 a	3.0 a	2.2 ab
T-30	186.9 ab	126.1 ab	62 ab	9.7 a	30.0 b	0.6 a	2.8 ab	2.0 abc
T-40	187.3 ab	131.8 a	62 ab	9.4 a	29.6 b	0.4 a	2.8 ab	2.1 b
T-50	173.2 b	120.0 b	65 b	9.5 a	29.6 b	0.6 a	2.5 b	1.8 c

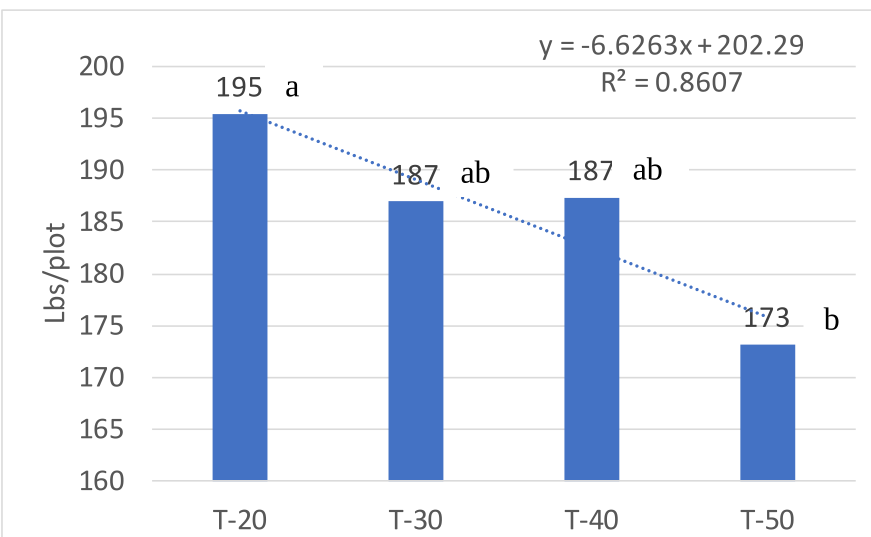

Figure 1. Total yield (entire plants) collected within 20ft of the center bed of each plot (average of four replications).

Figure 2. Soil water tension for treatments T-20, T-30, T-40 and T-50. The horizontal red bar in each graph indicates the target soil water threshold for starting the irrigation of each treatment.

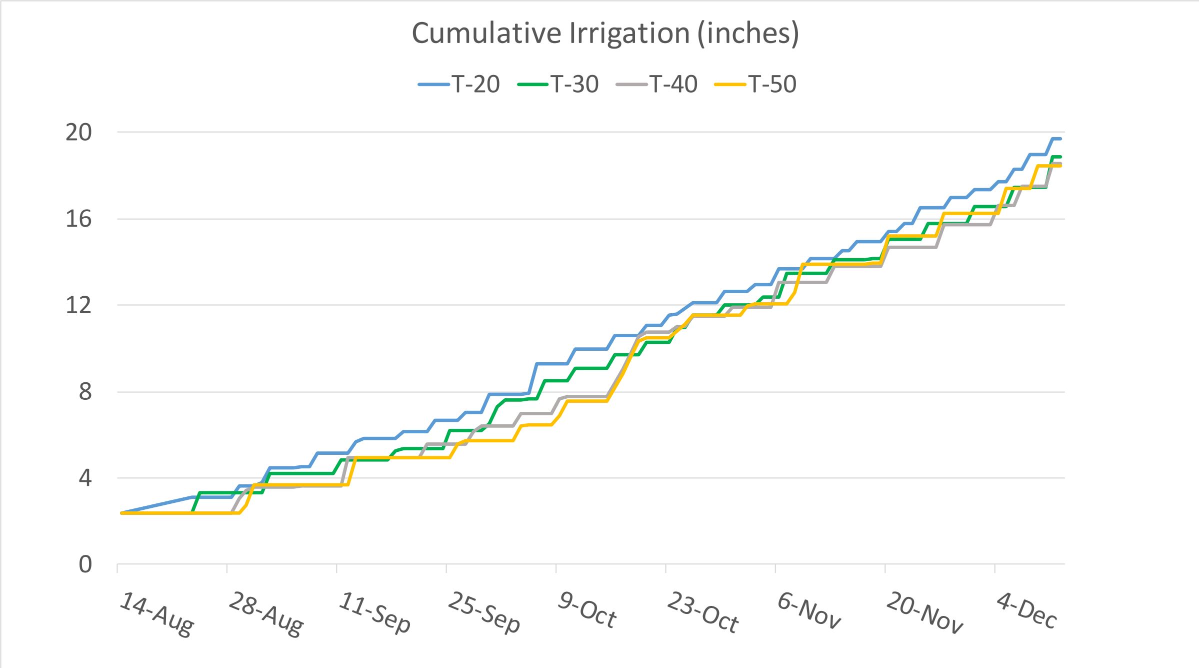

Figure 4 . Cumulative irrigation for treatments T-20, T-30, T-40 and T-50.

Conclusion

Overall, the results of this study suggest that increasing soil water tension from 20 to 50 centibars significantly decreased celery yield, plant height and plant weight, but it didn't affect pith.

Literature cited

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