Soil Salinity Monitoring at Dubai

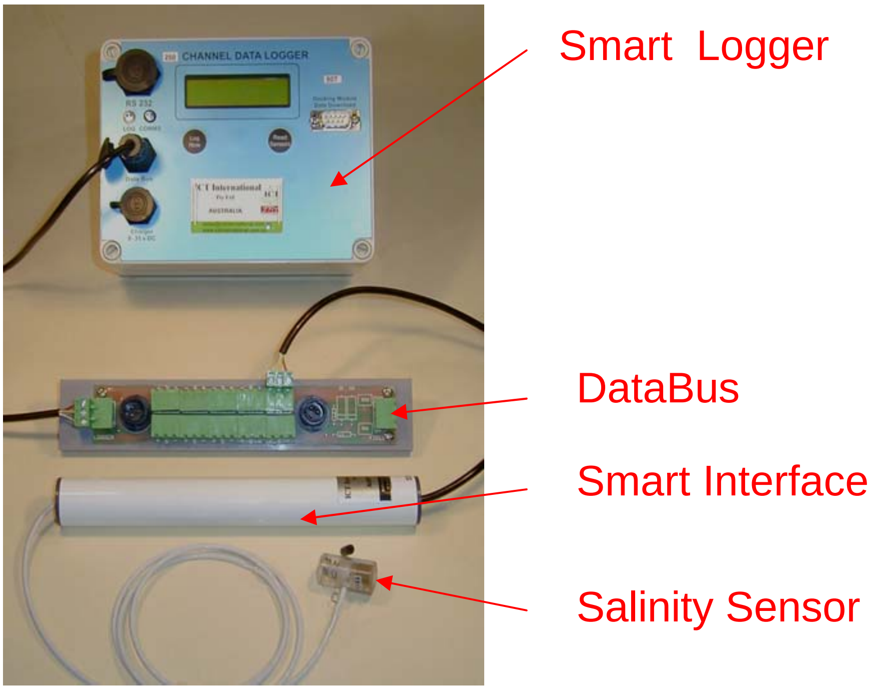
Salinity Monitoring System

- Irrigation using saline water (10, 20, 30 dS/m) was undertaken on a fine sandy soil at Dubai.
- A soil salinity sensor system was supplied and installed by ICT International, an Australian company which specialises in soil moisture, salinity and plant water use monitoring instrumentation.
- Following installation, logging of soil salinity was carried out on an hourly basis.

Salinity Field Station

- The salinity station is operated by simply plugging in each salinity sensor and interface to a DataBus.
- The DataBus is attached to a Smart Logger and both are housed in the Field Station.

Salinity Field Station



- Each salinity sensor is fitted with an external smart interface that consists of an integrated microprocessor.
- This smart interface contains all the required information to allow autonomous operation of the sensor, including power requirements, logging interval and sensor calibration.
- A feature of this salinity monitoring field station is that it does not require any knowledge of electronics or computer programming.

Data Recording

- The Smart Logger searches the DataBus, automatically identifies the number of salinity sensors connected and begins logging in units of dS/m with conductivity corrected to 25°C.

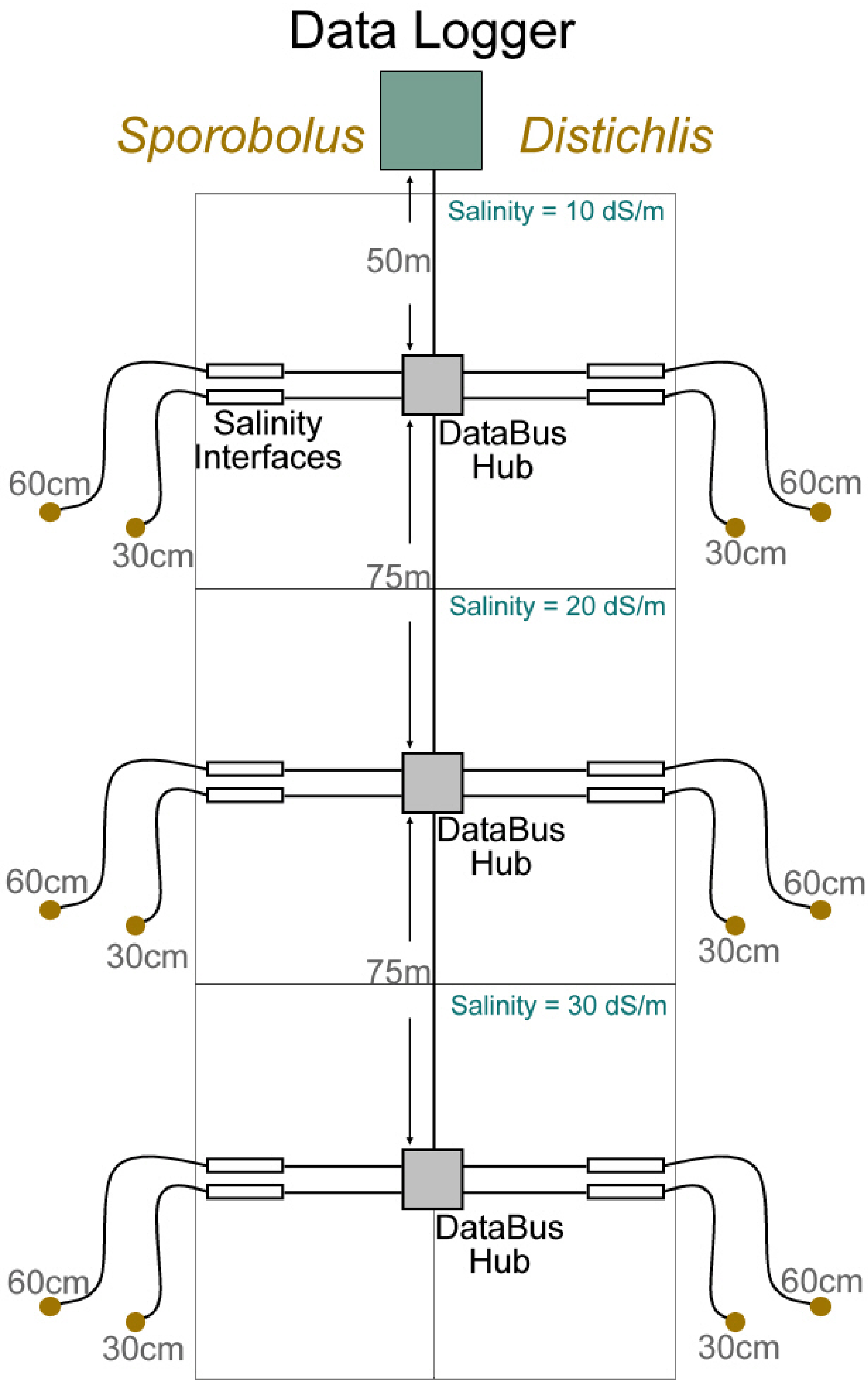
Data Recording

- Instantaneous readings from the sensors can be viewed on the logger’s display in the field without the need for a laptop computer.
- Instantaneous readings from the sensors can also be viewed on a DataBus Reader display at any position in the monitoring system.
- Data can be accessed in the field by memory stick or remotely using a mobile phone modem.
- This data is then available for graphing and interpretation using Excel.

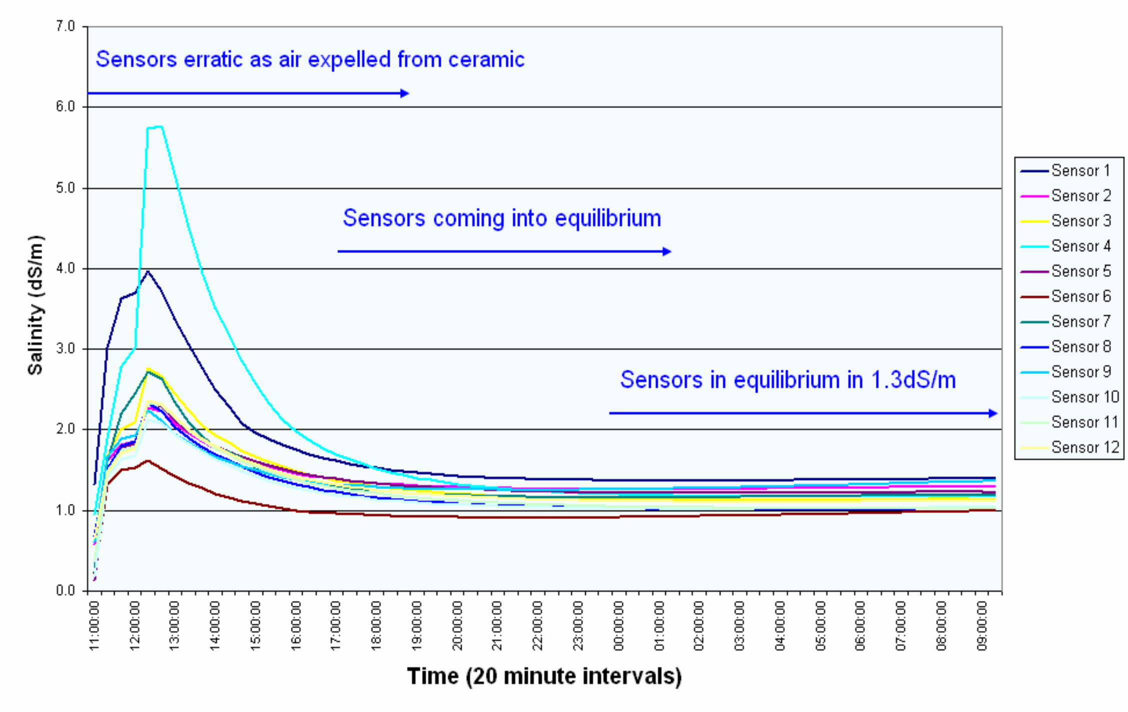
Saline Irrigation Treatments

- The experiment has three irrigation treatments with saline water on a field planted with *Distichlis*:
  - 10 dS/m
  - 20 dS/m
  - 30 dS/m
- Sensors were placed in each treatment at two depths:
  - 30 cm
  - 60 cm
- The effects of spatial variability was considered with the number and positioning of salinity sensors.
- Soil suction was logged using a “smart” tensiometer in one treatment (10 dS/m) at the 30 cm depth.

Field Experiment Design

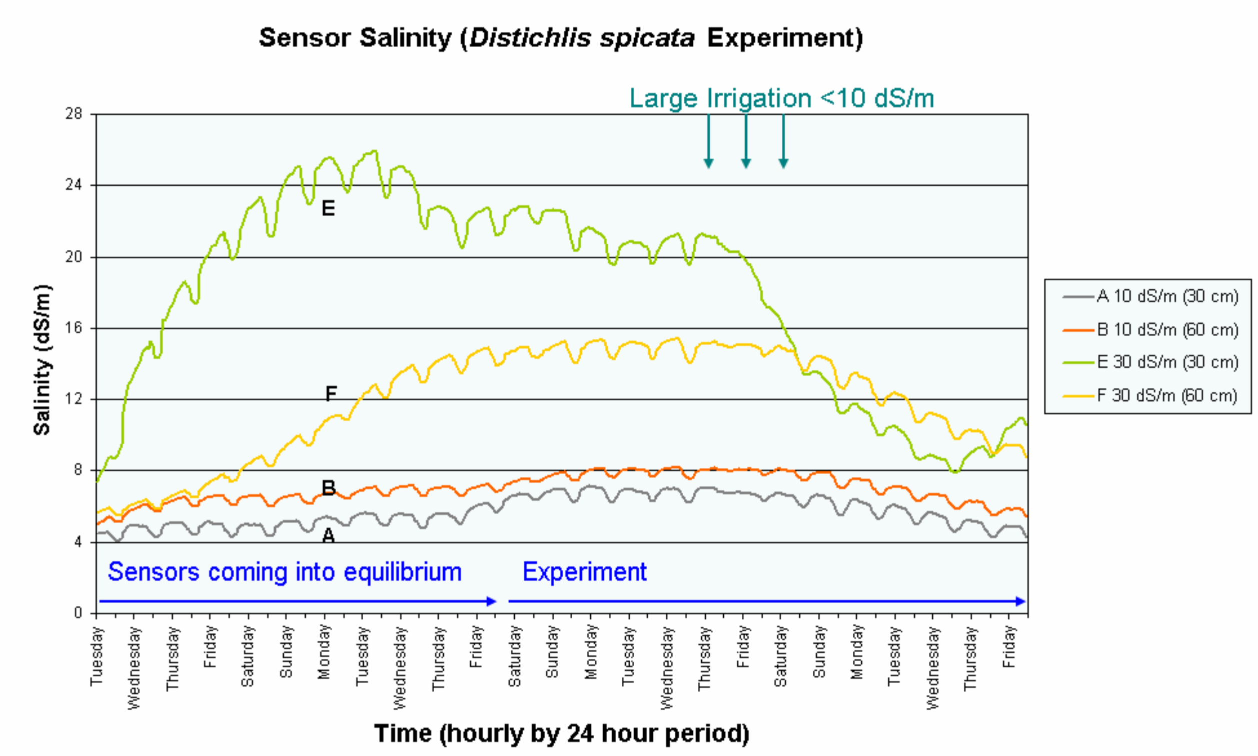


Sensors Before Installation



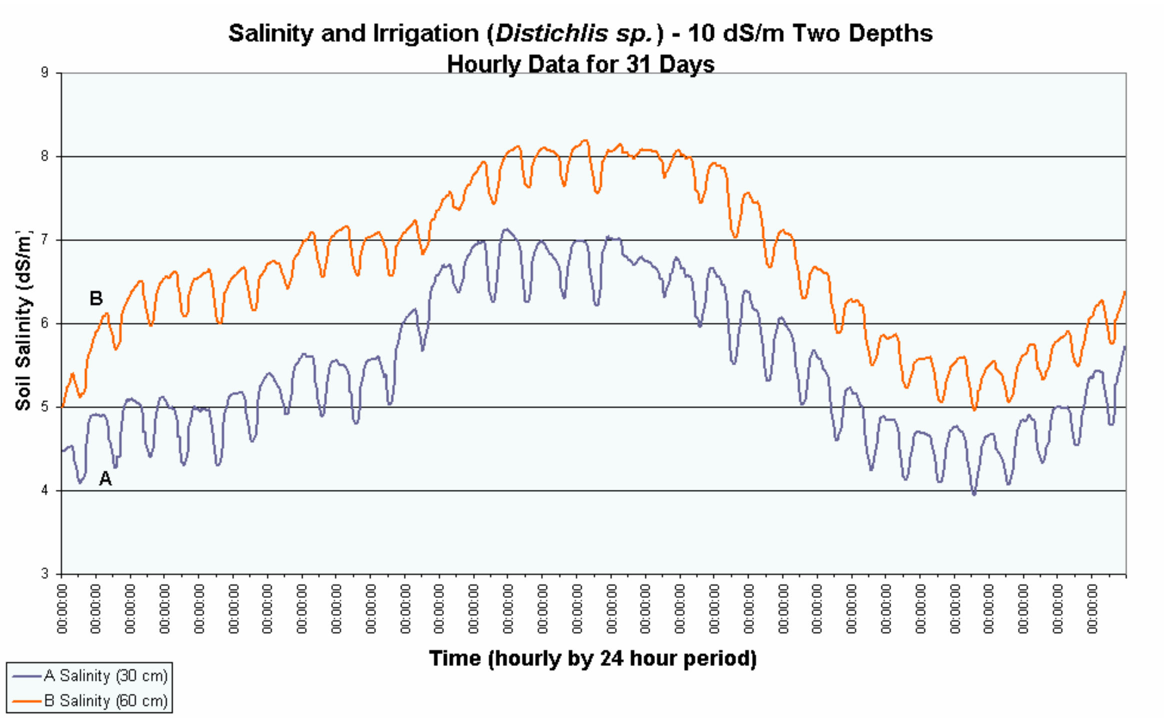
- Prior to field installation, the salinity sensors were soaked in a saline solution (1.3 dS/m) at 23ºC.
- This was done to remove air from the pores of the ceramic containing the electrolytic element of the sensors and to remove any excess salts that might be present.
- The graph shows “noise” in the first few hours of soaking as air is expelled from the sensors.
- Sensor readings then quickly stabilise.

Sensors After Installation



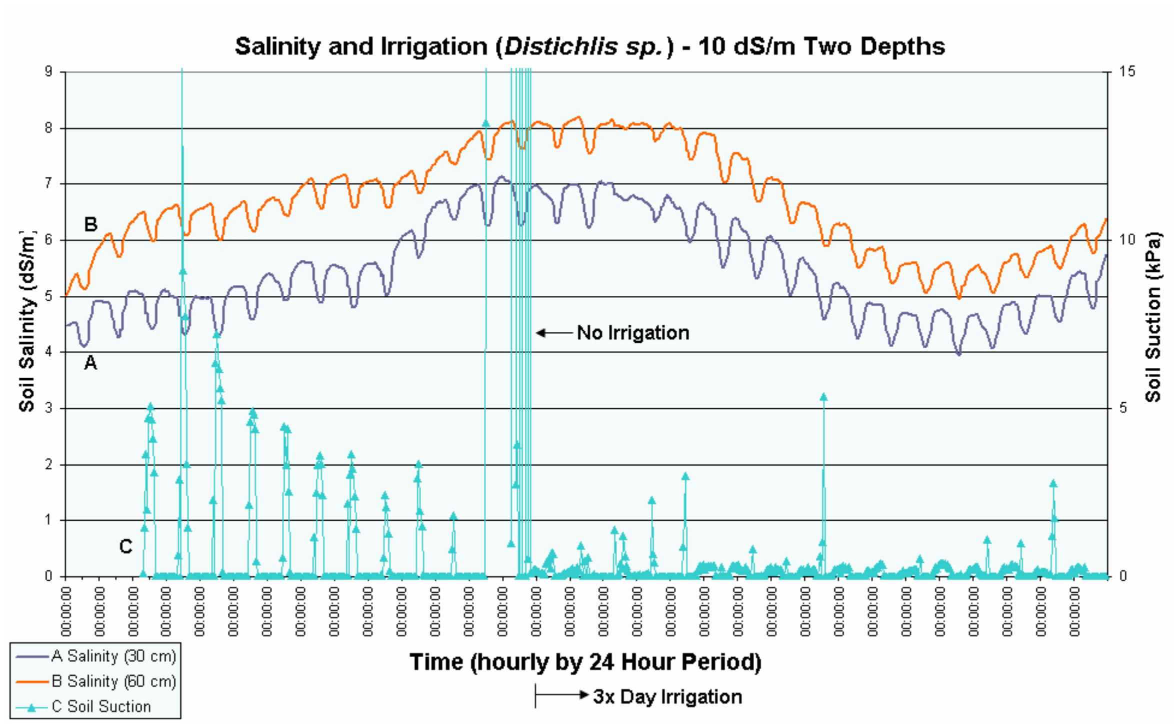
- After the initial installation in the field, the sensors may take up to 10 days to come to equilibrium with the soil solution.
- This is most apparent for the 30 dS/m treatment.

Salinity and Irrigation



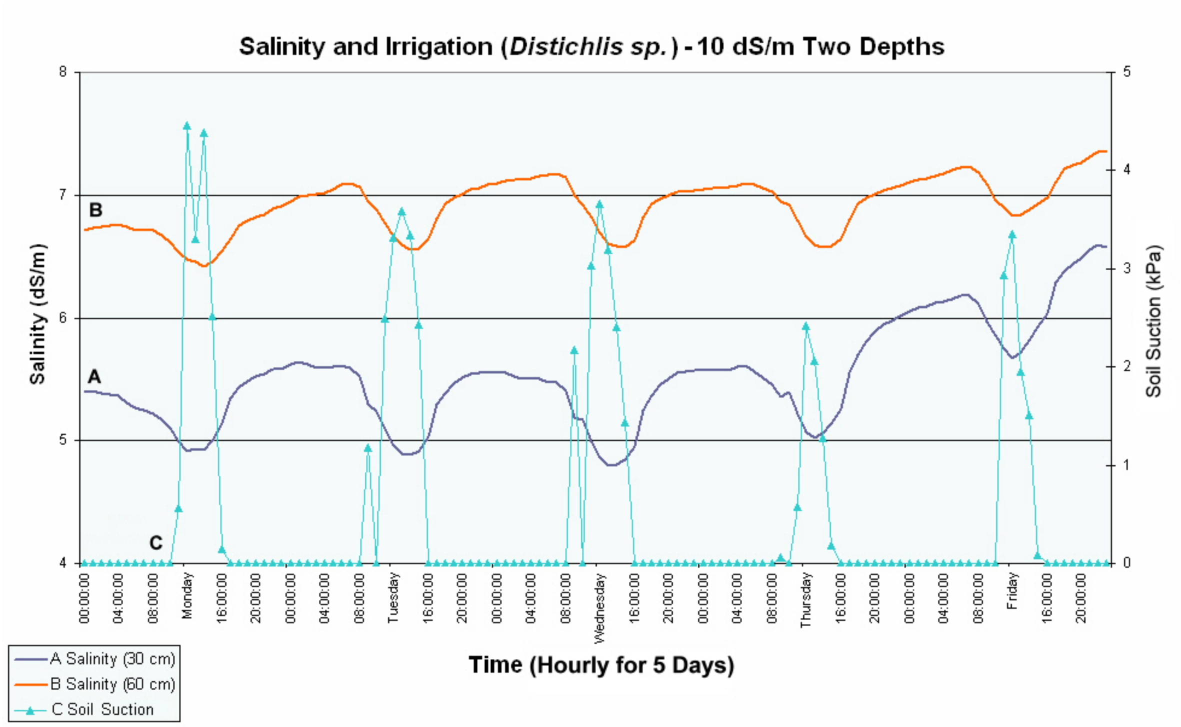
- Irrigation increases salinity due to the regular (2xdaily) addition of saline irrigation water.
- Diurnal salinity levels are related to diurnal soil moisture and vary with irrigation in this sandy soil.

Tensiometer and Irrigation



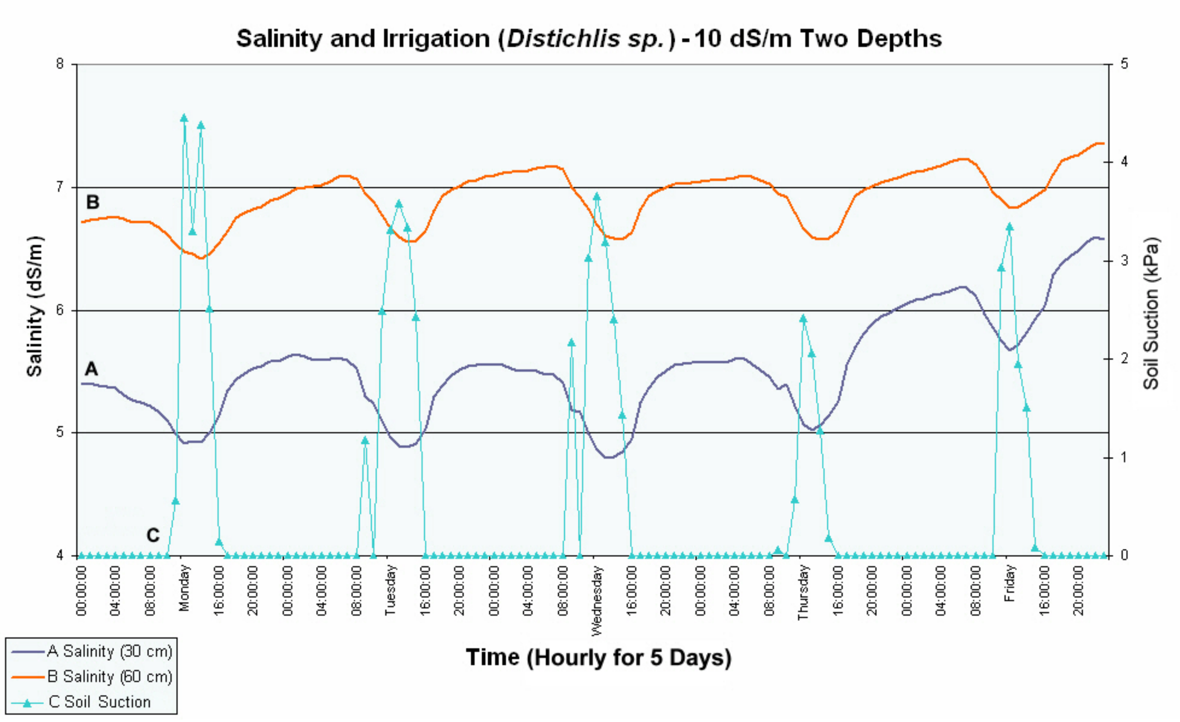
- Soil suction (monitored hourly) varies with irrigation.
- Irrigation decreases soil suction, tensiometer reading.
- When irrigation stops, soil suction increases.
- No irrigation over several days due to mowing & grass removal. Tensiometer values typically reached 60 kPa.
- 3 x daily irrigation commenced after mowing & soil suction constantly 0-1 kPa.

Tensiometer and Irrigation



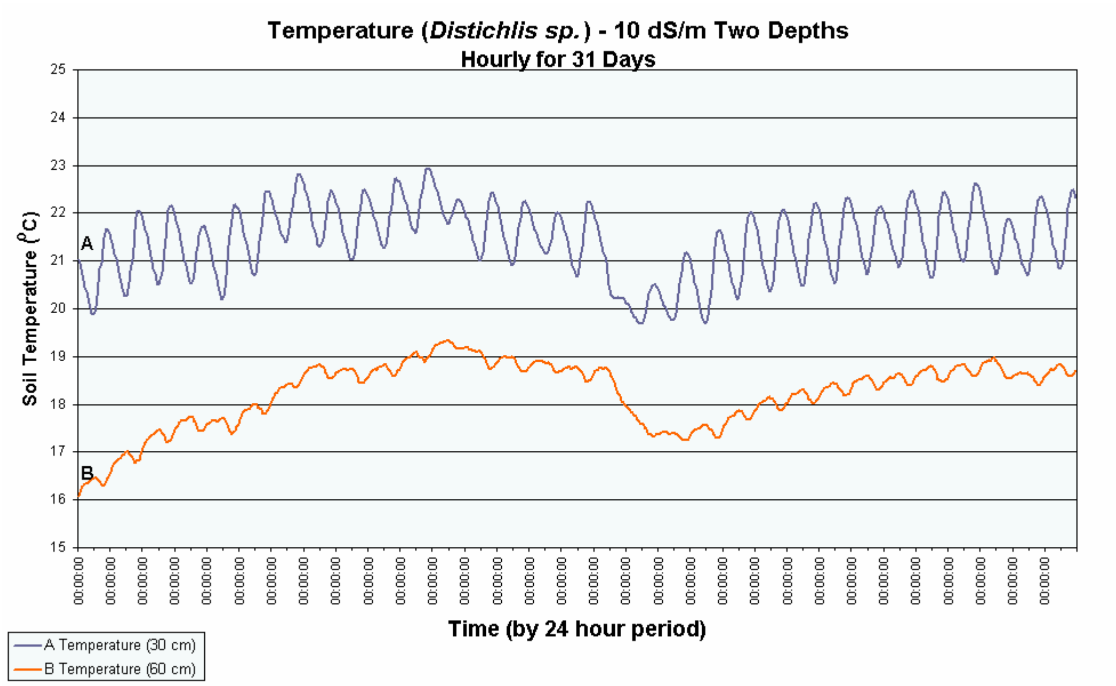
- Soil suction (tensiometer) varies with irrigation and soil moisture movements.
- Soil suction is 0 kPa from 1600 (4:00 pm) to 0800 (8:00 am) each day indicating that the soil is at field capacity overnight. Irrigation is applied at 1530 (3:30 pm)
- From 0800 each day, tensiometer suction increases as the soil dries from plant water use.
- Irrigation applied at 0930 and the tensiometer suction decreases to a minimum by 1000.
- Tensiometer readings sometimes reach 0 kPa at this time (1000) indicating that the soil is saturated.

Tensiometer and Irrigation



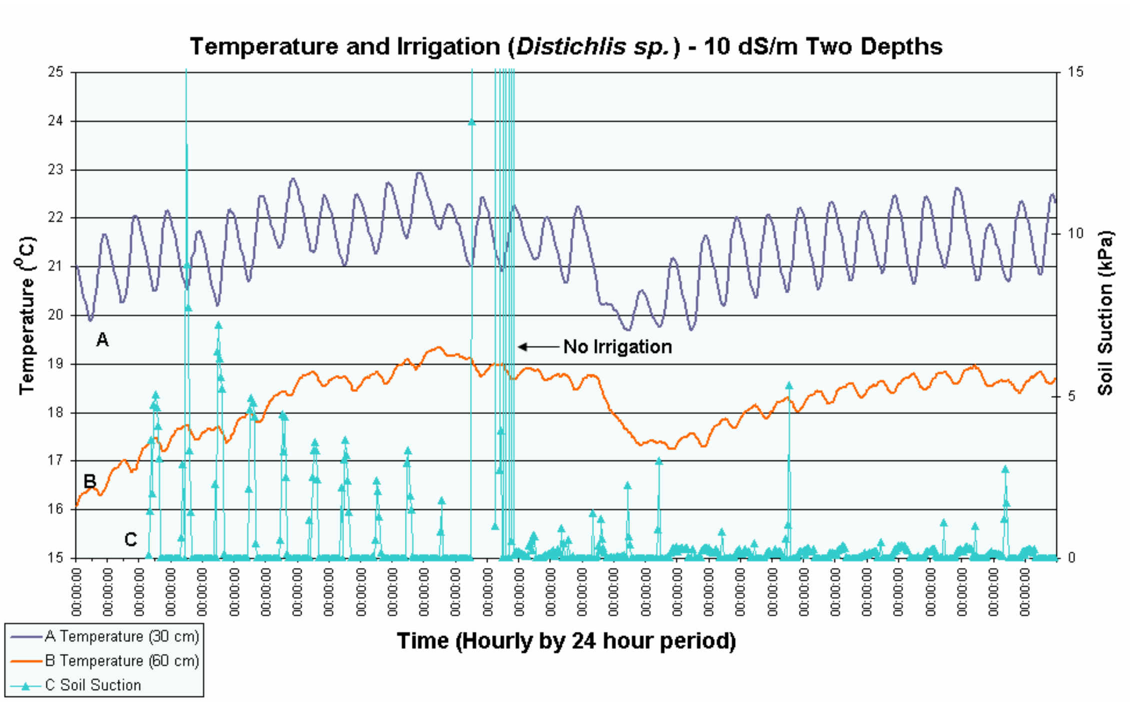
- Tensiometer suction increases, but doesn’t keep increasing when irrigation stops.
- Suction peaks around 1300 each day then decreases to 0 kPa by 1600 after irrigation at 1530.
- This decrease occurs as an upward moisture flux moves rapidly into the root zone, 30cm tensiometer.
- Soil suction of 3 to 4.5 kPa around 1300 each day is sufficient to form a gradient for water to flux upwards.
- Upward moisture flux is a result of plant water use and bare soil evaporation.
- Upward flux rate is at a greater rate than transpiration after 1300 each day.

Soil Temperature



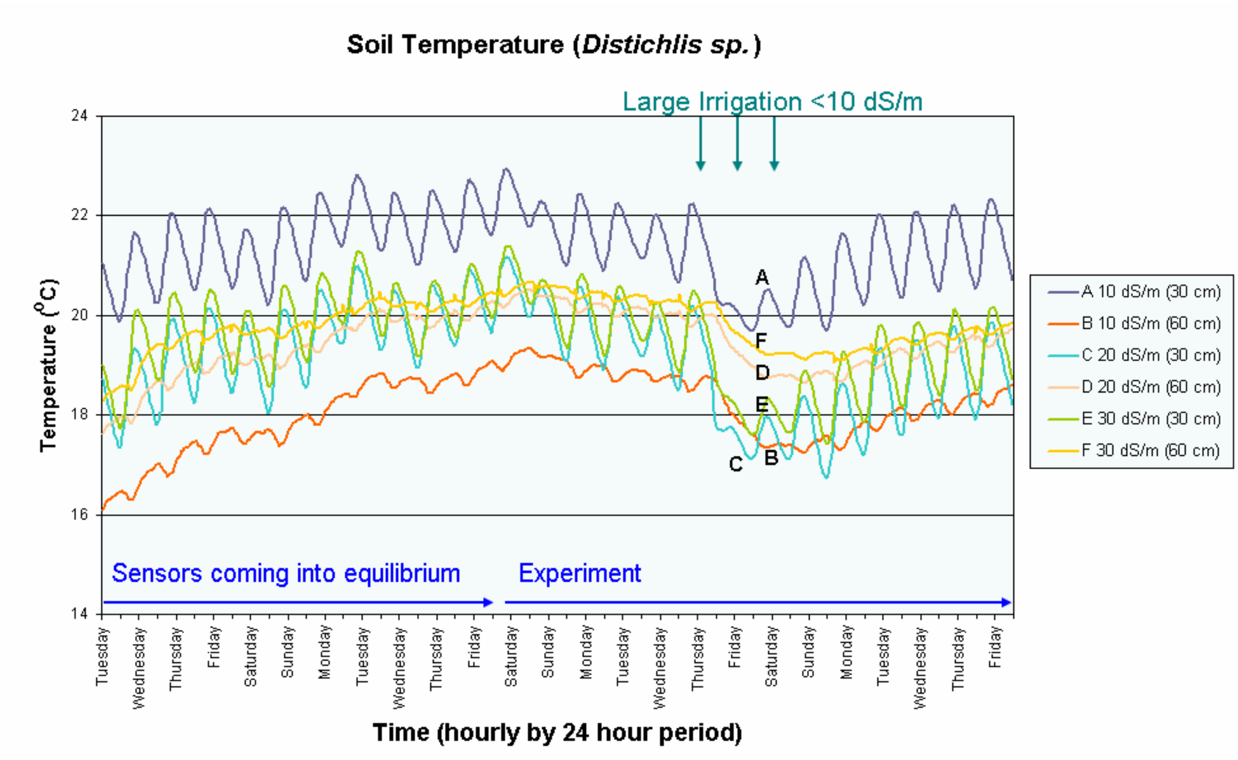
- Salinity sensors record soil temperature to enable correction and conversion of soil electrical conductivity to units of dS/m at 25ºC.
- Temperature at 30 cm depth shows diurnal pattern.
- Diurnal temperature pattern at 60 cm is not as great.

Soil Temperature and Tension



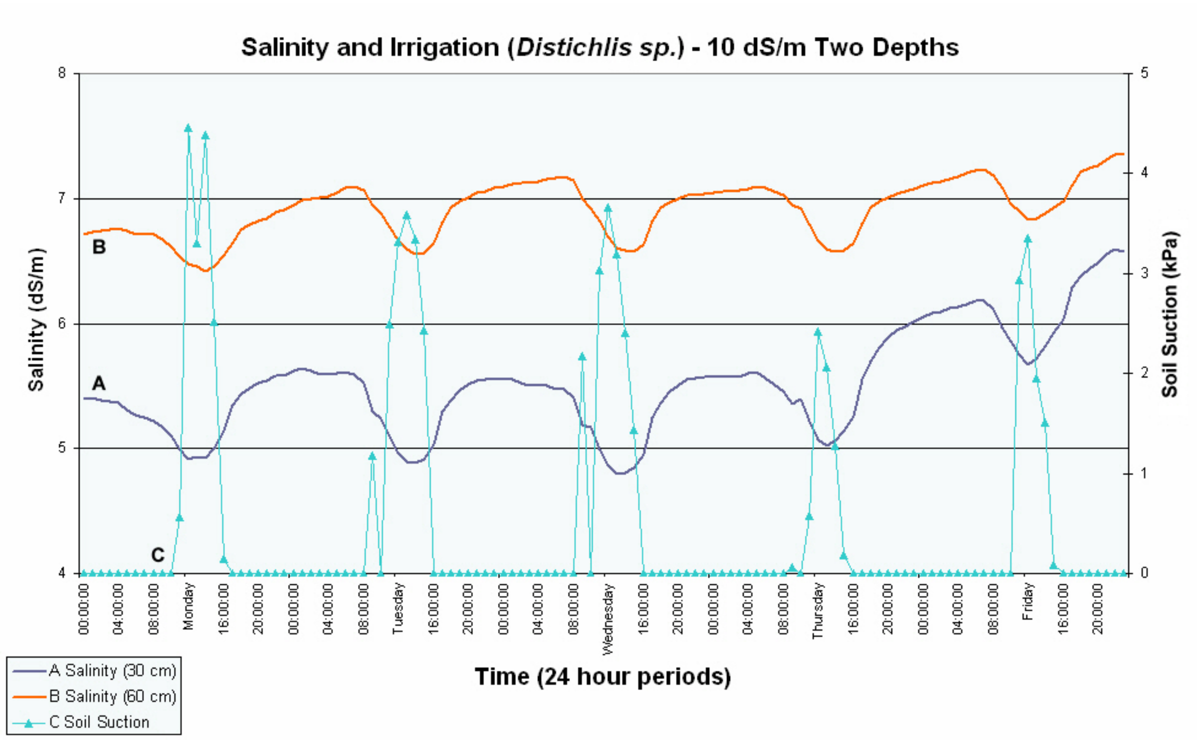
- Salinity sensors recording soil temperature can act as surrogate for a soil moisture sensors.
- Soil moisture sensors (tensiometers) were not routinely installed and hence temperature was also used as an indication of irrigation input.
- A sudden decrease in temperature can indicate an increase in soil moisture from irrigation.

Soil Temperature and Irrigation



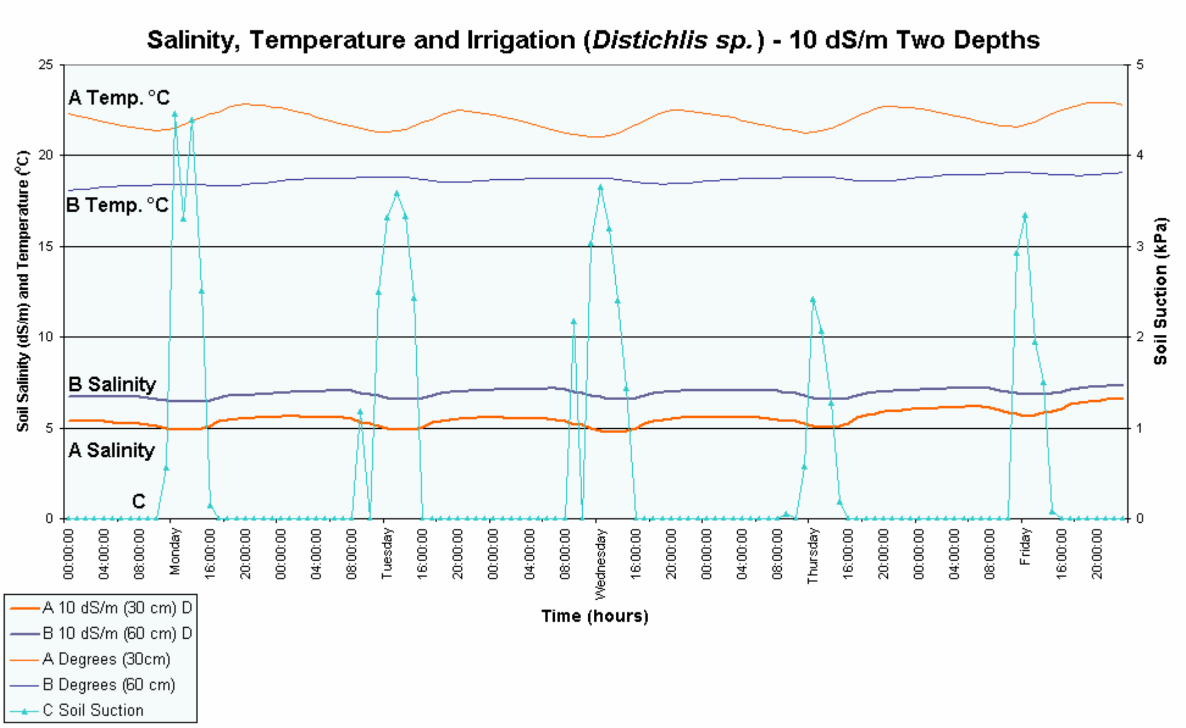
- Large irrigations with low salinity water (less than 10dS/m) occurred for 3 x days after mowing.
- Soil temperature falls with irrigation.
- After irrigation, soil temperature decreased at both 30 cm and 60 cm depths, indicating infiltration of irrigation water to 60 cm.
- Lower temperature B=10 dS/m (60 cm) is due to a perched water table from proximity of a drainage line.

Salinity and Irrigation



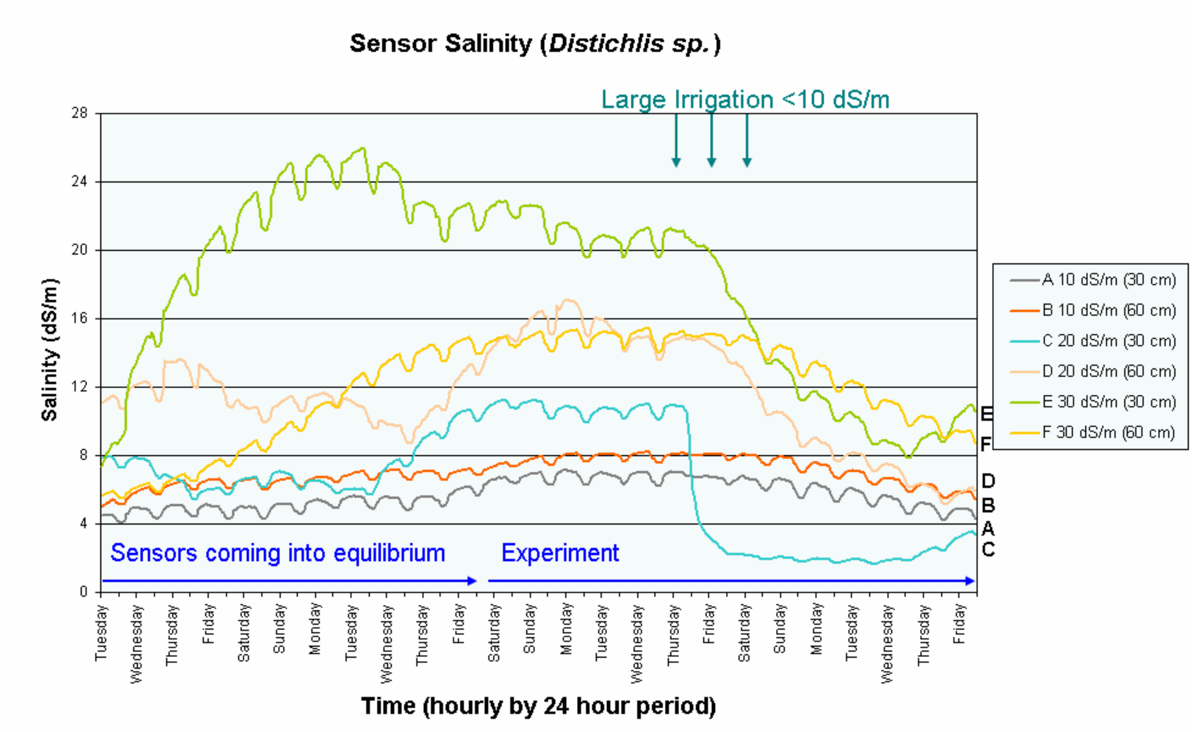
- Salinity levels demonstrate a diurnal pattern within longer term levels.
- Diurnal salinity levels decline as the soil moisture deficit increases.
- Tensiometers needed in 20 & 30dS/m treatments at both 30 & 60 cm to further detail upward flux and hence water & salt movement in the root zone & profile.

Salinity, Soil Temperature and Irrigation



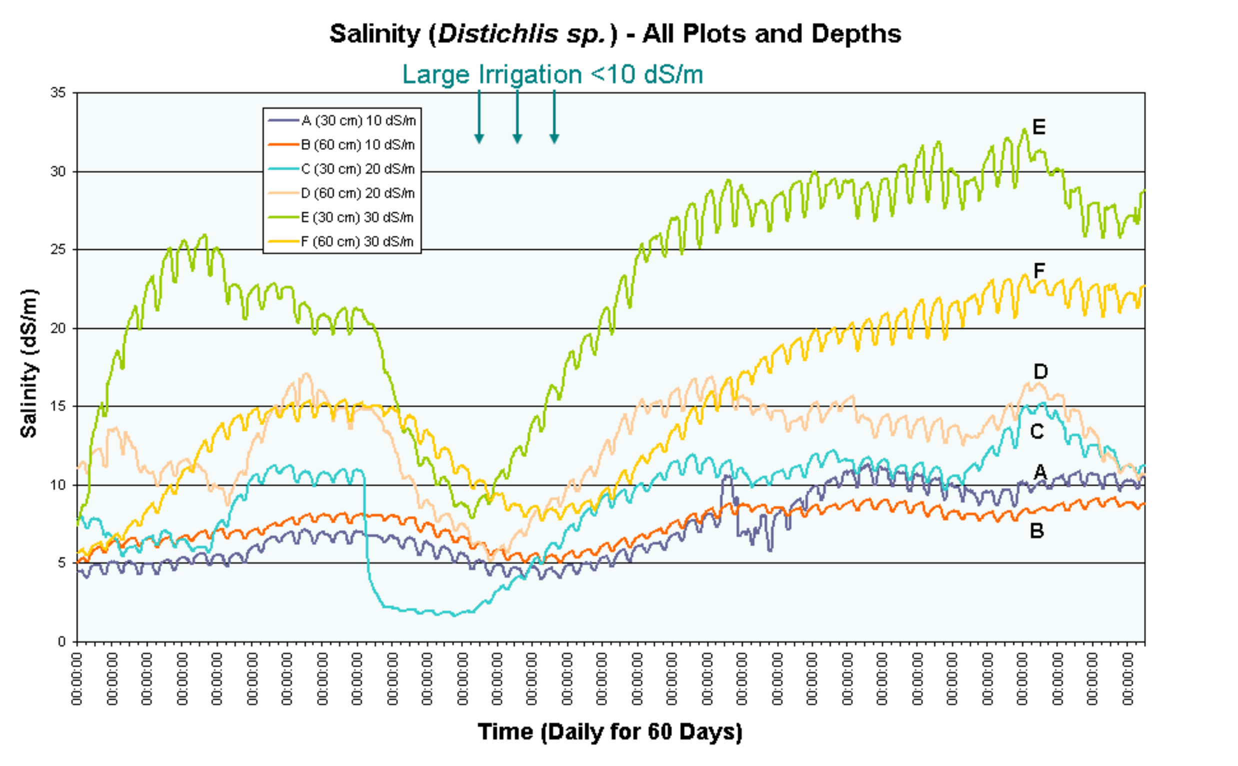
- Low salinity coincides with peaks of soil moisture deficit.
- As salinity is constant with changes in temperature, this cycling is a result of irrigation.
- Note: the sensor conductivity values are corrected to 25°C in the smart interface.

Salinity and Large Irrigations



- Large irrigations with low salinity water (<10dS/m) occurred for 3 x days following mowing. This reduced the salinity levels for all treatments.
- Low salinity irrigation treatment (10 dS/m) had the smallest reduction in salinity of 2-3 dS/m - remaining relatively stable at 6-8 dS/m.
- High salinity irrigation treatment (30 dS/m), was reduced by 12 dS/m from >20 dS/m to >8 dS/m over 7 days.
- Salinity increases once water from the large irrigation is leached. This was 7 days after irrigation.

Salinity Trends Over Time



- Graph shows 10, 20 and 30 dS/m treatments for 60 days with diurnal fluctuations in soil salinity.
- Salinity at 30 cm and 60 cm depth behaves similarly in each irrigation treatment.
- Increasing salinity trend over time after large irrigations with low salinity water (less than 10dS/m) occurred for 3 x days following mowing.
- Salinity levels 15-20 days after this are relatively stable and similar to the salinity concentration of the saline water applied in the irrigation.

Conclusion

- A greatly improved understanding of the dynamic behaviour of salinity of the soil solution was achieved.
- Irrigation time and amount can be adjusted to change salinity levels in the root zone.
- Irrigation influences salinity levels in the root zone.
- Irrigation scheduling and water saving opportunities are very clear. The salinity monitoring system is demonstrating that irrigation water in excess of crop water demand is being applied. This is shown by the constantly low suction (wet) tensiometer readings.