NSW GOVERNMENT Department of Primary Industries

primefact

Using capacitance probes for irrigation scheduling

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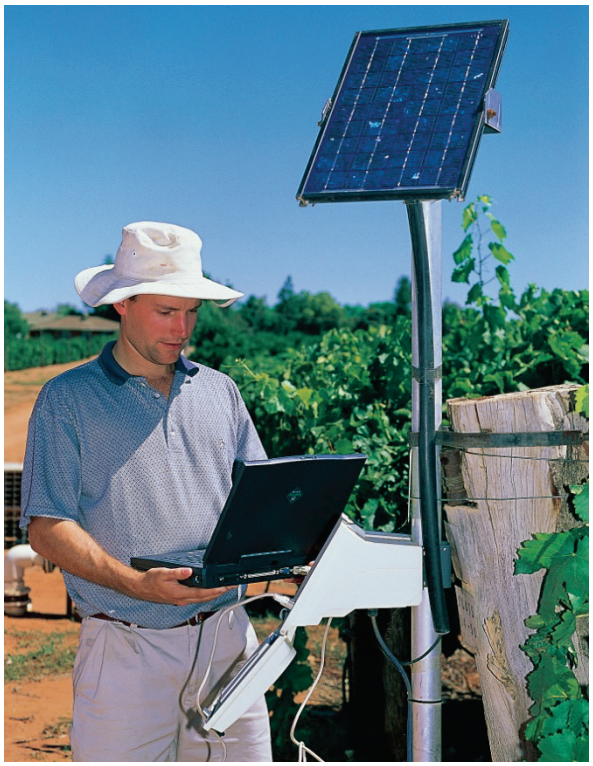
Agriculture NSW Water Unit

Soil moisture measurement indicates the water stress that a crop may be undergoing to irrigation managers. Volumetric measurements using capacitance probes have become popular as they tell managers the volume of water required to refill the soil profile (deficit) in an irrigation event. They are also able to provide information on rooting depth, saturation, full point, drainage and onset of stress. This Primefact addresses the in-field and agronomic issues related to capacitance probes.

Continuously logged capacitance probe

(For example Sentek range of EnviroSCAN® products, EnviroPro, AquaCheck®, AquaSpy®, Buddy)



These systems use capacitance sensors located within access tubes (generally PVC or ABS) installed at representative sites and depths for the duration of the irrigation season. Sensors use electrical capacitance to measure soil moisture, with a high frequency electrical field around each sensor passing through the access tube into the soil. Sensors are commonly spaced at depth intervals of 100 mm within the access tube, and are generally adjusted to suit the rooting depth of the crop. The sensors are traditionally connected to a central data logger by cabling or telemetry to record sensor readings at pre-determined time intervals. Modems connected to probes to send data direct to the internet are becoming more popular, avoiding the need for cabling and allowing multiple users to access data from multiple locations. Probes (examples listed above) are generally marketed as a package, incorporating various software, data logging and delivery methods. Numerous options and combinations are available.

Benefits

- Very sensitive to moisture change.
- Soil moisture content throughout the profile is estimated.
- Near continuous measurements are a key feature, often at intervals down to 1 minute.
- Soil moisture measurements from individual sensors within a probe (typically those within the rootzone) can be summed to provide a single total soil moisture line, which is easily interpreted by managers.

- Soil moisture is recorded automatically, reducing labour time required to manage irrigation.
- Soil moisture estimates are often provided in millimetres. If this is the case, and the probe is calibrated, readings can be used to accurately calculate crop water use, crop water productivity and drainage losses. Site calibrated probes installed using undisturbed methods provide scientifically credible volumetric moisture contents.
- Generally probes are not calibrated, so soil moisture trends over time are produced, (soil water dynamics) rather than absolute values. This is often considered to be the most valuable feature of data from capacitance probes, as soil water dynamics are used by irrigators for deciding both when and how much to apply.
- Infiltration rate, drainage, root activity, plant drought and waterlogging stress and crop water use are relatively easily interpreted from continuous data.
- Probes with additional nutrient, salinity and temperature options are becoming available.
- Various models are available for particular purposes, including submerged (turf), smaller, readily removable probes (annual crops), as well as sealed, non-serviceable probes with fixed sensor depths.

Limitations

- Capital costs can be significant depending on the system chosen and the number of probes required.
- Initial training and support is often required and recommended. Some time is needed (usually one season is sufficient) to fully understand and use the continuous soil water data to make informed irrigation management decisions.
- Ongoing maintenance is necessary.
- Precise installation is necessary with good contact between soil and access tube to ensure readings are representative, and to prevent the preferential pathflow of water along the length of the probe. The soil surrounding probes should be disturbed as little as possible. Slurry installations should be avoided wherever possible.
- Computer software is required for some probes to display data. New advancements in ‘cloud’ technology may avoid the need to install desktop computer hardware.
- Cables may be required throughout the property to connect probes to an automatic data logger, although new software and hardware options are overcoming this.
- The setting of full and refill lines are required at initial installation, and then adjusted from season to season, and often within seasons, depending on crop physiological changes such as canopy and rootzone development. It can take time in the first season to confidently determine these lines, which are unique for every site.
- Calibration requires considerable skill and may be a service provided from certain suppliers. Established calibration equations based on scientific studies, are available for particular products.
- If individual components fail within a sealed probe, they cannot be individually repaired and the whole probe must be replaced. Fully serviceable probes allow access into probes, and individual components can be repaired or replaced.
- Short term crops such as annual vegetables and ornamentals are generally less suited to these probes as paddocks are regularly rotated within crop cycles of less than 6 months.

Manually logged capacitance probe

(For example, Diviner 2000®, PR2 Profile Probe, Green Light Red Light, and Gopher)

These systems also use capacitance to determine the moisture content of the soil. Access tubes are installed for the duration of the irrigation season, with single or multiple sensors on a rod manually passed down the access tubes. Manual readings are taken at representative depths, which are recorded in a data logger and available on a field display unit or downloaded to a computer. At a minimum, readings should be taken before and after irrigation or rainfall events to determine water use trends.

Benefits

- Lower capital costs.
- Soil moisture profile data is available.
- Numerous sampling sites are possible for little extra cost.
- All depths can be measured at each reading.
- If soil moisture estimates are provided in millimetres, and if the probe is calibrated, readings can be used for deciding both when, and how much to apply.
- Easy to operate.
- Manual reading requirements encourage irrigators to regularly visit the crop, enabling further agronomic observations to occur.

Limitations

- Manual reading can be expensive with regard to labour inputs, time-consuming and inconvenient.
- Results are only available when readings are taken, which becomes less likely during busy production periods, unless a continuous logging option is available and utilised.
- Readings may not be taken frequently enough to establish water use trends, which are necessary in predicting future irrigation timing. This is particularly true in frequently irrigated situations such as drip irrigation or shallow rooted crops.
- Drainage volumes cannot be easily estimated, unless continuous logging option is used.
- Equipment tends to be fragile and therefore more likely to fail with continuous use.

More information

Primefact 1364 *Irrigation scheduling principles for horticultural crops*

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NSW Agriculture, 2002, Irrigation for Horticulture in the Mallee.

PROwater® Irrigation Training Series Module 9 ‘Scheduling irrigation’

Acknowledgments

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