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SUSTAINABLE IRRIGATION OF DATE PALMS USING SALINE GROUNDWATER

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Introduction

The United Arab Emirates annually produces nearly 1 million tonnes of dates, which is nearly 12% of the world's production. Date palms (*Phoenix dactylifera* L.) cover nearly 200,000 hectares in the United Arab Emirates. Irrigation is essential. Groundwater is used for irrigation, and date palms account for one third of the water allocated for irrigation. However, 64% of the groundwater extracted is drawn from aquifers in excess of their renewal rates. Furthermore, the groundwater supplies are becoming more saline and date palms are sensitive to salinity. Sustainable irrigation practices need to be developed. A joint project between Environment Agency Abu Dhabi, the International Center for Biosaline Agriculture, Plant & Food Research, and Maven Consultants is seeking to develop these sustainable irrigation and salt management practices.

Pilot Project: 2014

In 2014, a pilot experiment was set-up at the International Center for Biosaline Agriculture (ICBA) near Dubai. The focus was to determine the water use of the cultivar 'Lulu' being irrigated twice daily with 5 dS/m water (Figure 1). Tree water-use was measured directly using sap-flow sensors placed in the tree trunks, and indirectly using time domain reflectometry in the root-zone.

Figure 1. *One of the instrumented 'Lulu' date palm tree in the low salinity (5 dS/m) treatment at the International Center for Biosaline Agriculture, Dubai.*
The irrigation bubbler is in operation.

Local weather data were used to calculate the hourly and daily ETo, and derive an appropriate value for the crop factor, Kc. Our data showed the water use of the palm trees to be less than half the amount suggested by the FAO-56 guidelines. Furthermore, much of the irrigation water was seen to be rapidly lost by deep drainage through the highly permeable desert sands whose saturated hydraulic conductivity is of the order of 2-5 m/hr.

Results: 2015

In 2015, a comprehensive project commenced on two additional cultivars ('Shahlah' and 'Khalas'). The experiments were extended for all three cultivars to irrigation with 15 dS/m water. We have measured a decline in tree transpiration in relation to the irrigation water salinity, and for the cultivar 'Lulu', the increase in salinity from 5 to 15 dS/m results in a halving of the tree's water use (Figure 2). In Figure 2 can be seen the reduction of tree size with salinity.

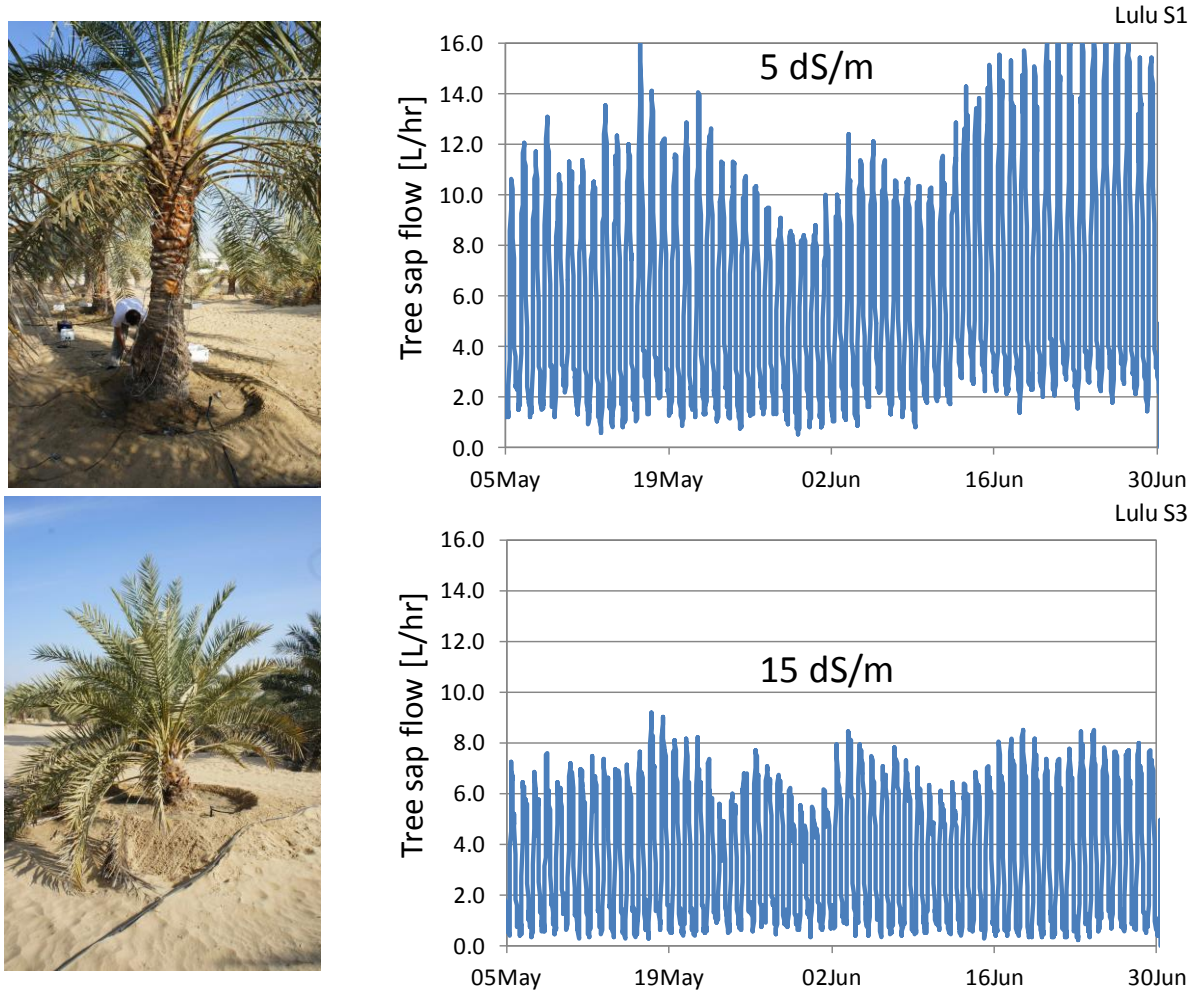

Figure 2. *Comparison of the measured pattern water use of the 'Lulu' date palm trees irrigated with 5 dS/m water (S1, top) and 15 dS/m water (S3, bottom). The measurements were made every 30 min throughout the day.*

Part of this drop is due to the impact that salinity has had on the leaf area of the canopy. To measure the leaf area of the palm trees' canopies we have developed a light stick that measures the area of the shadow cast by the trees (Figure 3).

Figure 3. *Ahmed Al Muaini measuring the area of the shadow cast by date palm trees using the light stick. The inset show the details of the light sensors. There are 20 sensors on the stick.*

Our measurements show that the salinity rise has reduced the 'Lulu' canopy area by only 25% (Figure 4). Therefore other processes must be involved, and these likely involve stomatal control of transpiration, as affected by salinity. We will investigate this.

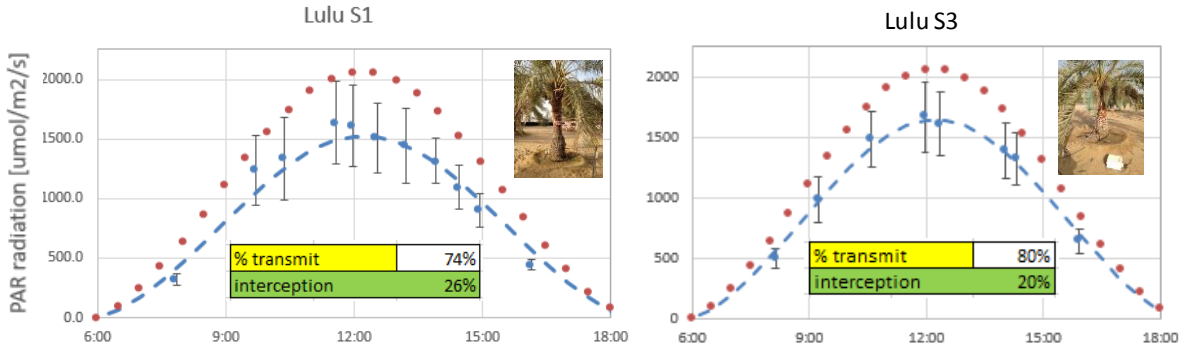

Figure 4. *Measurements of light interception by the canopy of the 'Lulu' trees in the low salinity treatment (S1, 5 dS/m, left) and the high salinity treatment (S3, 15 dS/m, right).*

Conclusions

Irrigation of date palms consumes one third of the UAE's groundwater takes, and this resource is dwindling and becoming more saline. Therefore it is imperative that improved irrigation techniques be developed to minimise the use of groundwater, and to minimise the impact of salinity.

We have shown that irrigation can be reduced to better match the palm's needs for water, and yet maintain a leaching fraction to flush salts away.

Through our measurement we have shown that tree water use is reduced when higher salinity irrigation water is used. This reduction of water use with salinity varies between cultivars in relation to their differing tolerance to salinity. However, the reduction in water use is due not only to the reduction in the tree's canopy area with salinity, but also due to physiological processes. This will be investigated further.

With the knowledge that is being gained from this project, a decision support tool is being developed to optimise irrigation use and enable salt management as well.